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SEPTEMBER 1960

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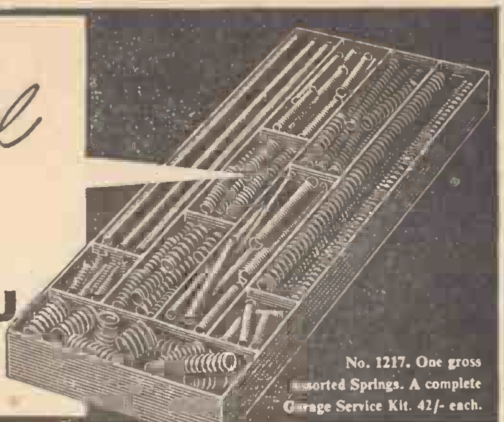
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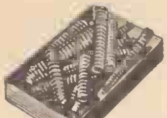
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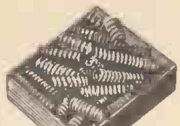
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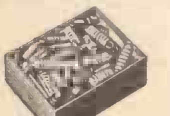
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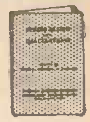
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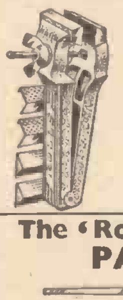

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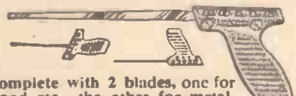

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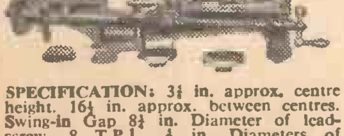

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Practical Mechanics

SEPTEMBER, 1960

Vol. XXVII No. 317

Editorial and Advertisement Offices
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CONTENTS:

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

THE NEW PRACTICAL MECHANICS

STARTING next month PRACTICAL MECHANICS will appear in an entirely new and improved form. For convenience in reading and handling and to meet certain production problems, the page size is being reduced to approximately the same as that of our companion Journals *Practical Wireless* and *Practical Television*. This smart new easy-to-read version will be further enhanced by the addition of more pages and a cover in full colour. The additional pages will include an increased variety of subject material as comprehensive and informative as before; indeed, by making greater use of short features, we hope it will be wider in its scope than at any time in the past.

A Free 3-in-1 Blueprint

Revolutionary as the new issue is, this is not the end of the good news for PRACTICAL MECHANICS readers. To mark the launching of the new modern PRACTICAL MECHANICS we are giving away a 12s. 6d. two-sided diagram sheet measuring 32in. × 24in. and containing diagrams relating not to one subject but to THREE!

The first of these subjects will appeal to the motorist and especially to the modern teenager who likes to carry his favourite " pop " records wherever he goes. It describes the construction of a battery-operated record player which will produce a really significant volume of sound when coupled up to the car battery. It is just the thing for a picnic or beach party. Those who spend their summer holidays in a beach chalet or caravan will appreciate this unique luxury. Incidentally we are also describing a battery/mains version.

The second subject on this sheet is a sailing canoe. This is a family craft; really solidly constructed and stable. It is simple to make, being well within the scope of anyone with average ability as a carpenter.

Subject number three is a synchronous skeleton electric clock. The chief feature of this design is its simplicity, most of the parts being available from an old disused clock and from a toy construction kit. Actual construction work is kept to a minimum and only a few handtools are required.

As mentioned previously all this detailed information, which would normally cost 12s. 6d. and which will be available at that price after the publication of the October issue, is being given away free to purchasers of the October number.

Following this announcement and considerable press publicity in the national newspapers, we anticipate a considerably increased demand for the issue and would take this opportunity of advising you to give your order to your newsagent early to avoid disappointment. The price of the new issue will be 1s. 6d.

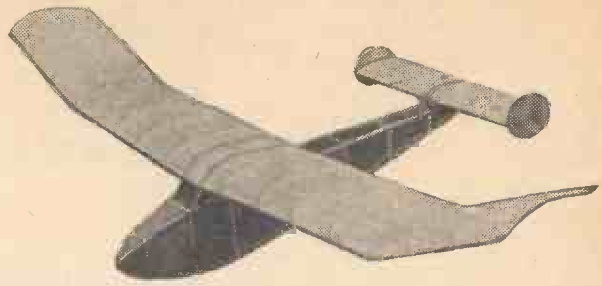
THE MAIN TASK OF JODRELL BANK

The radio telescope, with its supporting lattice work of steel must be familiar to almost everyone, due to the great prominence given to its role in tracking Sputniks and the American range of satellites, probes, etc. The importance of this task has not been exaggerated and we, the British people, are justly proud that both America and the U.S.S.R. have come to us for help in tracking their space vehicles. The prestige value of Jodrell Bank is the only credit Britain has in this great age of exploration and it comes as something as a surprise when one is told that tracking satellites is very much a secondary task of the telescope. In fact of the several thousand hours during which the radio telescope has been operating in the past three years, only 10 per cent. of the time has been devoted to satellite tracking.

It is ironic that so much publicity should have been given to aspects of the telescope's work which are subsidiary to its main purpose of pure research. The results of this fascinating study of the stars in limitless space (which are being observed, not as they are now but as they appeared many thousands of light years ago) have never been published in any newspaper—in fact they have yet to be published at all, even in the most technical of scientific journals!

The October, 1960, issue will be published on September 30th. Order it now!

Build this CONTEST MODEL GLIDER



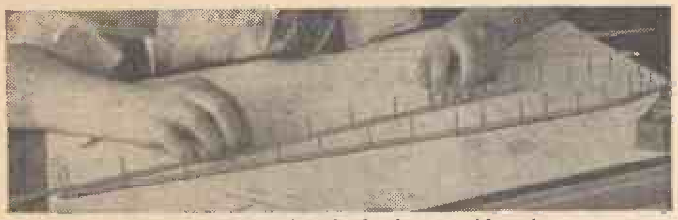


Fig. 1.—Positioning the fuselage outside strips.

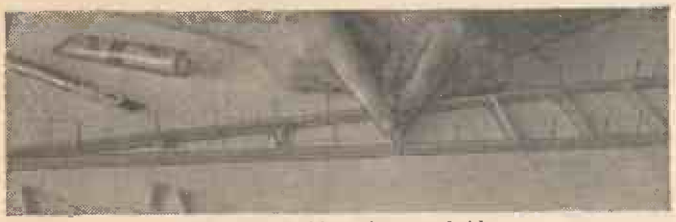


Fig. 2.—Building the second side.

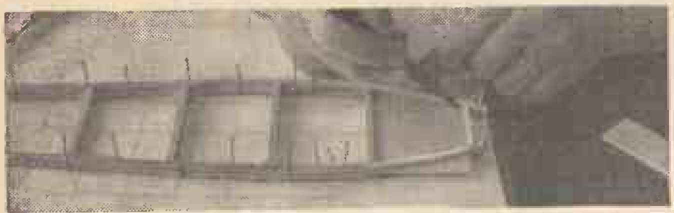


Fig. 3.—Marking out the nose panels.

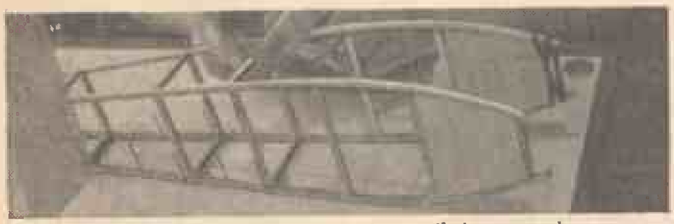


Fig. 4.—Spring the frames together until the cement has set.

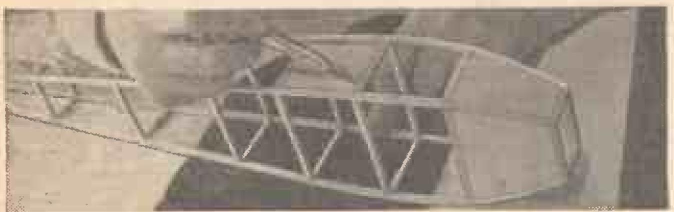


Fig. 5.—Cutting wing support slots.

Fig. 6.—Fixing the tailplane support.

Fig. 7.—Covering the fuselage.

Building is simplicity itself if you follow our step by step instructions

QUITE apart from the fascination of making this type of model, flying the finished aircraft will give hours of enjoyment. It has been so designed that when it is launched from a long nylon tow-line it will take advantage of rising currents of warm air (" thermals " to use gliding jargon) and fly for several minutes in soaring flight. In fact it is an excellent model for entry in many national model flying rallies organised up and down the country during the spring and summer months.

Scaling up Drawing

First draw out full size the shape of the fuselage in side view and top view (see Fig. 10). Draw accurate 1in. squares on a piece of cartridge paper or buy a large piece of graph paper which is already divided. Pin this down to a flat board and plot the outside shape of the fuselage side view and top view, using the squared drawing opposite as a guide. Mark the points where the fuselage curves (which are the same on each side and top and bottom) cut the vertical and horizontal lines of the various squares. Join up the points with a smooth continuous line, using a piece of springy wood. Mark the thickness of the fuselage outside strips (⅛in.) and draw in the lines. Follow this by drawing vertical parallel lines ⅛in. apart to represent the spacers positioned as indicated. At the junction of spacers with outside strips rub the drawing with a candle to prevent the eventual cement joints from tearing the paper.

Building the Fuselage

At alternate intervals of about 1½in. push straight pins into the lines representing the fuselage outside strips, and between them slide strips of ⅛in. square hard balsa (Fig. 1). Now cut off the various spacers to length and at the correct angles at their ends, and fix them in place with balsa cement.

Build a second side in exactly the same way directly on top of the first but place pieces of wax paper between the two frames (Fig. 2). Cut protruding ends and separate the frames. Mark shape of nose panels (Fig. 3) on ⅛in. sheet balsa, cut them out and cement in place flush with the *outsides* of the frames.

Fix pins on *top view* as before but only on the straight portions—not on the curves and erect the two side frames between them. Working from the back, cement the cross braces in place in pairs and make sure the structure is kept square with a setsquare.

At the point where the frames begin to curve, remove the frames and cement the remaining nose spacers (which are cut in pairs directly over the drawing to ascertain correct lengths and angles of ends) by springing the frames together at the nose until the cement has set (Fig. 4). Then fill in the top and bottom nose panel with ⅛in. sheet.

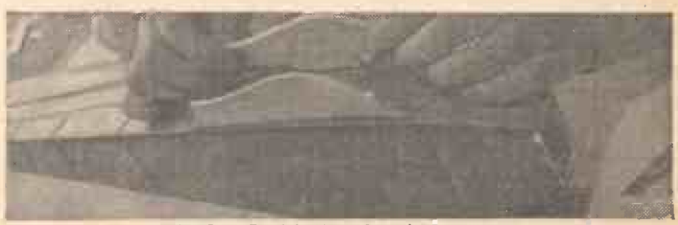


Fig. 8.—Positioning the wing supports.

Fig. 9.—Trimming the nose block.

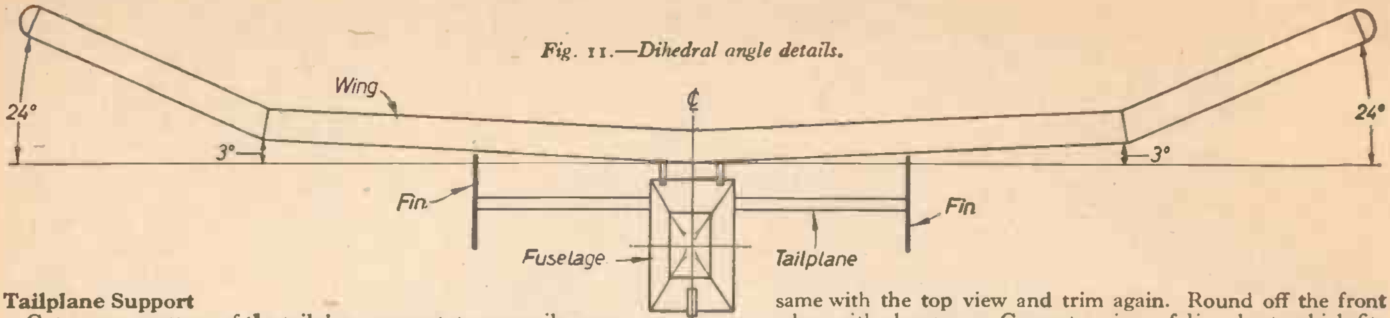


Fig. 11.—Dihedral angle details.

Tailplane Support

Cut a paper pattern of the tailplane support, temporarily gum it to a piece of hard 1/8in. sheet balsa and cut the shape out. Remove paper and round off the front and rear edges with fine glasspaper. Glue the two small pegs in place as shown. Cut out the millimeter plywood platform and cement this to the support at right angles as shown. Use plenty of cement to form a fillet at each side. Cement the unit to the body between the rear two spacers of the fuselage and make sure it is upright. Then fill in with 1/16 in. sheet at the sides of the support (Fig. 6).

The two wing supports fit in slots in sheeting cemented flush with the frame at the top of the fuselage. Fix a single piece of 1/8in. sheet (Fig. 5) and then cut the two slots with a trimming knife.

Covering the Fuselage

Four separate pieces of fine model tissue are used—one for each side. Fix each piece in place with photo-mounting paste, starting at the front and working a few inches at a time towards the back (Fig. 7). Trim the surplus away with a razor blade after each side is covered. When the paste is thoroughly set, spray the tissue evenly with cold water. Do this with a garden syringe held about 1ft. away. Leave to dry in a fairly warm atmosphere. After the tissue has shrunk and become taut, apply two coats of clear cellulose model dope or banana oil.

Cut and cement in place the wing supports in the same way as the tailplane support (Fig. 8).

Nose Block

Cut a pattern of the side view of the nose block and gum this to a laminated block of balsa consisting of sheets of 1/8in. balsa cemented together with the grains crossing (Fig. 9). Trim to shape. Do the same with the top view and trim again. Round off the front edges with glasspaper. Cement a piece of 1/8in. sheet, which fits neatly in the opening in the nose of the fuselage, to the back of the block which serves to locate the block in the fuselage.

The Wing

The shape of the wing ribs is shown in Fig. 10 half full size. Scale this drawing up and then cut out and shape all wing ribs from 1/16in. sheet balsa. Cut the trailing edge pieces from 3/8in. × 1/8in. balsa. At 2in. intervals on the trailing edge mark and cut slots 1/16in. × 1/8in. for the ribs. Pin the trailing edge down to the building board and glue the ribs in place, making sure that they are all square with the exception of the inner and outer ribs.

The leading edge pieces are cut from 1/4in. × 1/8in. strip balsa and glued in place. Do not glue the inner and outer ribs yet. Make up two templates, one angled at 3 deg. and the other at 10½ deg. Cut from 1mm. plywood 15 dihedral keepers (see Fig. 10). These should be glued in place as shown. Glue the upper spars in place—each spar to be a little oversize. Glue the inner ribs, checking with the 3 deg. template. Make sure that these ribs are square with the trailing edge. Insert the top three dihedral keepers and glue together with spars. The outer ribs of the centre section should now be glued in place using the same procedure as for the inner ribs. Check with the 10½ deg. template.

Remove the wing from the building board, turn it over and glue the two lower spars in place together with the dihedral keepers.

The two centre sections can now be glued together. Lay one half flat on the building board and jig at 6 deg. The correct dihedral is shown in Fig. 11.

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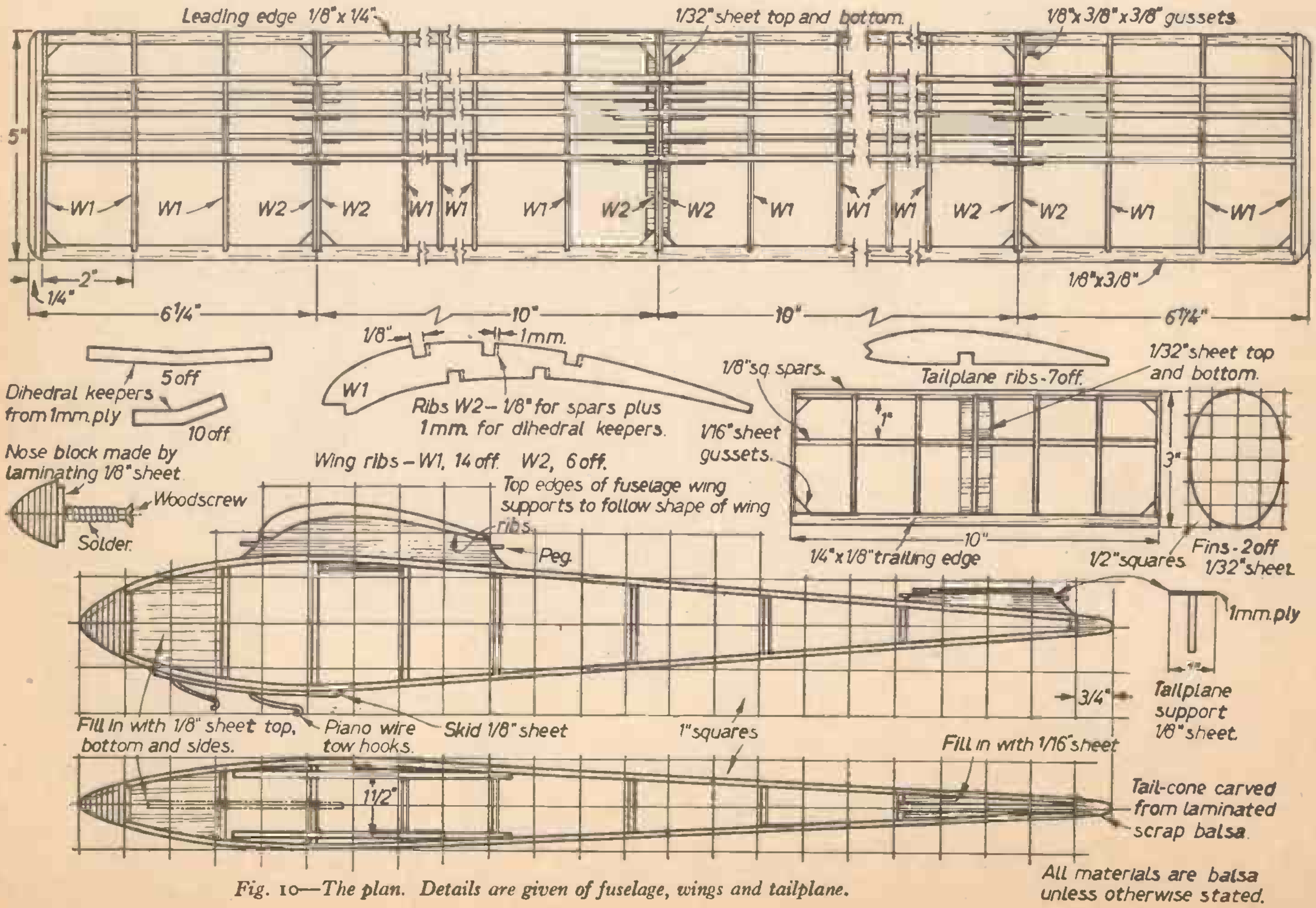


Fig. 10—The plan. Details are given of fuselage, wings and tailplane.

FOR those readers who possess a centre lathe and wish to undertake the construction of a piece of equipment which will eventually prove of considerable use in the workshop or garage, the spray gun illustrated at Fig. 1 and Fig. 6 is not a difficult article to undertake, and if the main parts are machined from aluminium as a means of promoting a light assembly, with various bushes at the positions where wear is likely to occur, there is every reason to anticipate the gun will give long and trouble-free service.

A Spray Gun

Fig. 1.—The finished gun in use.

A useful accessory for the workshop or garage

By J. A. Waller

The design follows orthodox lines, but it is emphasised that too large a tank capacity obviously causes fatigue on the wrist and soon makes the work of spraying a large object a tiresome operation. The paint tank portrayed here is about the largest which can be comfortably handled, and will cover a considerable area of a car wing that may have been damaged.

The following detailed drawings show sizes which the reader can initially use for making the parts, but once they are made it should be appreciated that some further weight is easily taken off the gun by filing, grinding or milling away unwanted areas where the metal is still a little too thick for the work the assembly has to do. There is no point in complicating the drawings at this stage by giving cross sections where this metal removal can occur as this gives the impression the gun is much more difficult to make than it really is, and an actual examination of a finished product will show how much and where the metal is best removed.

Main Body

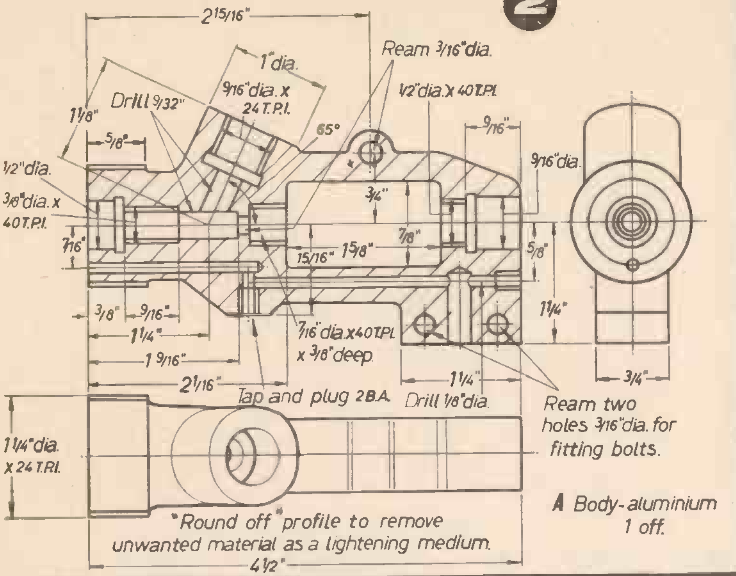
Fig. 2 portrays the main body—a large piece of circular aluminium or a length from a rectangular bar is suitable because if a casting is preferred then the complete gun with the handle should be made in this manner. Using bar material reduces costs and means that every reader can undertake the construction with average tools. The first operation is to clean up one surface and then machine another perfectly square to this facing—this is an important and essential process because it then permits the machining of other faces and holes in relation to each other with the assurance that accuracy between them is achieved.

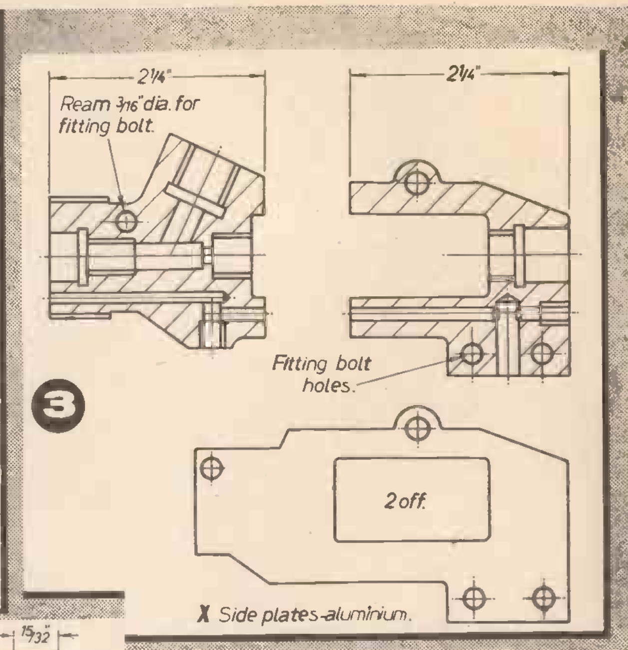
One difficulty arises during the boring of the holes in this body member—the inside threaded hole is likely to provide an awkward operation if screwcutting is attempted as the overhang of the tool is so great, and special long taps are needed if this process is followed. While the latter tools are not difficult to make (shanks are brazed on existing standard taps), it is felt that an alternative method of manufacture whereby the body is made in two parts, effects a solution and one which most constructors will prefer. The next drawing at Fig. 3 illustrates how the body becomes a two-part detail with side plates and fitting bolts provided to align the pieces when they are assembled together. Remember the two sections are square formed, the centre clearing hole cut and then both are held together while the holes for the bolts are drilled and reamed. Both ends are now threaded—the two-part detail is now virtually a solid block while this operation is proceeding, and then having removed the side plates and bolts to free them, the final operation of threading the inner hole is undertaken with the assurance that on re-assembly the blocks and plates will yet again assemble correctly.

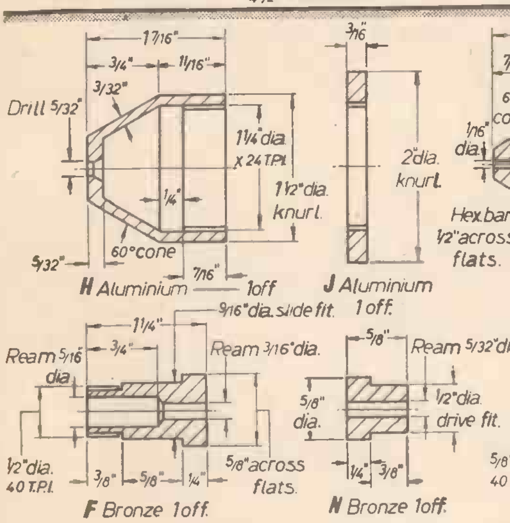
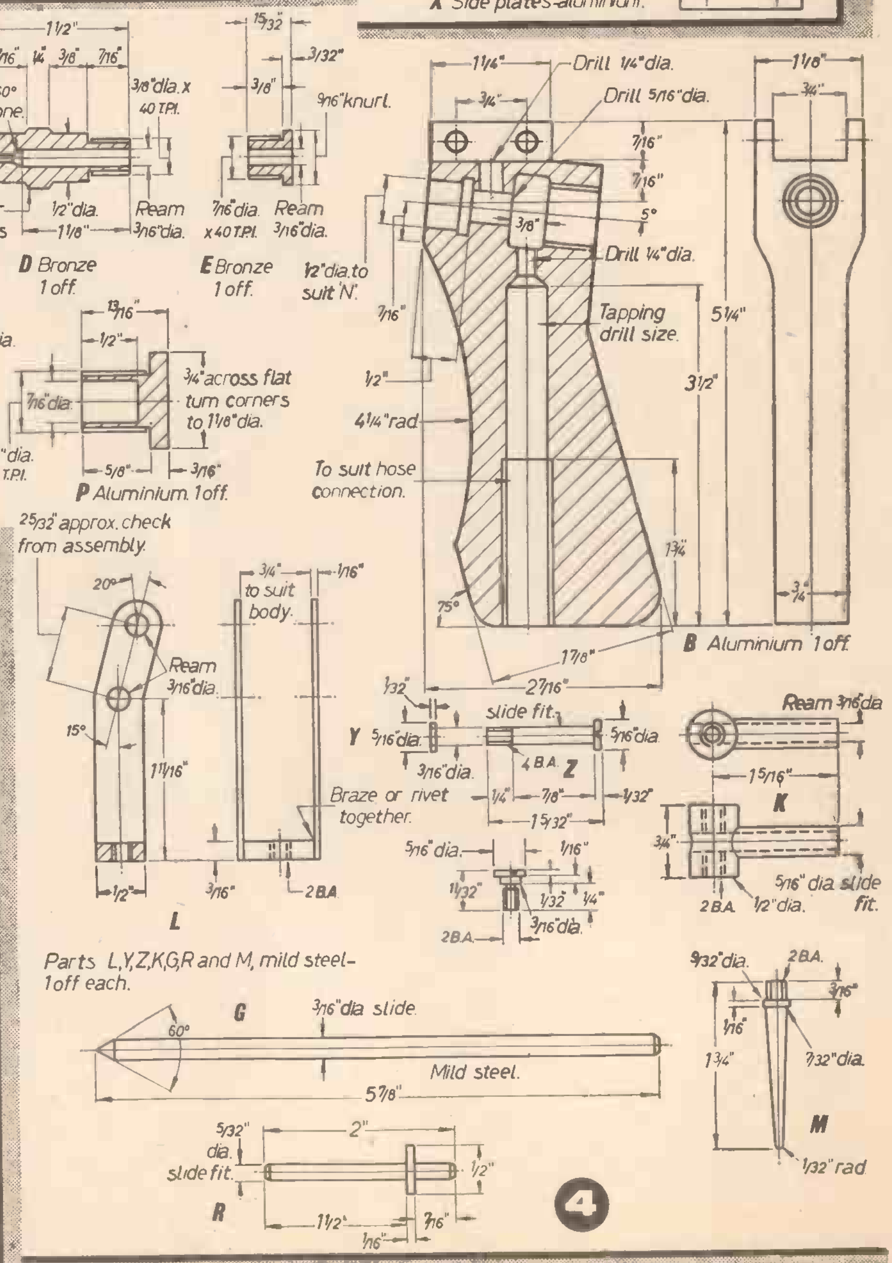
In order to ensure that the needle slides properly and without any suggestion of stickiness, both the front jet " D " and the rear needle pilot " F " are turned with a register that fits closely into a corresponding recess in the body detail. If these latter diameters are used as locations during later machining operations—the threading of the inner diameter mentioned above is a typical instance where correct alignment is necessary to make sure the needle operates easily, the parts will subsequently assemble and there is no suggestion of mis-alignment.

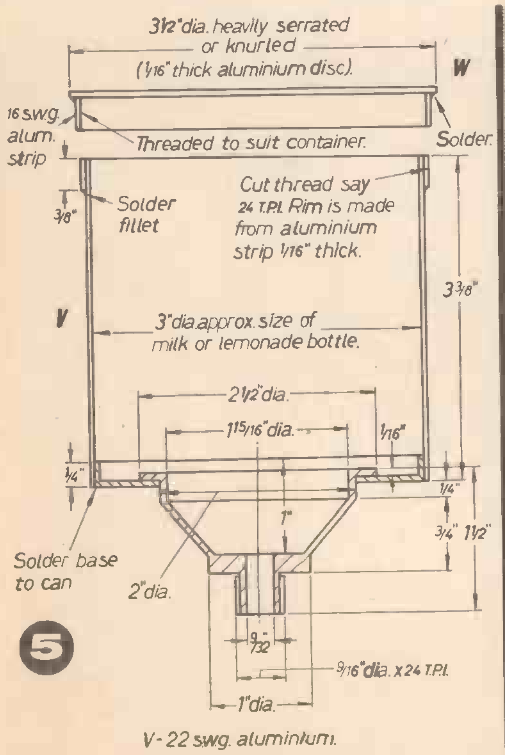
Air Hole

The long 1/8in. dia. holes which bring the air from the handle to the nozzle require careful drilling as any attempt to rush this work usually results in a hole running off centre; if they do


2
2 15/16"
1" dia.
Ream 3/16" dia.
9/16" dia. x 24 T.P.I.
1/2" dia. x 40 T.P.I.
Drill 9/32"
1 1/8"
5/8"
65°
9/16"
9/16" dia.
1/2" dia.
3/8" dia. x 40 T.P.I.
3/4"
7/16"
7/8"
15/16"
1 5/8"
5/8"
3/8"
9/16"
1 1/4"
1 1/4"
1 9/16"
7/16" dia. x 40 T.P.I. x 3/8" deep
2 1/16"
Tap and plug 2 B.A.
Drill 1/8" dia.
1 1/4"
3/4"
Ream two holes 3/16" dia. for fitting bolts.
1 1/4" dia. x 24 T.P.I.
"Round off" profile to remove unwanted material as a lightening medium.
4 1/2"
A Body-aluminium 1 off.


2 1/4"
2 1/4"
Ream 3/16" dia. for fitting bolt.
Fitting bolt holes.
3
2 off.
X Side plates-aluminium.



1 7/16"
3/4"
11/16"
3/32"
Drill 5/32"
1 1/4" dia x 24 T.P.I.
1 1/2" dia. knurl.
1/4"
60° cone
5/32"
7/16"
H Aluminium 1 off
3/16"
2" dia. knurl.
J Aluminium 1 off.
1 1/2"
7/16"
1/4"
3/8"
7/16"
60° cone.
1/16" dia.
3/8" dia. x 40 T.P.I.
Hex bar 1/2" across flats.
1/2" dia.
1 1/8"
Ream 3/16" dia.
D Bronze 1 off.
15/32"
3/32"
3/8"
9/16" knurl.
7/16" dia. x 40 T.P.I.
Ream 3/16" dia.
E Bronze 1 off.
1 1/4"
9/16" dia. slide fit.
Ream 5/16" dia.
3/4"
Ream 3/16" dia.
1/2" dia. 40 T.P.I.
3/8"
5/8"
1/4"
5/8" across flats.
F Bronze 1 off.
5/8"
Ream 5/32" dia.
5/8" dia.
1/2" dia. drive fit.
1/4"
3/8"
N Bronze 1 off.
13/16"
1/2"
7/16" dia.
3/4" across flat turn corners to 1 1/8" dia.
5/8" dia. 40 T.P.I.
5/8"
3/16"
P Aluminium. 1 off.
1 1/4"
Drill 1/4" dia.
3/4"
Drill 5/16" dia.
7/16"
7/16"
5°
3/8"
Drill 1/4" dia.
1/2" dia. to suit 'N'.
7/16"
Tapping drill size.
1/2"
4 1/4" rad.
To suit hose connection.
5 1/4"
3 1/2"
1 3/4"
75°
1 7/8"
2 7/16"
1 1/8"
3/4"
3/4"
B Aluminium 1 off.
25/32" approx. check from assembly.
20°
Ream 3/16" dia.
15°
1 11/16"
1/2"
3/4" to suit body.
1/16"
3/16"
2 B.A.
L
Braze or rivet together.
1/32"
slide fit.
Y 5/16" dia.
5/16" dia.
3/16" dia.
4 B.A. Z
1/4"
7/8"
1/32"
1 5/32"
5/16" dia.
1/16"
11/32"
1/32"
1/4"
3/16" dia.
2 B.A.
Ream 3/16" dia
15/16"
K
3/4"
2 B.A.
1/2" dia.
5/16" dia. slide fit.
Parts L, Y, Z, K, G, R and M, mild steel- 1 off each.
G
3/16" dia. slide.
60°
Mild steel.
5 7/8"
9/32" dia.
2 B.A.
3/16"
1/16"
1 3/4"
7/32" dia.
M
1/32" rad
5/32" dia. slide fit.
2"
1/2"
R
1 1/2"
7/16"
1/16"
4


3 1/2" dia. heavily serrated or knurled (1/16" thick aluminium disc).
W
16 s.w.g. alum. strip
Threaded to suit container.
Solder.
3/8"
Solder fillet
Cut thread say 24 T.P.I. Rim is made from aluminium strip 1/16" thick.
3 3/8"
V
3" dia. approx. size of milk or lemonade bottle.
2 1/2" dia.
1 15/16" dia.
1/16"
1/4"
1/4"
1"
3/4"
1 1/2"
Solder base to can
2" dia.
9/32"
9/16" dia. x 24 T.P.I.
1" dia.
5
V-22 s.w.g. aluminium.

not meet the vertical drilling or only half a hole is apparent when the break through comes, obviously there is a severe restriction in the air supply thus creating a situation which is difficult if not impossible to remedy satisfactorily.

Drill through the aluminium slowly running the lathe at the fastest speed, taking care to withdraw the drill after piercing the work for an ⅛in. or so and then both holes will intersect the vertical hole exactly on the centre line. Drill this vertical hole first of course.

The hole into which the paint container screws is initially marked out in order to bring it in the centre of the boss, and the lower hole through which the paint emerges should break into the centre bore if a reasonable degree of accuracy has been observed during the marking out stage.

Another hole which requires reaming is the linkage pin hole about which the link "K" pivots—again an easy fit is desirable otherwise the gun will need considerable effort to operate, but a slack fit is best avoided as this gives the assembly a ramshackle appearance. Incidentally when operating on aluminium you will find that a touch of paraffin produces an excellent finish to the surfaces and for such operations as reaming it is essential to use it.

The Handle

Fig. 4 portrays detailed drawings of the remaining parts, chief among them being the large handle "B" which is again made of aluminium if it is available. This is an ideal detail where a reduction in weight is not difficult to accomplish by drilling a series of holes into the butt for a certain depth but not, of course, breaking into the air inlet hole.

In making this handle the best procedure is to square form the block of material disregarding the shape of the handgrip as this is easily added after the major operation of boring the inlet hole at the top and adding the fitting bolt holes has been carried out. The spring plunger bore is not of great importance on this occasion as this detail is merely used, as the assembly drawing indicates, to return the trigger mechanism to the starting position, but it is advisable to machine the surface against which the washer "T" contacts carefully as this overcomes an escape of air at this point. While the latter is not particularly serious, it does in time cause annoyance to hear air continually escaping despite the fact it only makes a gentle hiss. However as this plunger is not so important as the long detail "G," no attempt has been made to provide the glands with location diameters, but it should slide back and forth with ease. Cut the threads in the lathe using one as a pilot while machining the other, then true insertion of the glands is possible.

Glands and Jet

The best material for the glands and jet—details "D," "E," "G," "N" and "P" is phosphor bronze as the wearing qualities of this metal result in long life. There is really little wear on parts of this nature other than the slight tendency of the hole to become oversize, so a set of parts made from this bronze should last several years with average use. The importance of drilling the jet hole concentric with the pilot diameter cannot be overstressed as a drilling offset can cause trouble. Here again, the hole is preferably drilled after the larger diameter has been turned, and continued withdrawal of the drill will prevent it running off centre.

The Tank

The construction of the tank may present a problem to some readers as they will undoubtedly find it almost impossible to secure a piece of aluminium tube as large as this. Aluminium is specified for obvious reasons, but there is no reason to despair because rolling up a flat piece of this material approximately of the same thickness is not a difficult task, as the metal bends easily. For a former round which to bend the sheet, use a beer or lemonade bottle—the actual diameter does not matter, but remember to calculate the required length of strip, multiply the diameter of the bottle by 3·14. Add an ⅛in. for overlap and solder both ends together. The joint is eased away by a file until the surfaces blend, and you can add the bottom end cap by simply knocking over the edge of a circular disc to fit tightly on to the tank. The former for this cap is turned up from a piece of timber—hard wood for preference, which is made the same diameter as the outside diameter of the the tank. If the operation is carefully done and the tank offered two or three times during the turning over process, a tight floor is secured which you can solder into place. Details of this tank are depicted at Fig. 5.

The soldering of aluminium calls for specialised technique—the orthodox methods of applying a flux does not remove the oxide skin formed on the metal, so the latter is removed mechanically during the course of the soldering operation. The aluminium solder is melted on the metal and the surface is then scraped with the aid of a broken hacksaw blade. Fryal is a good material to apply for this work, and once a surface is sufficiently tinned, the joint is then easily made with tinsmith's solder and the temperature for this work is about 250 degrees C.

Threaded Top Cap

If a threaded top cap is desired, this is much better than the simple push-on member, a thickening of the container is essential as a very fine thread is difficult to locate especially if small quantities of paint remain in the threads. Roll up a narrow piece of aluminium using the former for the bottom detail, and solder this to the container as depicted at Fig. 5. A somewhat thicker material is preferable as this allows the cutting of a coarse thread without fear the root diameter will meet the outside diameter of the container; in other words the collar is not cut completely away. Run a generous fillet of solder where shown on this sketch and the thread is then ready for cutting. Finally the screwed cap is made in a similar manner—the cylinder portion is rolled up and set approximately true on the previously cut disc which creates the grip. Once the container is made the lower tapered detail is turned and soldered to the floor—there is no point in making this from sheet material as it takes longer than turning from bar and, as the latter is best and easiest for the threaded end, the work is completed in a matter of an hour.

Another detail which is easily built-up from strip material is the trigger assembly, and the first member to make is the "U" frame seen at "L." This is merely a narrow bridge which holds apart two side strips—the latter are marked out and filed from bright strip using one as a jig for the other. If both are held together with the aid of a simple clamp during the drilling and reaming stage, both holes are correctly aligned and the trigger should

(Concluded on page 549)

Fig. 2.—Details of the main body.

Fig. 3.—Further details of the body, showing how it becomes a two part detail.

Fig. 4.—Constructional details of the handle, etc.

Fig. 5.—Dimensions for making the tank and soldering to gun.

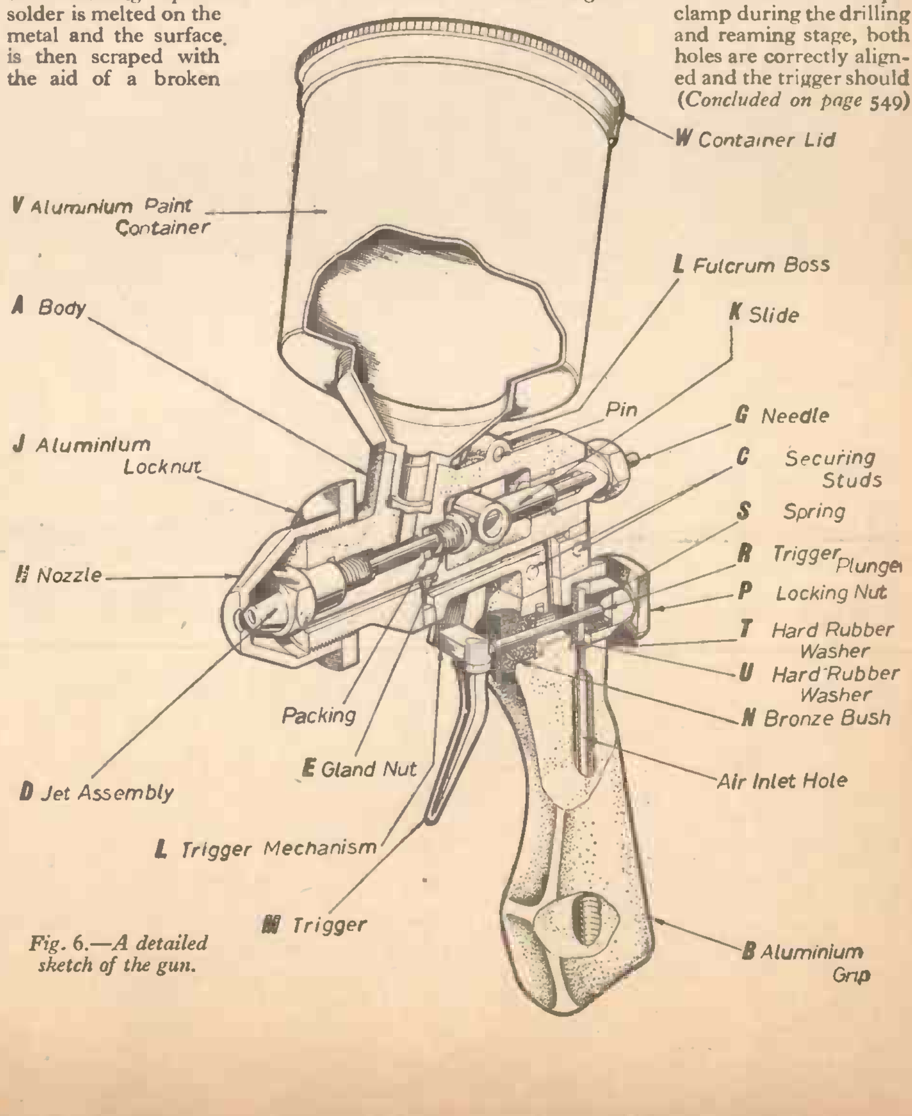


Fig. 6.—A detailed sketch of the gun.

through in a second or so before the boat responds.

The degree of turn can be initially adjusted by changing the distance between pivot and link pin. The escapement sometimes controls a wheel with four or more teeth. The rudder can then be brought to rest in half-to-starboard and half-to-port positions, as well as turning the boat sharply when required.

It will be seen that there will always be two positions where the rudder is straight. If a small cam on the spindle opens two contacts at one of these positions, this will allow the driving motor to be switched off. The four positions will then give port, straight, and starboard steering, in addition to stopping the model when necessary (rudder straight).

With a four-toothed wheel, additional positions may be used to bring in a resistor, for half-speed sailing; or sailing astern may be arranged by using a reversing relay. Such a relay has double-pole double-throw contacts, so as to reverse the polarity to the motor, which must be a permanent-magnet type, for sailing astern.

With many steering mechanisms it is helpful to fit red and green sailing lights on the model, with contacts on the steering unit wired to these bulbs. It will then be at once clear which way the rudder is, before the model responds. A central white bulb can indicate straight ahead, with motor on.

STEERING BY RADIO CONTROL

F. G. Rayer describes various types of steering gear

THERE are many different methods of steering a model boat by radio control, and each has particular advantages. Some are very realistic; others are very simple, or occupy little space so that the mechanism can be fitted in small boats. In general, the actual constructional details of such mechanisms are not very critical, and dimensions, etc., can be modified to suit parts to hand.

The advantages and limitations of some of the best and most reliable systems will become clear from the details given here, which will allow the items of equipment required to be made up. For many small mechanisms of this type, constructional toy gears, wheels, and axles will be ideal, being easy to assemble, and available in various sizes.

With the exception of the tuned reed control system, any of the steering devices shown here may be worked with any ordinary carrier wave transmitter and receiver. The transmitter power, and use of a transistor or valve receiver, depend on the range over which control is wanted, and do not influence the steering unit, the choice of which depends more on the *size* of model, and degree of realism to be achieved.

Escapement Control

This method is used in many commercially manufactured and home built models of all sizes. The receiver relay contacts are wired to a magnet and battery, as in Fig. 1. An armature, or escapement catch engages with an arm fitted to a spindle, which can be rotated in the direction of the arrow. To obtain turning power, this spindle can be the shaft of a small clockwork motor. In light models, twisted elastic is sometimes used instead.

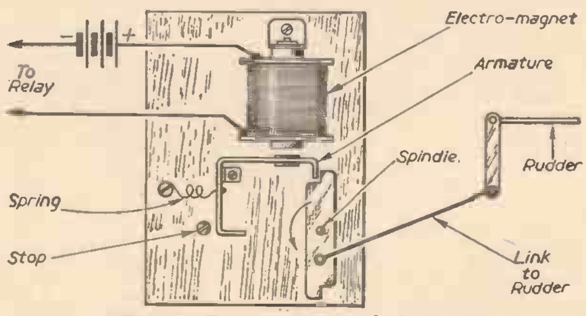


Fig. 1.—Escapement control of rudder.

With the unit set as in Fig. 1, the rudder is straight. When the transmitter is keyed, the receiver relay closes and the armature is drawn to the magnet. The arm then turns 90 deg. engaging with the second end of the escapement. The link moves the rudder, so that the model turns to the right. When the transmitter is keyed again, the arm turns a further 90 deg. restoring the rudder to a straight-ahead position. Keying the transmitter again moves the rudder the other way.

By keying the transmitter, the rudder can thus be made to take up, at once, such a position as will give straight sailing, or turn the boat either way. Unrequired settings can be flicked

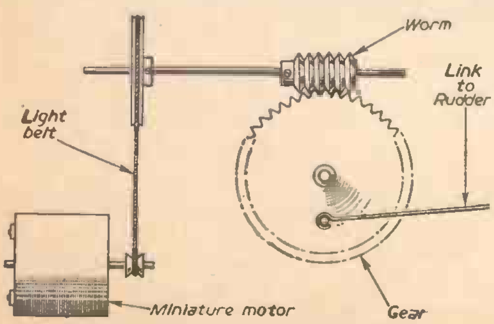


Fig. 2.—Variable steering by motor.

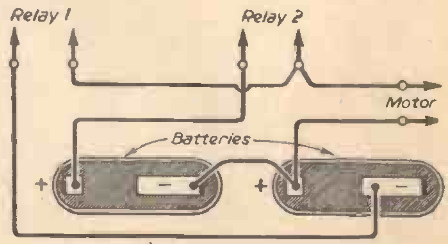


Fig. 3.—Reversing the steering motor.

Infinitely Variable Steering

For very realistic sailing of a large model, a mechanism like that in Fig. 2 will allow the rudder to be moved to any position. The miniature motor speed can be reduced, if necessary, by using a low voltage, or series resistor. However, a fairly high reduction ratio should be provided, so that a complete side-to-side movement of the rudder takes at least 15 sec. A white straight-ahead signal bulb on the model, lit when the rudder is straight, is useful.

If the receiver relay controls the motor

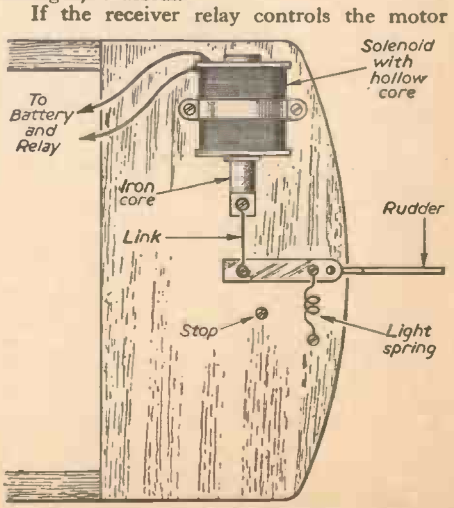


Fig. 4.—Space and mark steering unit.

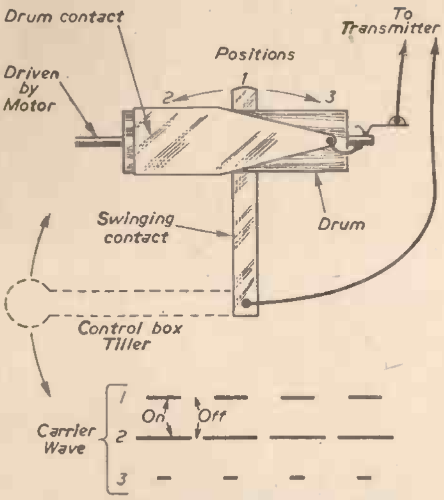


Fig. 5.—Mechanical space/mark keyer.

direct, it has to be run in one direction only to bring the rudder to the required position. This may mean that it is sometimes necessary to pass through an unrequired position. In practice, this is not of much importance.

If it is desired to reverse the steering motor, for maximum possible realism and fine control, a double-pole relay, wired as mentioned for reverse sailing, will do this. Another method, needing no relay, is shown in Fig. 3, and makes use of an extra battery. Small dry batteries suffice, because current is only taken when moving the rudder. To reverse the steering motor it is necessary to have control over two relays or sets of contacts. Such two-channel circuits are dealt with later.

Space and Mark Steering

With this method, the transmitter space and mark generator or keyer forms an additional item which has to be built, but the boat itself can have an extremely small, light and simple steering unit. It is necessary that the receiver be well adjusted, with a high-speed

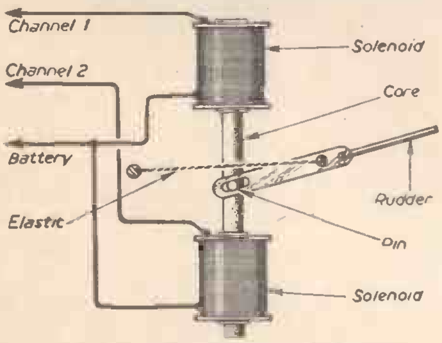


Fig. 6.—Two-channel steering.

relay such as the popular 1700 Ω twin coil type with light armature.

The simplest form of boat unit is shown in Fig. 4. An iron core moves freely in the solenoid. When no current flows through the windings, the light spring draws the core out, so that the model turns to the right. When current flows continuously through the solenoid, the core slides fully in, turning the model to the left. For straight sailing, with the rudder and core as in Fig. 4, the magnetic power of the solenoid is such that it just overcomes the spring.

The way in which this is achieved is best understood by reference to the space/mark keyer in Fig. 5. For a mechanical keyer, a wooden drum about 1in. in dia. and 4in long will be satisfactory. A contact, cut from thin metal and shaped to fit the drum, fully encircles the drum at one end, and is reduced to a point at the other end of the drum. At the centre of the drum, this contact covers about 180 deg. of the drum. A swinging contact bears on the drum, the position of this contact being controlled by a fairly large tiller. The drum is rotated at about 500 r.p.m. by means of an electric motor in the control box.

With the swinging contact at position 1, the carrier wave will be on and off for equal intervals. The iron core controlling the rudder of the model cannot move in and out with such rapidity, so it takes up a central position, for straight sailing. With the contact moved to position 2, the transmitter carrier is on continuously, or nearly so, and the core is drawn fully in. With position 3, the carrier is completely off, or nearly so, and the core controlling the rudder is fully out.

When correctly adjusted, the rudder in the model will follow movements of the tiller on the control box, which may thus be used to steer the boat about in a realistic manner. It is best to test the equipment initially by wiring the mechanical space/mark keyer directly to the boat, with the appropriate battery. The spring tension, etc., can then be adjusted so that the rudder is straight with the control box tiller and swinging contact placed as in Fig. 5. Vibration of the rudder shows that the keying *speed* is too low. But unnecessarily high keying speeds are best avoided because adjustment of the receiver relay will be more difficult. A variable resistance in series with the drum driving motor will allow its speed to be modified. A reduction ratio of about 6 : 1 or so between motor and drum will be suitable.

Two-Channel Steering

When the required transmitting equipment and receiver can be provided, two-channel steering can be extremely easy to fix up in the model. Fig. 6 shows a system which can be accommodated in very small, light boats.

The thin elastic normally holds the rudder straight. When one solenoid is energised, it draws the core in, turning the rudder. The other solenoid moves the core the other way. With both solenoids inactive, the rudder again becomes straight.

Each channel circuit consists of the contacts of a relay. If the model is used at fairly short range, with a powerful transmitter, a simple transistor receiver will suffice. The use of two receivers, tuned to slightly different frequencies (but both in the Model Control band) is then feasible. To avoid using two transmitters, a low-loss switch may bring in pre-set tuning, or an arm may be fitted to the transmitter tuning condenser, with stops fixed to allow only a slight change of frequency. Whatever method is used, one frequency gives port, and the other frequency gives starboard sailing. With the transmitter off, the model sails straight. A simplified form of tiller at the transmitter can be used for right, left, and centre steering, the central position being "off."

With a transmitter fixed on one frequency, and a single receiver, two channels may be obtained by employing an escapement as shown in Fig. 1, with contacts on the spindle to close either the left- or right-hand solenoid. This may sometimes allow a more convenient layout, as no rudder link wire is needed from the escapement arm.

Another method of obtaining two-channel operation is to use two relays, one adjusted for maximum sensitivity, and the other for half-current operation. Control is then achieved by keying the transmitter at half or full power as required; or by using a space/mark keyer. Such a system tends to be influenced by the distance between model and transmitter, but it can be satisfactory over a limited range.

Tuned Reed Circuits

It will be seen that it is often convenient to have two or more separate channels, corresponding to the use of two or three separate transmitters and receivers. The tuned reed system often provides three channels, with one receiver.

For this method of control, the receiver needs to provide a good signal, not a current change as used to operate a relay. Some three valves (detector and two A.F. amplifiers) will normally do. The final anode circuit has

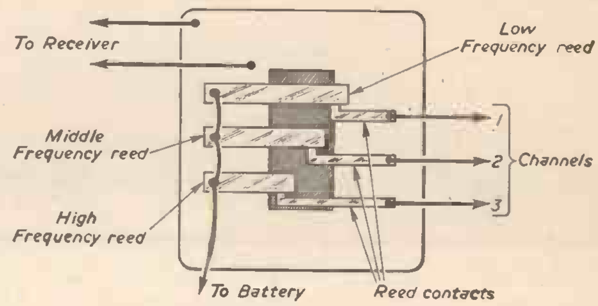


Fig. 7.—A tuned reed relay.

tuned reed relay like that in Fig. 7. The longest reed may be tuned to several hundred cycles; the middle reed responds to a few thousand cycles tone; the short reed is for the highest frequency of all, vibrating only when the signal is of several thousand cycles per sec.

The simple carrier wave type of transmitter cannot be used, as it stands, because the carrier wave has to be modulated with the control tone. The modulator consists of an audio-frequency oscillator, such as that in Fig. 8. Any large power pentodes or triodes will do. C1 and C2 will be about 0·05 μF, and R1 can be about 50K Ω. The three-tone control of pitch frequency potentiometers are between about 10K Ω and 50K Ω. The actual

(*Concluded on page 562*)

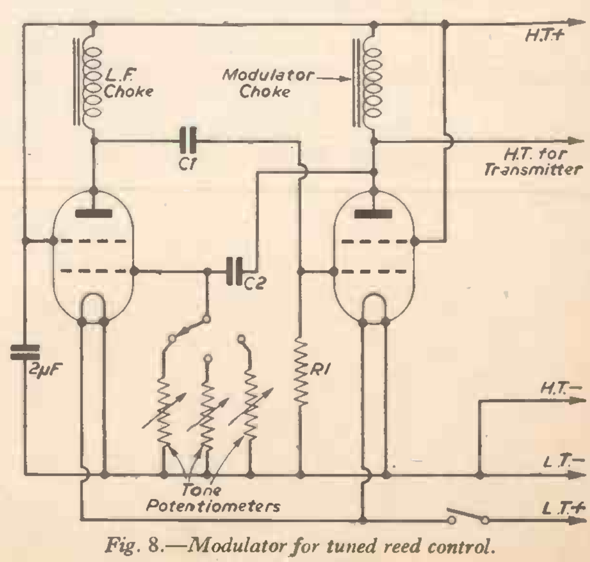
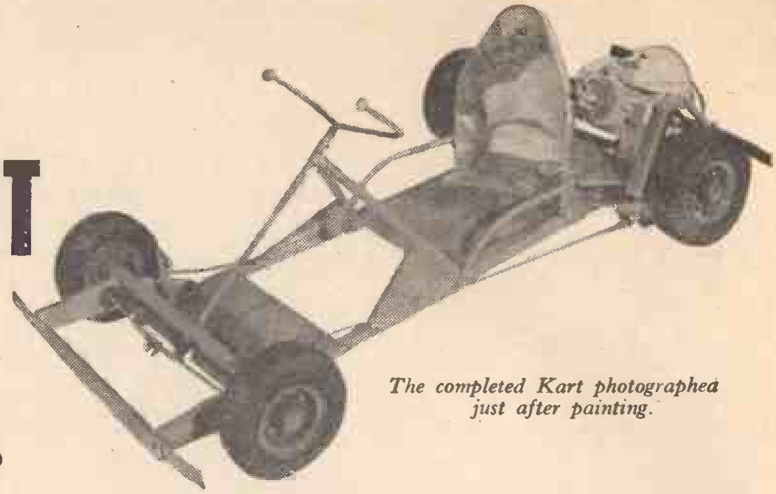


Fig. 8.—Modulator for tuned reed control.

Here It Is—
Your Completed
MECHANIKART



The completed Kart photographed just after painting.

In response to readers' requests we show here the completed MechaniKart built in our Tower House Workshop together with some of the details

SINCE the completion of our short series of articles describing the construction of the MechaniKart in our April, May, June and July issues, we have, in addition to a number of letters congratulating us on the design, received some queries about prices and also a number of requests for some more pictures of the completed Kart. This page is designed to satisfy all those requests. A close study of all the photographs should give potential constructors a good idea of the appearance of the completed Kart and below we are printing a price list prepared by Messrs. H. A. Wills Ltd., Pyle Street, Newport, Isle of Wight, listing all the parts they supply and the prices. All queries regarding these materials should be addressed to Messrs. H. A. Wills and not to PRACTICAL MECHANICS.

THE MECHANIKART

Price List of Parts

Side Members, 1in. × 1¼in. × 14 s.w.g. Channel .. (per pair)		16	6
Front Member, 3in. × 1½in. × 10 s.w.g. Channel		7	6
Front Member complete with Stub Axle Assemblies	£2	12	6
Rear Member, 3in. × 1½in. × 10 s.w.g. Channel		7	6
Front Stub Axle Assembly (per pair)	£2	3	4
Rear Stub Axle .. (per pair)	£2	2	6
Set Sheet Metal Parts for Chassis (per set)	£10	0	0
Avon Tyred Connolly Wheels for Single-Drive use, complete with Ball-Race Hubs .. (set of 4)	£20	4	4
Handle Bar Assembly	£1	2	0
Set of nuts, bolts, washers, including self-aligning Ball-Joints for Steering Drag Links	£2	5	0
Engine, J.A.P. S.80	£16	15	1
Engine, Clinton A.490	£21	14	0
Engine, Clinton E.65	£44	7	6
Chain Guard for Clinton		5	2
Chain Guard for J.A.P.		5	2
Also available is a Welded Steel Chassis of slightly different design but which is dimensionally the same, complete with Stub Axles and Seat	£16	10	3

All prices are ex-works, Newport.

Goods are normally despatched carriage forward via British Road Services.

TERMS: Nett Cash with Order.

DELIVERY: 10-14 days ex-works.

Special Kart Parts made to order.

KEY TO PHOTOGRAPHS

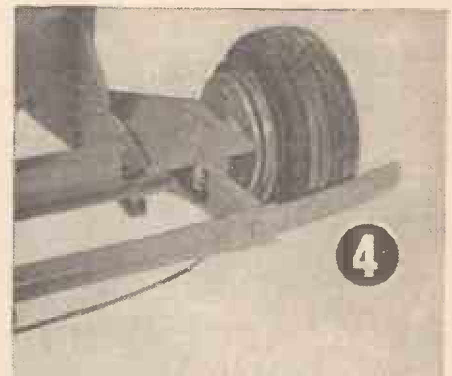
Fig. 1.—Front end showing steering pylon and handlebars.

Fig. 2.—Rear wheel, showing band brake.

Fig. 3.—Front wheel, track rods and accelerator pedal.

Fig. 4.—Further view of the rear wheel, showing braking arrangement mounted on sprocket.

Figs. 5 and 6.—Two views of the engine mounting, showing chain cover and starting cord.



THE AUTOMATIC HOUSE
PART 7

A CONDENSER TIME CLOCK AND SWITCH

E. V. King describes a further unit in this series.

THE idea of a varying capacitance being made to cause either commencement or cessation of oscillations in a valve circuit is not new and the author does not claim to have originated a new circuit. However, the author believes the idea of making the hand of a clock one part of a variable condenser to be quite novel.

A small light metal plate is soldered to the hour hand. When this passes beneath a plate fixed on the outside of the glass a relay pulls in and circuit is made. The outside plate may take the form of many plates to control lights, etc., at varying times.

Great care must be taken with this unit to verify that no interference is being caused to radio reception of nearby neighbours. Details about this are given later.

The Clock Modifications

Any clock will do. The prototype used an old type alarm clock, but an electric clock would be better in all respects.

The clock must be dismantled enough to solder a small piece of brass shimming (from the local garage) about the size of a postage stamp and 0·001in. thick to the hour hand. The minute hand is removed. The hour hand is then bent upwards slightly so as to bring the metal plate as near to the glass as possible without touching it. The clock is then tried out to make sure the added weight does not quicken it up between 2 and 4 and slow it down between 8 and 10. A counterbalance will need to be fitted if it does, the counterbalance must project backwards from the hand and should be made of lead as its surface area must be small. The author found no balancing was necessary. See Figs. 62 and 63.

The Fixed Condenser Plate/s

The plate may take the form of metal foil stuck on the glass or of a metal plate held on the glass by stiff copper wire attached to a small wooden strip held down by suction discs such as are used on toy " arrows " etc. These devices are shown in Figs. 62 and 63 and should require little explanation. The co-ax. connections should be with air spaced television cable, the outer metal being soldered to the metal clock casing and the inner to the fixed plate.

Another type of controlled fixed plate could be arranged on much the same lines as the moving centre contact of Fig. 50 in the car clock conversion.

For temporary fixing, the plates may be stuck on with H.M.P. grease obtainable from any garage. Any number of plates may be fixed around the dial, all being wired to the centre lead of the co-axial cable.

Surplus 24-hour Motors

If a motor which gives one revolution in 24 hours is used then a plywood, hardboard or Perspex disc must be attached and the moving plate fixed to it. If a thin disc is used the moving and fixed plates may be on opposite sides and no glass is necessary if a good insulator such as Perspex is used.

Fig. 54.—The completed unit.

PARTS REQUIRED

Relay: P.O. type 3000, two pairs of c/o contacts. 20,000Ω or greater up to 100KΩ. Prototype used No. 229 from Messrs. Sallis of Brighton. Any relay working on 8 to 10 m/A will suit. If pilot lamps are omitted a single make type is quite suitable.
Coil: Wearite P.A. 2 or other similar long wave coil.
Terminal Block: 2 or 3 way insulated.
Valves: 3, 4, and 5 all E.F. 50's with B9G bases to suit. Surplus valves will suit, most high slope pentodes could be used. A thermionic diode will do for V4. A small triode would do for V3. Non-technical readers should keep to specification.
Transformer: 6·3V. filament to suit A.C. mains. Prototype uses surplus speaker transformer.
Chassis: A cake tin from a walk round store, 4in. × 5½in. × 2⅞in. high with the bottom soldered in.
Switch: On/off. throw over two pole toggle with insulated lever or two pole two way rotary with insulated knob as on prototype.

Condensers:
C8. 0·01μF 1000V. working. Not required for power pack model.
C9. Electrolytic, 200V., 32μF approx. Not required unless very fine adjustment is used and relay chatters. Not shown on prototype.
C10. Electrolytic, 300V., 8μF.
C11. 0·01μF, 1000V. working. Not required unless interference to radios is caused.
C13. As for C11.
C7. As for C11.
C12. As for C11.
C14. 0·01μF, 1000V. working.
C15. 0·01μF, 1000V. working. Not required on power pack model.
C16. See text. May not be required, in first instance leave out completely, or use very small value say 50pF.
C17. 500 pF. See text.

Resistors:
All ½W. unless stated.
R13. 1MΩ.
R14. 47KΩ.
R15. 100KΩ.
R16. 100KΩ.
R17. 470KΩ.
R18. 47Ω.

Rectifier:
All metal rectifier for 30 m/A or more at 250V. will do.
Plugs and Socket. Normal TV aerial type will do.
Co-axial cable (18in.). Wood for cabinet and metal foil (optional) to line the inside. Perspex paxolin, etc.
Neons: Three required, Arcolectric SL160, 150/300 volts. Red.
Variable Condensers:
Vc2. This is a 300pF trimmer, insulated from chassis.
Vc3. A short wave 50pF rotary condenser. It is possible to do without it, see text.
Coupling shaft such as Bulgin E.H. 16 is required.

The Condenser Switch Unit

Briefly this is a unit which pulls in a relay when a very small capacity (i.e. condenser vanes on clock) is applied to it. Other uses could be:

1. A burglar alarm. A plate (about 18in. × 18in.) would be fixed say behind a mirror, but well insulated. The intruder himself would be the other plate. This will work up to 3ft. away.
2. Switching on lights, etc., as a person passes a certain place.
3. Novelty toys. I.e., a box that rings a bell when anyone's hand approaches within 6in. of it.

The Chassis and Layout

A baking tin measuring 5in. × 4in. × 2⅞in. high approx. is suitable. The valves are mounted as shown in Fig. 55. The filament transformer is mounted on top as shown and the relay is fixed by bolting through the chassis and using suitable hardboard packing so that the relay coil connections do not short to chassis. Alternatively holes may be cut so that the coil tags are clear of all metal. If necessary cut the coil tags off ⅛in. long as on prototype.

The small trimmer VC2 is mounted on the back, and if the two plates of it are not isolated from chassis it must be mounted on Perspex, etc. This is very important. Likewise the *complete* co-axial socket *must also be* insulated from chassis on Perspex or paxolin. (See Fig. 56b.) The small terminal block may have two or three terminals and change-over switching arranged. C8 is soldered between the chassis and the outside of the co-axial plug.

The inside layout is shown in Fig. 64. If a different length of rectifier is used a bracket may be necessary. Most components are held in the wiring, but particular care is necessary over the variable condenser. This must be insulated from the chassis by mounting as shown in Fig. 56b. The variable condenser must be insulated completely from the chassis (Fig. 56a). The shaft must be insulated by using a flexible coupler, see Fig. 64.

Condenser VC3 can be omitted, this will make the setting of the instrument somewhat tricky as fine adjustment of the screw on VC2 is difficult and inconvenient.

Wiring the Unit

The wiring of the unit is shown in Figs. 60 and 65 and should present no difficulty. The condensers starred in Fig. 69 may be omitted, and are safety devices in case the mains is connected wrongly.

Inexperienced readers should leave all relay contacts and neons unconnected at first until the unit is tested.

Key to illustrations:

Fig. 55.—How to mount the valves.

Fig. 56.—(a) Insulating mount for Vc3. (b) Insulating co-ax socket from chassis.

Fig. 57.—Valve connections and base viewed from underneath.

Fig. 58.—Top view of the unit.

Fig. 59.—Pilot neon connections.

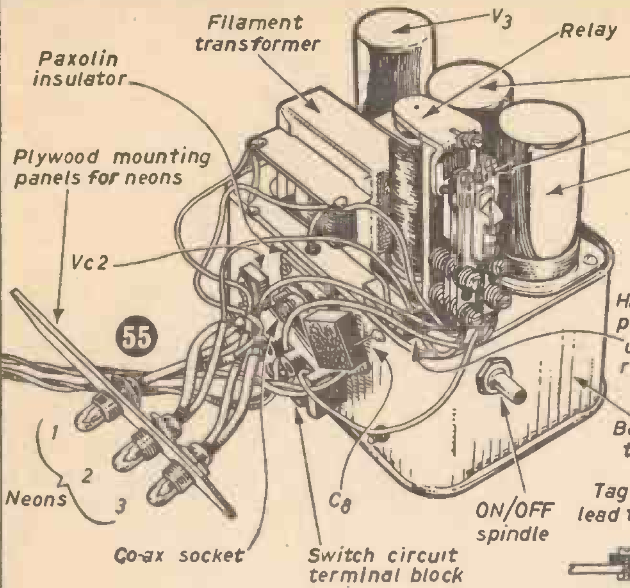
Fig. 60.—Details of relay contacts and signal lamps.

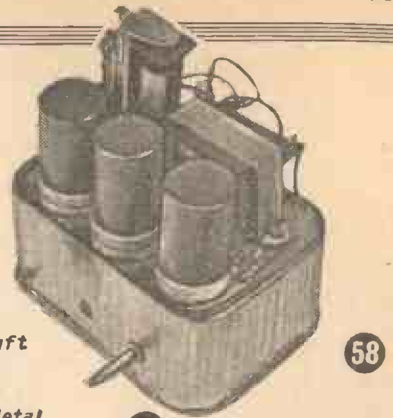
Fig. 61.—Case to hold unit with large clock.

Fig. 62.—Fixed plate stuck in position between 6.30 and 11 p.m.

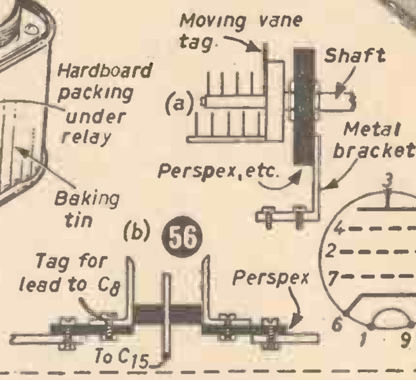
Fig. 63.—Alternative suction fixing plate.

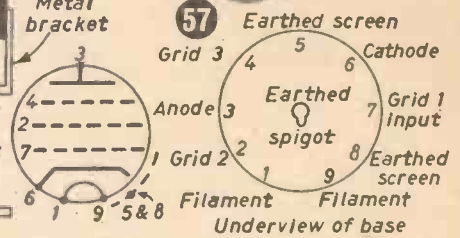
Fig. 64.—Layout for the inside of the chassis. Also wiring diagram with a few components moved to clarify connections. Earth to chassis.


Filament transformer
Paxolin insulator
Plywood mounting panels for neons
V3
Relay (20,000Ω H1011MT)
V4
N/C and N/O
V5
Vc2
Hardboard packing under relay
Baking tin
55
1
2
3
Neons
Co-ax socket
C8
Switch circuit terminal block
ON/OFF spindle



58


Moving vane tag
Shaft
(a)
Metal bracket
Perspex, etc.
(b) 56
Tag for lead to C8
Perspex
To C15


57
Earthed screen
Grid 3
Cathode
Anode
Grid 1 input
Earthed spigot
Grid 2
Earthed screen
Filament
Filament
5&8
Underview of base

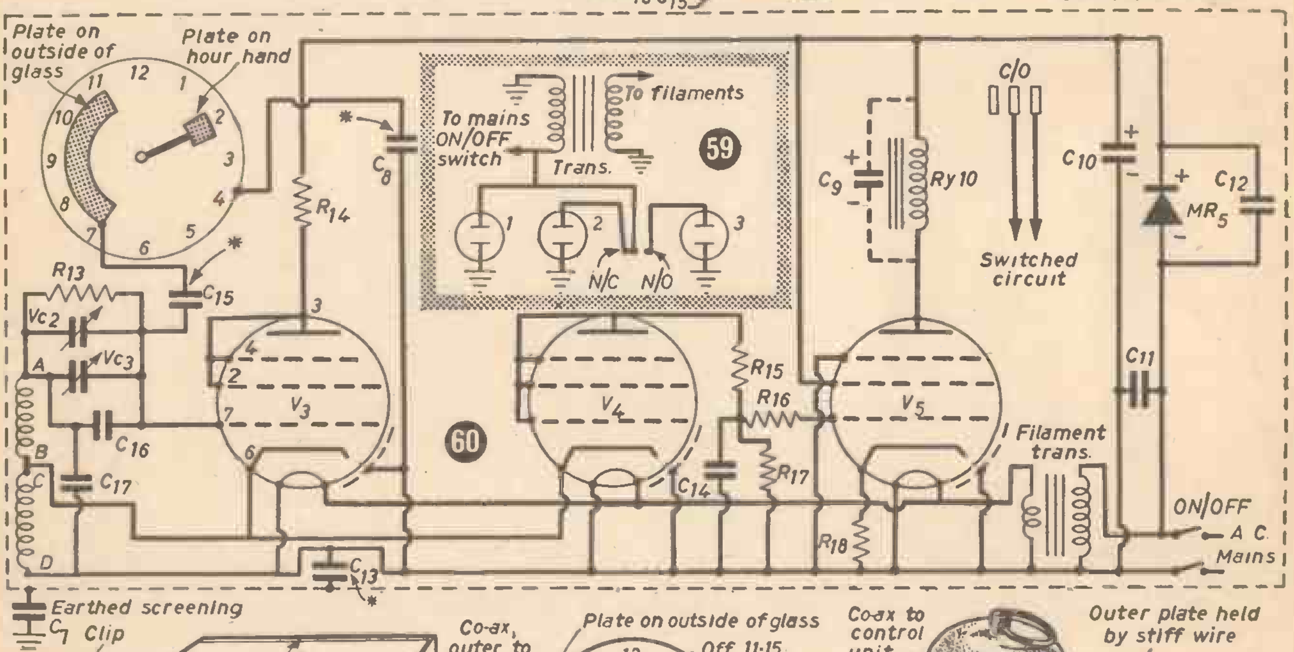
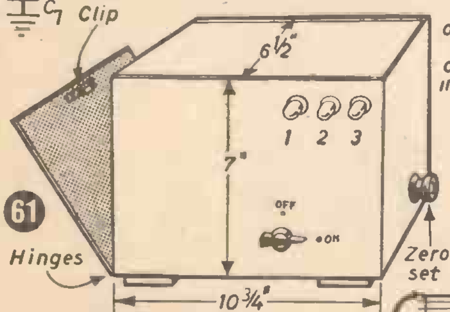
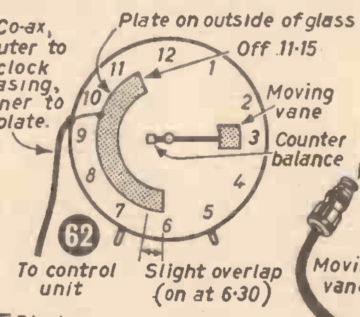
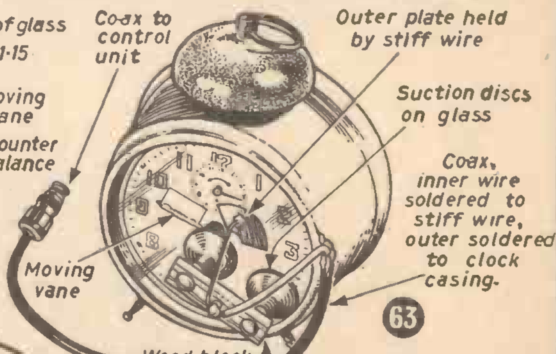
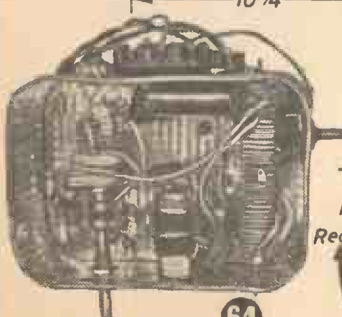


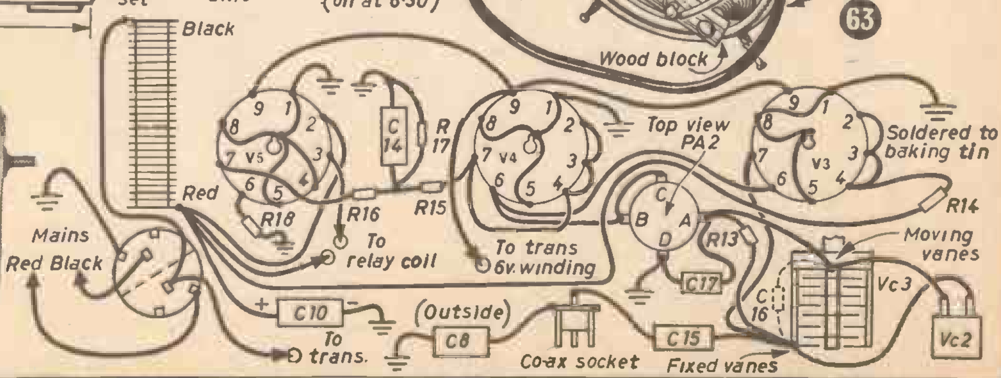
Plate on outside of glass
Plate on hour hand
To filaments
To mains ON/OFF switch
Trans.
59
N/C
N/O
C8
R14
C/O
C9
Ry10
Switched circuit
C10
C12
MR5
R13
C15
Vc2
Vc3
A
B
C
D
C16
C17
V3
60
V4
V5
R15
R16
R17
C14
C11
Filament trans.
R18
ON/OFF
A.C. Mains
C13
Earthed screening
C7
Clip


6½"
7"
1 2 3
OFF
ON
61
Hinges
10¾"
Zero set


Co-ax, outer to clock casing, inner to plate.
Plate on outside of glass
Off 11·15
Moving vane
Counter balance
62
To control unit
Slight overlap (on at 6·30)


Co-ax to control unit
Outer plate held by stiff wire
Suction discs on glass
Coax, inner wire soldered to stiff wire, outer soldered to clock casing.
Moving vane
Wood block
63


64


Black
Red
V5
C14
R17
R18
R16
R15
To relay coil
V4
Top view PA2
To trans 6v. winding
V3
Soldered to baking tin
R14
R13
C17
Moving vanes
Vc3
C16
Vc2
Mains Red Black
C10
To trans.
(Outside)
C8
Co-ax socket
C15
Fixed vanes

Testing the Unit

Plug in to mains, switch on and wait five minutes. Screw VC2 in or out until the relay is released if it has pulled in. With a piece of wire short A to D of the coil. The relay should then pull in. If not a fault is present and must be rectified first. Check particularly the coil connections with Fig. 64, making sure A is red.

Having tested the unit in this manner set VC3 to its mid position (plates half in). Now adjust VC2 so that the relay just does NOT pull in normally. Touch Pin 7 of V3 with a small screwdriver and touch the metal of it with the finger. The relay should pull in. Make sure mains are connected correctly in this test.

Now plug in the clock unit using *one foot* of air spaced television co-axial cable for the coupling. Set VC3 and VC2 as before and finally reset VC3 accurately. Bring your hand near the fixed plate on the clock. The relay should pull in. Now turn the hour hand of the clock and as it passes under the fixed plate the relay should pull in, and as it passes fall out.

Modifications

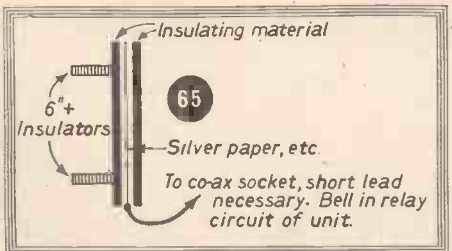
Any departure from plan, lead lengths, etc. may involve some experiment with value of C16. In the prototype layout *no condenser C16 was necessary.* Where large plates are used for burglar alarms, etc., slight experiment may be necessary and R13 may be increased also up to about 3MΩ.

Radio Interference

As designed the unit oscillates outside broadcast bands at 120 Kc/s. The random radiation is very small indeed; much less than many TV sets, but readers must satisfy themselves that no interference is being caused to radio reception. The best way to do this is to enclose the whole unit in a suitable case lined with tin foil suitably earthed directly or via C13 if the live chassis version described is built. C11 will prevent radiation back into the mains. These items and others which are optional are starred in Fig. 60, and more information is given under the components list.

A Suitable Case

Fig. 61 shows a suitable case made of wood and hardboard with a lay down lid, for easy access to the time clock which is housed within. When the lid is up, if the unit is "silver paper" screened, all radiation is trapped. If the screening is done inside, it should be covered in card so that the chassis does not touch it.



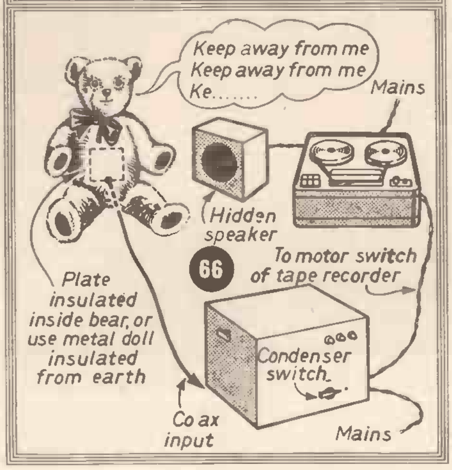


Fig. 65.—This may be adapted to work lights, motors, etc.

Fig. 66.—This can be used to warn people away from dangerous apparatus.

The Zero Setting Lamps

Three small Arcolectric Neons (SL 160's) are wired one side of each direct to mains, see Figs. 55 and 59, on the live chassis version this means a chassis connection.

No. 1 is wired directly to unit side of on/off switch or the transformer, see Fig. 55. This gives simple warning if the unit is switched on.

Nos. 2 and 3 are wired to each side of one set of c/o contacts. The centre contact joining the mains switch of transformer lead.

Using the Lamps

Switch on. Lamp 1 verifies this action. Adjust VC2 with VC3 in mid position for change over from lamp 3 to lamp 2. Adjust Vc3 finely for this change over of illumination on No. 2 and 3. The unit is then set. Any alteration of the leads, etc., or plugging in the clock afterwards will entail resetting.

If two settings are possible, which will only occur on some models, only one setting will be suitable. Bring your hand near the "plate," if the lamps change over all is well, if not the other position is required.

Other Uses

Some ideas about other uses are given in Figs. 65 and 66. Readers must be prepared to experiment if they fix these up as the length of wire and standing capacity to earth effect operation. The unit is very critical to stray capacity, but is very sensitive once set up.

Fig. 65 may be adapted to work lights, motors, visual or oral indicators, etc., or to count people calling at a house or walking down a passage if a P.O. counter is fitted. Details of counters will be given later.

Fig. 66 may be adapted to tell people to keep away from some dangerous apparatus, bee hives, etc. It is possible to use one round length of tape or wire in the recording system. Such a system was used at a parents "Open day" at a Surrey School. As parents entered the Science Laboratory a speaker said "Welcome to ——— school" whenever a parent passed the "plate."

New Transatlantic Cable

A NEW Transatlantic telephone cable—the largest oceanic cable yet—will come into operation in 1963. It will carry 128 telephone circuits between the United Kingdom and the United States, and will provide for the increasing telephone traffic between the two countries.

This news was given recently with the publication of an agreement between the British Post Office and the American Telee phone and Telegraph Company to lay the new cable, which will be known as TAT 3. The signed agreement needs to be approved by a Resolution of the House of Commons before it can become effective.

Polluted Air

IT was stated recently at a conference in New York, that urban air is so polluted that in the case of an air conditioned building, it would be far better to clean and recycle indoor air, in preference to bringing in "dirty" outdoor air.

Star Projector

THE Science Museum at South Kensington has recently brought into operation a star projector to demonstrate the daily motion of the stars and their appearance at different parts of the world and at different times of the year.

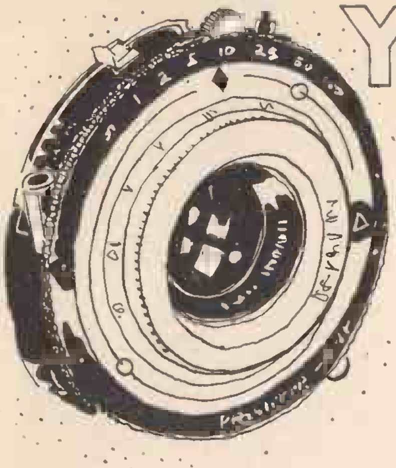
The stars are projected on the inside surface of a hemispherical plaster dome 20ft. in diameter.

Tougher Road Surfaces

WHEN 2 per cent. or 3 per cent. asbestos fibre is added to asphalt, it has been found that rougher road surfaces result. Tests recently carried out in America have shown that asbestos-asphalt mixes give increased resistance to indentation under heavy traffic and also to cracks resulting from exposure to the elements. There are also many more advantages in using this combination.

The New "Bluebird"

The photographs show Donald Campbell's new Bluebird-car, with which he will make an attempt on the world's land speed record on the Bonneville Salt Flat, Utah, some time this month. The car is powered by a Proteus gas turbine engine and has 4ft. 4in. dia. wheels. The present record stands at 394 m.p.h. and was set up by John Cobb. It is estimated that the car cost £1,000,000 to develop.



Your camera shutter explained

Basic principles of the various types are discussed

by J. C. Lowden

THE camera shutter regulates the period of time for which the light is allowed to fall upon the film. In the early days of photography the film was exposed by removing the lens cap for the requisite time and then replacing. Many superbly equipped workers still use shutterless "technical" cameras for studies of inanimate objects, portraiture and interior architectural work. For this type of exposure a rigid support is essential.

The Roller Blind Shutter

One of the earliest mechanical shutters was the roller blind type (Fig. 1), usually mounted behind the lens. The blind, in which a square aperture was cut, was mounted on a pair of rollers with a spring drive. When the spring roller was released, often by a tasselled cord, the blind raced across the surface of the lens and light was admitted through the aperture. Some slight variation of speeds as well as "brief" and "time" exposures were possible, but high shutter speeds were not a feature of the roller blind shutter.

The Rotary Shutter

Box cameras are almost invariably fitted with a rotary shutter. A disc of metal is pivoted close to the lens. At rest, the disc covers the lens. In action, the disc partly rotates and an elongated slot or cutaway section in the disc passes behind the lens, admitting light. The rotation of the disc is restricted by projecting tabs.

The motive power of this type of shutter is invariably a spring. Tension is applied to the spring by pressure on the release lever. As the tension is built up the disc is released, and the spring is usually so arranged that, as the shutter comes to rest, tension on the release is removed. The disc remains at rest, and the lever returns to inactive position. In the following exposure the disc rotates in the opposite direction.

Provision is normally made for "brief time" exposures. A slide is brought into play which checks the travel of the disc when the lens is fully uncovered. The lens remains "open" until the release lever is allowed to return to the inactive position.

The actual time of exposure on "Instantaneous" is nominally 1/25 sec.

Blade Shutters

The single blade shutter is similar in construction and design to the rotary. A single leaf of metal covers the lens, and is flicked aside, by spring power, to give Instantaneous exposure.

In order that the user may be offered a wider range of speeds, the multi-bladed shutter is fitted. Two or more leaves of very fine, blackened metal, when at rest, cover the lens. These blades are normally situated between the elements of a compound lens, and are therefore referred to as "between-lens" shutters.

One drawback of this type of shutter is that it is not practicable to use it with interchangeable lenses. In action, the blades fly aside, remain at rest for a controlled period of time, and then return to closed position.

The great majority of cameras sold for general-purpose use today are fitted with between-lens shutters. These shutters fall into two main types, the "everset" and the "preset."

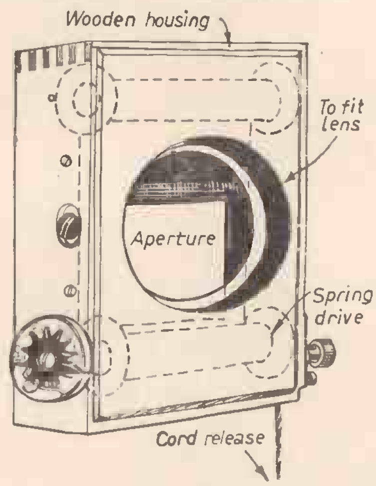


Fig. 1.—A typical roller blind shutter

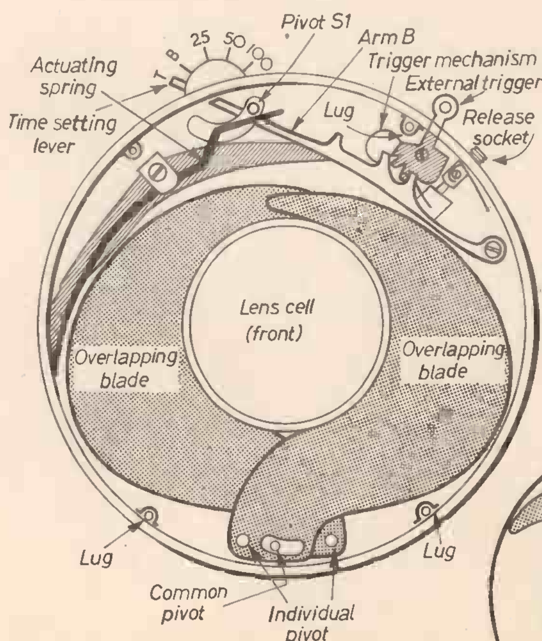


Fig. 2.—The "Vario" two-blade, three-speed, B and T "everset" shutter. When the time setting lever is moved, the pivot S1 bears on the actuating spring, adjusting tension for various speeds. The actuating spring is tensioned and tripped by movement of the arm B, actuated in turn by the trigger mechanism.

Everset Shutters

This type of shutter is usually fitted with two blades, as in Fig. 2, or in some cases three. The motive power is normally a straight (non-spiral) spring. Pressure on the external release lever tensions this spring until a point is reached where the shutter is "tripped." The blades then part, remain open for the set time, and return to closed position. The release lever then moves into position for the next action. To increase the speed of the shutter—i.e. to decrease the "open" period—the setting lever is moved. This movement adjusts the tripping tension of the actuating spring. The inexpensive "everset" shutter is normally offered with a maximum speed of 1/100 sec. The usual range of speeds covered is:

T (Time), B (Brief Time), 1/25, 1/50, 1/100 sec. On some better-class everset shutters slow speeds down to ½ sec. may be provided.

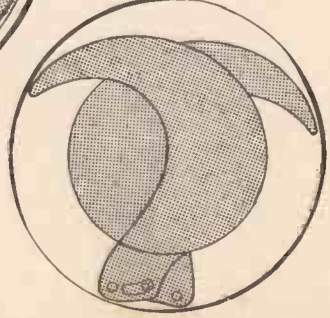
Preset Shutters

Good class between-lens shutters work on a different principle. Most of them offer a range of eight or nine speeds, from 1 sec. to 1/500 sec.

The actuating springs of this type of shutter work at a much higher tension, and have to be tensioned before use by a lever. Very often this tension is applied by the user in the act of winding on the film for the next exposure. This ingenious device eliminates one action, and makes accidental double exposure impossible.

Once the actuating spring is fully wound it is released by a separate triggering lever. This, of course, need have only a "hair-trigger" action.

In a good preset shutter there may be four or five blades, each connected to an outer travel ring. As the ring rotates, the blades open. As the rotation is reversed, they close. The interval between opening and closing is regulated by the complex internal mechanism



(Figs. 3 and 4). When slow speeds, from 1 to 1/10 sec., are selected, an escapement mechanism is brought into play to delay closure of the blades. For the higher ranges of speeds, the variations are obtained by the gearing mechanism. Where a super-high speed of 1/500 sec. is offered, a very powerful auxiliary spring is brought into play. Most shutters are very consistent in their action, but their actual speed of opening and closing cannot correspond precisely to their set speed. Some fraction of time must be occupied by the opening and closing of the blades.

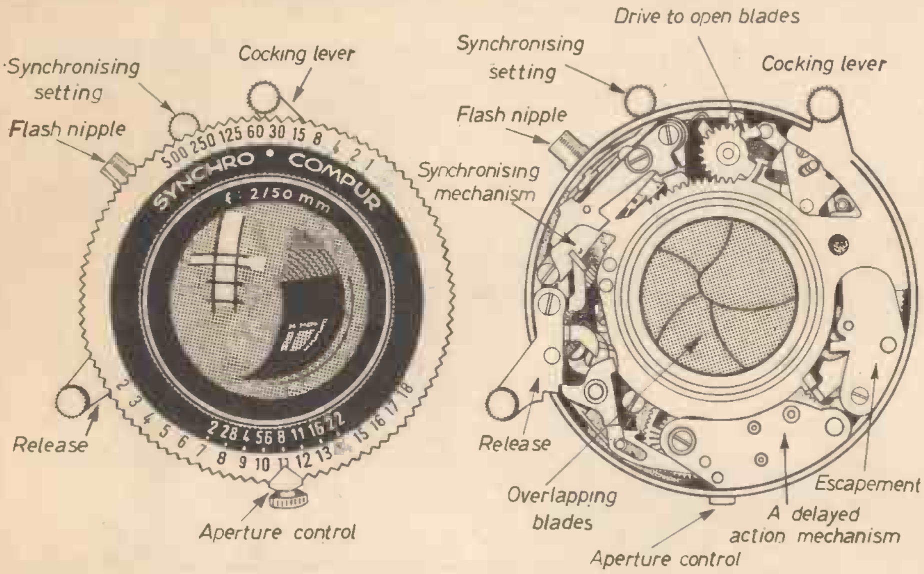


Fig. 3.—The intricate mechanism of the Synchro Compur shutter.

Cable Releases

Most good between-lens shutters are fitted with a taper-threaded socket in which can be screwed a standard cable release.

The cable release (Fig. 5) is a spiral covered with braided silk. Pressure applied to the finger stud drives forward a plunger. The plunger enters the shutter through the socket and releases the action from inside. The advantages are twofold. The operator is enabled to work in a more relaxed posture, and, since the action is inside the shutter, and no contact is made by the operator, there is far less risk of movement. This is particularly important when working at slow speeds on a tripod.

Delayed Action

Most good preset shutters are provided with a D/A. mechanism, for the purpose of allowing the photographer to include himself in the picture.

In the earlier models a small lever, usually marked with a red spot, is used to wind up an internal spring mechanism. After this is wound up, the normal release is operated, and the spring runs down, with an audible whirr, giving about 10 secs. delay. After exposure, the D/A. action is then inoperative until it is rewound.

In the more up-to-date models, delayed action is obtained by setting a datum lever to "V" setting. Operation is as before, but with many shutters this "V" setting is effective until the setting is returned to normal.

Any shutter fitted with a cable release can be used as a D/A. if the "Autoknips" or "Gitza" releases are used. These are neat little mechanisms which screw into the release socket. The mechanism is wound by finger pressure, and released. Audible and visual warnings are given for the delay of some ten seconds. The more advanced model of Autoknips can be adjusted to give not merely a delay, but to give accurately timed slow exposures from ½ sec. to several seconds. This last device is an extremely useful extension to the range of speeds as usually found on "everset" shutters.

Even without these mechanical aids, one need only secure an end of strong thread to the release lever (most levers are drilled for this very purpose) pass the thread under a stone on the ground, directly below the shutter (NOT under one leg of the tripod) and then join the group, holding the thread. A gentle pull will set off the shutter.

Focal Plane Shutters

A very important minority of really high class cameras have focal plane shutters.

In action and design, this shutter bears some resemblance to the roller blind, but it differs immensely in many important respects. The shutter is a blind of rubberised fabric, or in some cases, very fine metal slats. The blind is situated as closely as possible to the emulsion surface of the negative, i.e. as nearly as possible to the focal plane.

The ends of the blind are mounted upon spring-driven spindles. When the drive is operated, the blind is drawn across the focal plane at a uniform speed. The vital feature of the blind is a slit in the fabric. During the travel of the blind across the face of the emulsion, light passes through the slit, exposing the film strip by strip. Exposure time is the time which the slit takes to cross any single point upon the face of the film. Thus exposure time is governed by the width of slit and the speed the blind travels. Where both are adjustable, the range of speeds available is very wide indeed.

Most good F/P. shutters can work at an

Fig. 4 (left).—An exploded view of the Prontor SVS shutter.

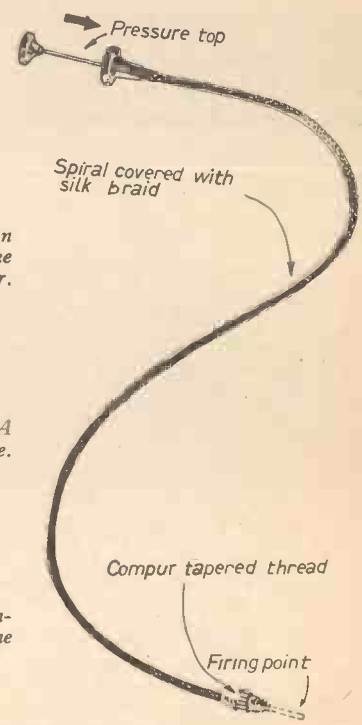


Fig. 5 (right). — A typical cable release.

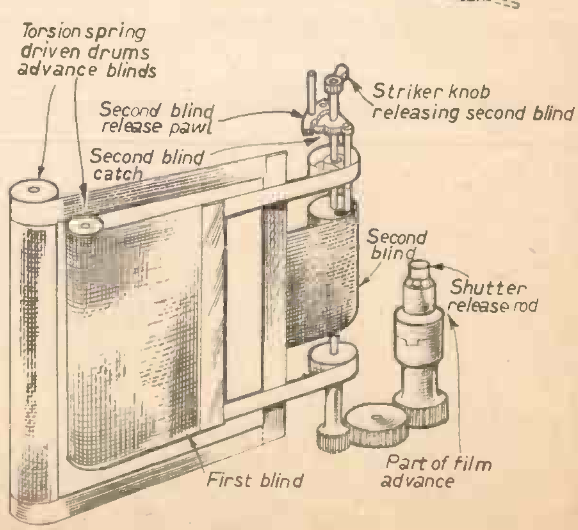


Fig. 6 (below).—Principles of the focal plane shutter.

exposure of 1/1,000 sec., and the top-class "Press jobs" are sometimes scaled as high as 1/1,500 or even 1/2,000 sec.

Up to now, the blind has, for the sake of clarity, been described as a single screen. Many good shutters actually employ two blinds, and the slit is formed by the gap between them (Fig. 6).

Interchangeable lenses may readily be used with the F/P. shutter. In common with the preset types of shutter, focal plane shutters must be rewound after each "take." During this action the blind is drawn back across the focal plane. Modern shutters incorporate two blinds, the ends of which overlap as they are rewound, thus protecting the negative. This action, known as "self-capping," is essential with roll film or 35mm. material, unless the lens were to be capped by hand at each rewinding. With older non-self-capping F/P. shutters rewind first, then insert the plate.

Focal plane shutters should never be left fully wound for long periods, or the drive mechanism will suffer.

Louvre Shutters

Louvre shutters resemble in appearance the domestic Venetian blind, the slats being made of very fine metal. In action, these open and close momentarily to give exposure. These shutters are fast, accurate, and very robust. They are normally fitted only to Service cameras, especially for aerial use.

"Freezing" the Target

So far the shutter has been discussed more as regulating the time for which light is allowed to reach the film so as to form an image of the correct density. Like most of the other components of a camera, the shutter has a dual duty. The second half is the *apparent* stoppage of movement.

Camera Shake

The movement may be of two varieties, the most pernicious being movement of the camera. If any degree of movement of the camera, however small, is permitted, the entire scene photographed will be blurred. The remedy is clear; always use the highest shutter speed compatible with adequate exposure.

Subject Movement

In a long exposure any moving object will travel an appreciable distance, giving a blurred image. The faster the shutter speed, the less the blur, until it is so reduced that it is indistinguishable.

Shots of objects moving at high speed require a high-speed shutter. There are, however, one or two "dodges" which can be used. One is narrowing the angle of approach of the target. Head on, there is no apparent movement, and quite a slow shutter speed will give a sharp image.

Another favourite dodge for shooting a moving target proceeding laterally across the plane of focus is "panning." Using an open sight, the ready focused camera is pointed towards the approaching target. It is placed centrally, and kept there by a smooth swing of the camera. As the target comes opposite, the shutter is released with the camera in motion. The swing MUST be followed through. A "panned" picture can always be recognised by a sharp central figure and a blurred background; the blurring heightens the impression of speed, see Fig. 7.

In many rhythmic actions there is a fraction of time when the subject is momentarily at rest, when the action may be captured with even quite a slow shutter speed. See Fig. 8.

Fig. 8.—Taking advantage of the "moment of rest."

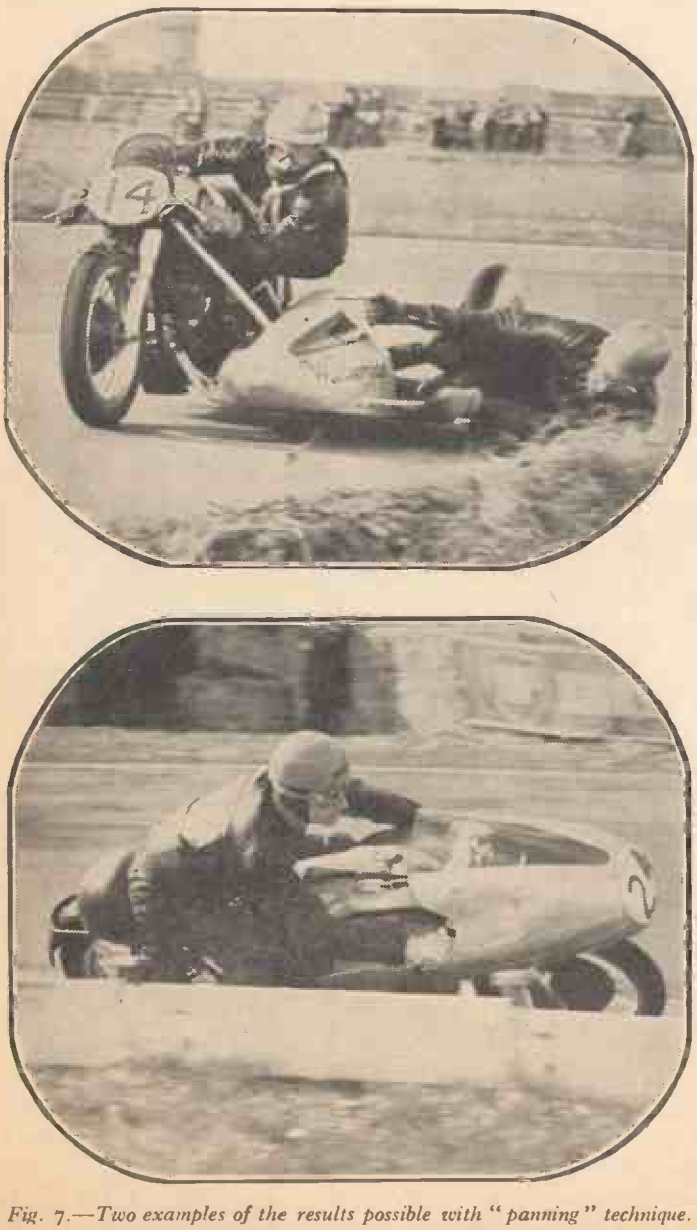


Fig. 7.—Two examples of the results possible with "panning" technique.

Care of Shutters

The biggest enemy of any shutter is grit. Especially by the seaside, keep your shutter protected. Avoid knocks and water, especially sea-water. Keep your camera in a dry, warm atmosphere, and preferably in a leather case.

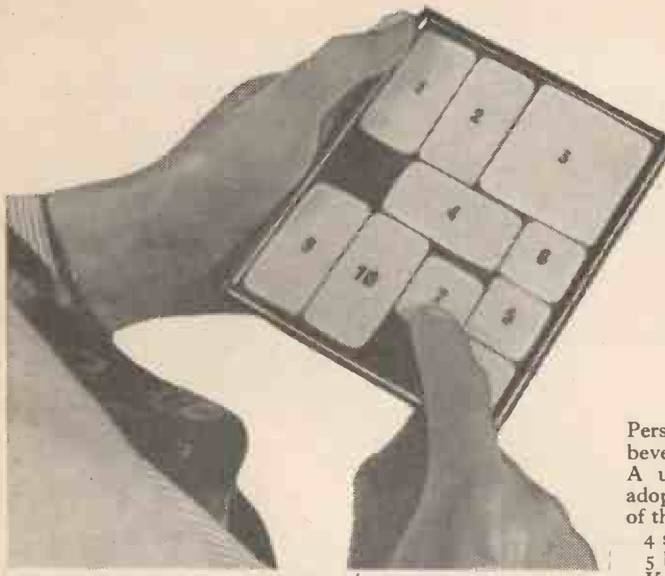
Most books tell you never to clean or maintain your shutter yourself. This is good advice to the non-mechanical, but a worker who is careful can maintain his shutter very well indeed if he follows a few simple rules.

Like all movements, shutters need lubrication. Never, under any circumstances, allow oil to touch the blades; it will gather grit. Blades may be cleaned, if dirty, with a trace of carbon tetrachloride, applied with a brush. Essential lubrication may possibly be given in extreme cases with graphite powder scraped from a very soft pencil. Every trace of loose graphite must be brushed away.

The pivots and moving parts may be oiled with the special oil used for watches, and no other oil. The oil should be applied with a very fine brush, which has been dipped in it and then drawn across clean blotting paper to remove all but the merest traces. Foreign bodies obstructing the mechanism should be removed either by brushing or with watchmaker's forceps. Components should never be handled, forceps only being used. Major repairs must be handled by experts.

MAKING A BLOCK PUZZLE

This novelty will amuse you for hours



By A. C. Airey

THE puzzle is made in wood with Perspex blocks, the "key" (No. 3) block being a different colour to the remainder. The base was made from ¼in. thick plywood 5 1/16in. × 4 1/16in. and covered with green baize, stuck down. The sides, which project 3/16in. above the base, were made from ⅛in. thick hardwood strips, pinned and glued to the base. All edges were rounded off, sanded, ebonised and wax polished (though they can be left plain or stained and polished).

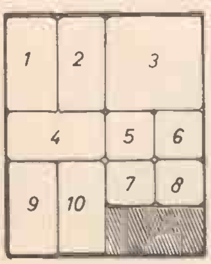
The blocks were made from ⅛in. thick Perspex, with edges slightly bevelled and corners rounded. A unit of 1in. square was adopted which made the sizes of the blocks as follows:

4 small blocks	1in. × 1in.
5 blocks	2in. × 1in.
Key block	2in. × 2in.

The blocks were cut to shape with an old tenon saw, edges and corners smooth filed, sanded and finally polished with metal polish (not the faces), which brings up the smooth surface of Perspex.

The puzzle is to slide the blocks (without lifting of course) until the "key" (No. 3) block is in the final position shown. Each individual movement is counted as a move. The least number of moves in which the writer has done it or seen it done is 81. Perhaps it can be done in less!

Solution to the Puzzle

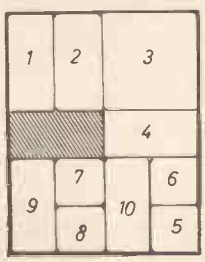


Start as shown here.

1st Stage: Blocks 1, 2 and 3 unmoved.

Move		No.
7, 8, 5 & 6	down one square each	4
4	across two squares to right	1
9, 10	up one square each	2
7	across two squares to left	1
10	down one square	1
4	across one square to left	1
6	up one square	1
5	across one square to right	1
10	ditto	1
7	ditto and up one square	2
9	down one square	1
4	across one square to left	1
10	up one square	1
8	across two squares to left	1
10, 6, 5	down one square each	3
4	across two squares to right	1
		23

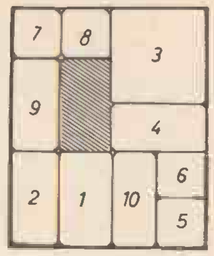
The blocks should then appear as above right.



Stage 2 layout.

2nd Stage:

7	up one square and across to left	2
2	down two squares	1
1	across one square to right	1
7	up two squares	1
9	up two squares	1
8	across one square to left	1
2	down one square	1
1	down one square	1
7	across one square to right	1
9	up one square	1
8	up two squares	1
2	across one square to left	1
1	down two squares	1
8	across one square to right	1
9	down one square	1
7	across 1 square to left	1
8	up two squares	1
		18



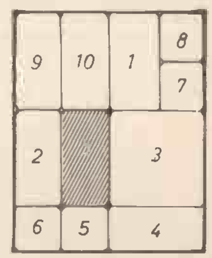
The space should now be in the middle.

The blocks should then appear as above:

3rd Stage:

1	up two squares	1
10	across 1 square to left	1
6	across 1 square to left and down one square	2
4	down one square	1
3	down one square	1
8	across two squares to right	1
7	across two squares to right	1
1	up one square	1
9	up one square	1
2	up one square	1
10	up one square	1
6	across two squares to left	1
5	across two squares to left	1
4	down one square	1
3	down one square	1
7	down one square	1
7	across one square to right	1
1	across one square to right	1
10	up two squares	1
		20

Layout for the 4th stage.



The blocks should then appear as above:

4th Stage:

3	across one square to left	1
7	down two squares	1
8	down two squares	1
1	across one square to right	1
10	across one square to right	1
9	across one square to right	1
2	up two squares	1
3	across one square to left	1
8	across one square to left	1
7	up one square	1
4	up one square	1
6	across two squares to right	1
5	across two squares to right	1
3	down one square	1
8	across two squares to left	1
7	across two squares to left	1
4	up one square	1
5	up one square	1
6	across one square to right	1
3	across one square to right	1
		20

Total 81 moves.

The solved puzzle.

A COMPOUND ASTRONOMICAL TELESCOPE

Design Formulae and a description of an Instrument for the Advanced Telescope Maker

By C. G. Shuttlewood, A.M.I.E.D.

ASTRONOMICAL telescopes for the amateur astronomer are generally of the Newtonian or simple reflector type, the optical train consisting of a paraboloidal primary mirror, a diagonal mirror or 90 deg. prism, and the eyepiece (Fig. 1).

The writer has made several of this type, ranging in size from 4in. to 9in. with focal ratios increasing with each new mirror up to f/11, or 99in. focal length, with the 9in. mirror.

Each of these instruments was more satisfactory than the one before, but the larger the mirror for a given focal ratio, the longer is the telescope. Eventually the user of the Newtonian reflector finds himself perched on a large pair of steps when observing any object with an angular height of more than approximately 35 deg. above the horizon, and a major balancing feat is required to view objects at or near the zenith.

With this in mind, and the need for an instrument of greater aperture for Lunar and Planetary work, various designs of reflecting telescopes were examined by the writer, until it became increasingly clear that the Cassegrain reflector (Fig. 2) would be the ideal instrument, but the figuring and testing of the convex aspherical (Hyperbolic) secondary mirror would present a difficulty.

Principle of Cassegrain Telescope

As will be seen from Fig. 2, the Cassegrain is a compound instrument, in which light enters the primary and is then reflected back to a focus, as in the Newtonian, but in the Cassegrain the cone of rays is then intercepted, not by a diagonal or prism, but by a convex hyperbolic secondary mirror. This, by the normal laws of reflection, causes the rays to diverge (Figs. 3 and 4) thus altering the angle of the cone of rays and hence the focal ratio of the instrument. The new or "Effective" focal ratio of the instrument is the number obtained by dividing the diameter of the primary into the length of the new angular cone produced to the diameter of the primary (Fig. 5). More simply, the convex hyperbolic secondary mirror has an amplifying effect on the focal ratio of the primary mirror, so that it is possible to build, as the writer has, an instrument of f/30 in the space required by an f/6 Newtonian.

Dall-Kirkham System

The difficulty of figuring and testing the hyperbolic secondary mirror has already been mentioned, but research by Horace Dall in England and Alan Kirkham in America has resulted in an ingenious method of overcoming this, and their formulae have been used in the construction of the telescope to be described, and are set out in these pages.

The Dall-Kirkham Cassegrain reflector differs from the normal Cassegrain only in the figures of its primary and secondary mirrors, the modified figures being such that they may be accurately made and tested by the average, experienced amateur.

The secondary mirror is deliberately left spherical, this condition being the same as an

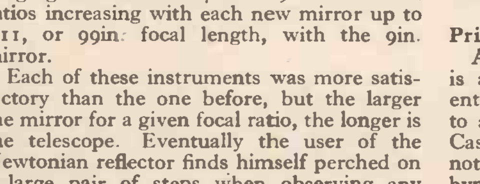


Fig. 1.—Optical train of Newtonian reflector.

Fig. 2.—Optical train of Cassegrain reflector.

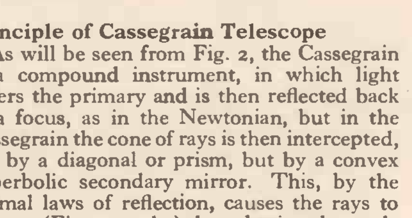


Fig. 3.—Convex mirror changing parallel rays to divergent rays.

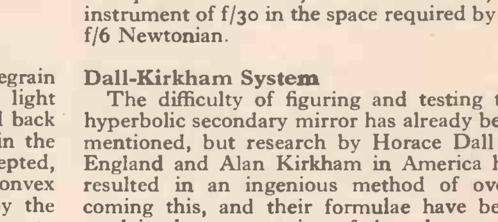
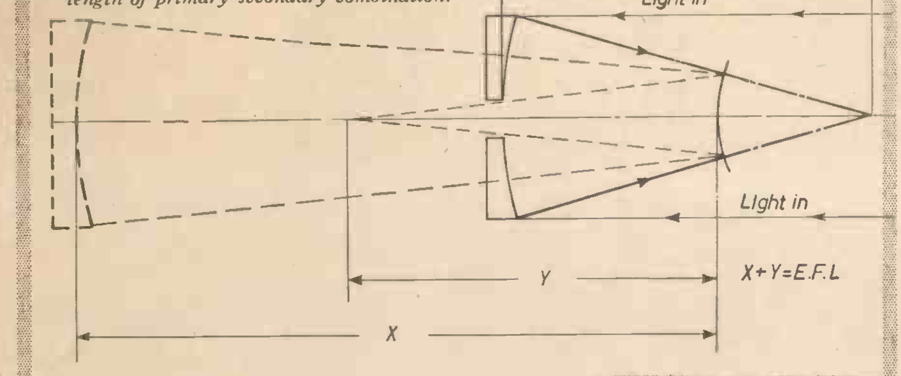
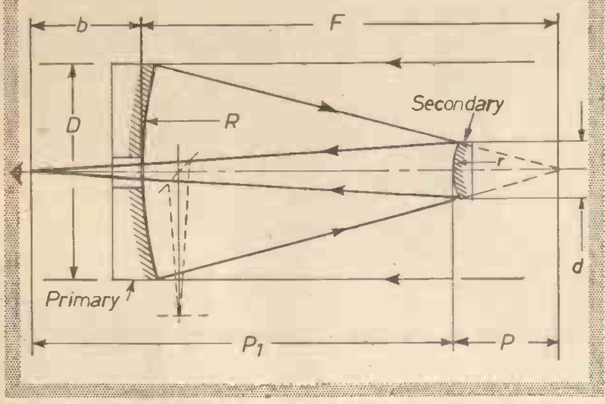


Fig. 4.—Change of angle from B to θ by convex mirror.

Fig. 5.—Focus of primary and effective focal length of primary-secondary combination.





A = amplification, e.g., with 60in. focus primary, and A = 3, *effective* focal length of telescope is 180in.

R = radius of curvature of primary.

r = radius of curvature of secondary.

A, F, b, are set by the designer.

Min. dia. of secondary.

$$d = \frac{D(\text{primary})}{F(\text{primary})} \times P$$

Formulae

$$P = \frac{F + b}{A + 1} \quad \text{— a}$$

$$r = \frac{2 \times P_1 \times P}{P_1 - P} \quad \text{— b}$$

Fraction of Correction (Primary)

$$F_R = 1 - \left[\left(\frac{4 \times P^2}{R \times r}\right)\left(\frac{P_1 + P}{P_1}\right)^2\right] \quad \text{— c}$$

Example

6in., f3 primary, A = 3, F = 18in., b = 6in.

$$P = \frac{18 + 6}{3 + 1} = \underline{\underline{6\text{in.}}}$$

$$r = \frac{2 \times 18 \times 6}{18 - 6} = \underline{\underline{18\text{in.}}}$$

$$F_R = 1 - \left[\left(\frac{4 \times 6 \times 6}{36 \times 18}\right)\left(\frac{18 + 6}{18}\right)^2\right] = 0{\cdot}606$$

say 0·61.

overcorrected hyperboloid and introducing negative spherical aberration into the system. To correct this, the primary mirror is under-corrected, giving it positive spherical aberration, thus cancelling out the negative spherical aberration introduced by the use of a spherical secondary. The net result is a Cassegrain optical system without the arduous work of producing a hyperbolic secondary mirror.

The primary mirror is ground and polished out to a truly spherical surface in the normal manner, and the corrections to be applied in the figuring of the mirror are calculated from formula "c," for clarity these should be set out as shown in the Table of Corrections.

Firstly, the corrections for each radius zone of the primary are calculated using the normal formula:

$$\frac{(\text{Radius of Zone})^2}{2 \times \text{Radius of Curvature}}$$

It should here be mentioned that the Foucault shadow test apparatus used by the writer has both knife edge *and* light source moving.

When only the knife edge is capable of movement along the cone of rays, the formula becomes:

$$\frac{(\text{Radius of Zone})^2}{\text{Radius of Curvature}}$$

Having calculated these corrections, their differences should be set down in the next column, as it is to these differences that the fraction of parabolisation, calculated from formula "c" must be applied, and, if set down in the last column, will show the actual corrections to make between each radius zone on the mirror, using the centre zone as the zero datum. When fully satisfied that the primary mirror measures up to these requirements, it should be carefully covered and stored away.

Secondary Mirror

Two discs of glass, equal in diameter and thickness, are required for the making of the secondary mirror, their diameters may be calculated using formula "d," and their thickness should be approximately one-sixth of their diameters in each case.

Grinding is carried out in the normal way, remembering that in this case the mirror is to be convex, therefore grinding is carried out with the mirror disc fixed down face uppermost and the tool disc on top, the tool disc being moved in the normal grinding strokes. Care should be taken to ensure that grits do not get to the back of the mirror disc during grinding, as it is necessary to see through this when testing the figure of the secondary.

Testing the Secondary

After fine grinding, the polishing of the convex spherical secondary presents no problems, but the testing does. The following method is the simplest and easiest to use, requiring, as it does, no elaborate equipment, merely a few moments extra work being necessary.

The idea is that, in the fine ground surfaces of the mirror and tool, we have two absolutely matching spherical surfaces, and if these matching surfaces were polished, then it would be possible to check the truth or otherwise of the spherical surfaces by reading the interference fringes or "Newton's Rings" formed by the two surfaces in contact.

To accomplish this, it is necessary to polish the concave tool, and this is best done in the normal way by building a polishing lap on the convex surface of, in this case, the mirror.

The writer has found that the making of laps is much easier if H.C.F., or "Honey Comb Foundation" beeswax is used. This may be bought quite cheaply from the local Apiarists supplier (approximately 1s. 6d. per sheet, 13in. × 8in.). It is a sheet of beeswax about $\frac{1}{16}$in. thick embossed all over with a regular pattern of small hollow hexagonal cells, the walls of which do the actual polishing. The hollow cells act as reservoirs for the rouge/water polishing agent.

Making the Lap

The surface on which the lap is to be built is cleaned, warmed, and swabbed with turpentine. A hot 60/40 mixture of melted pitch and turpentine is then painted over the surface, and a piece of H.C.F., a little larger than the mirror, is placed on this sticky pitch glued and pressed into form and contact by the previously rouged concave tool.

Polishing of the concave tool can commence after trimming the edge of the lap to a diameter slightly less than that of the tool, and the

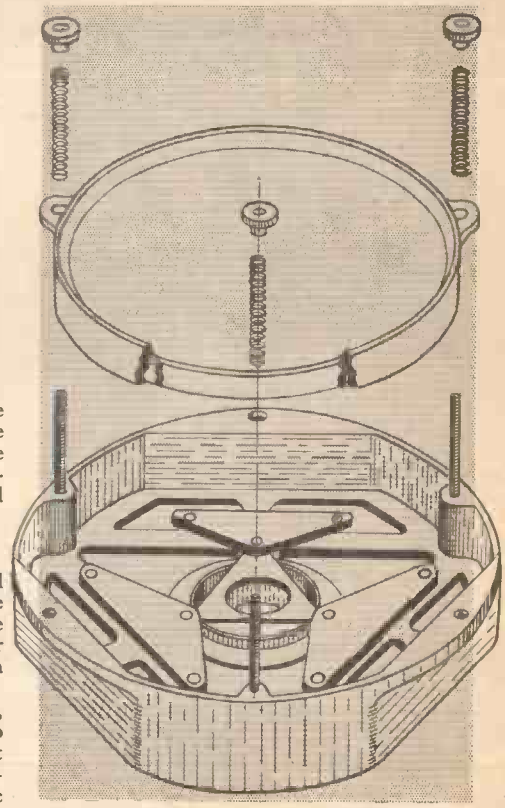


Fig. 6.—Exploded view of mirror cell.

Example of Layout of Table of Corrections for Primary

Zone rad.	$r^2/2R$	*Difference*	*Fraction*
0in.	0		
		} 0·014in.	0·008in.
1in.	0·014in.		
		} 0·042in.	0·026in.
2in.	0·056in.		
		} 0·059in.	0·036in.
2¾in.	0·115in.		

quicker the polishing is done, the more likely it is that the curve will remain truly spherical. By this is meant that the shorter the period of time spent polishing, the less likely is the chance of the surface becoming oblate.

When a polish has been attained, the surface can be tested in the normal manner for a concave mirror, by the Foucault shadow test or the Ronchi grid test, its radius of curvature being checked by direct measurement.

The polishing need only be carried to the stage where it is possible to see clearly through the fine ground surface. The greyness left by a few tiny grinding pits will not interfere to any great extent with the interference fringe test of the fully-polished convex secondary mirror.

The concave tool, when polished and truly spherical, can now be regarded as the " master plate " against which the convex secondary mirror must be tested, and it should, like the finished primary, be stored away in a place of safety until required.

Having used the glass tool to make the master plate, a tool must be made on which can be built the lap for polishing the convex mirror. A metal tool with the radius of curvature rough turned on one surface is to be preferred but where this is not possible, a tool of plaster of paris will do the job admirably.

Making and Using the Plaster Tool

The pitch and beeswax are carefully stripped from the mirror, turpentine removing the most stubborn pitch. It is then well washed, dried and the convex surface lightly greased to prevent the plaster mix adhering to it.

The mirror is then placed convex side up on a flat plate and a piece of thin card wrapped

Fig. 7.—The equatorial head of the 12in. telescope.

around its edge to form a cylindrical retaining wall. Into this, on to the greased surface of the mirror, is poured a thin mix of plaster of paris, to a depth of about twice the thickness of the mirror.

When the plaster has hardened, the band of card is stripped off, the mirror carefully slid out of contact. The plaster tool, after edge trimming where necessary, is pitch coated on its concave surface and a layer of H.C.F. pressed into form and contact by the convex surface of the secondary mirror, said surface having been cleaned, warmed, and wet rouge coated.

Polishing is carried out normally, using a short stroke. Immediately a polish is attained, the mirror is cleaned and dried. After a short interval (15 minutes) for cooling to ambient temperature, the convex surface of the mirror is carefully placed in contact with the concave surface of the master plate, making sure that no dust lies between the two surfaces.

If the two discs in contact are now laid flat on a dark background, and viewed by reflected light, a series of faint coloured rings will be seen. The number and concentricity of these immediately show the accuracy or otherwise of the figure of the mirror.

Should there be only three or less rings, and these be concentric with each other and the centre of the mirror, then the mirror is accurate to the test plate and polishing may be completed, with, of course, frequent reference to the test plate to ensure that the figure is being maintained.

Four to six concentric rings shows that the mirror is spherical but the radii of curvature of the mirror and the test plate differ very slightly, this is not serious, and may be corrected by suitable modification of the polishing lap, polishing then being completed with, again, frequent testing.

Six to ten or more rings show that fine grinding was not properly controlled, as does badly distorted or eccentric rings, and the writer would advise (from bitter experience!) that polishing be abandoned and the mirror and tool be returned to fine grinding.

The completed mirrors are now ready for aluminising or silvering, but this should not be done until the telescope is completed and ready to receive them.

The Telescope

The building of the telescope and its equatorial mounting is best left to the individual, but a description of the writer's instrument will give some idea of the work involved (see heading photograph).

The primary mirror is 12in. in diameter, with a focal length of 72in., and is 0·81 parabolised. The secondary mirror has a diameter of 2⅜in., and is truly spherical at a radius of curvature of 30in. The equivalent focal length of the combination is 360in. (f/30).

The base for the instrument is of skeleton form, being built of angle iron, triangulated for rigidity, and with the frame angle as near as possible to the angle of latitude of the site. It is an extremely rigid structure and is securely bolted down to a circular concrete base set deep into the ground.

The Polar axis and its bearings are carried on a length of channel iron, the bearing housings being bolted centrally on the web. A 70-tooth wormwheel is mounted on the 1¾in. dia. Polar shaft, fixed bearing collars on each side of the wormwheel retain it in position when it is unclamped from Polar shaft to allow speedy changes in Right Ascension setting.

The worm shaft bearings are built into the flanges of the channel, so that the worm is housed in and beneath the channel, a slot in the web allowing the worm and wormwheel to engage. Adjustment of centre distance, to eliminate backlash, is facilitated by shims under the Polar shaft bearing housings. The centre distance is set 0·010in. minus when boring the worm shaft bearing bores.

The bearings are, a plain phosphor-bronze sleeve at the front and a ¾in. combined journal and thrust ball race at the rear, the shaft being shouldered to take this.

The complete assembly is mounted on the base frame by pivot bolts at its centre of length, and, by adjusting on push bolts set to bear on the front and rear of the channel piece, the angle of the Polar Axis may be very finely set (Fig. 7).

The Polar Axis carries a large cast iron plate at its upper end, and to this is affixed the Declination shaft bearing assembly. These bearings are similar to those of the Polar Axis, with the addition of a thrust race to allow thrust in either direction along the Declination Axis. The direction of thrust depends on the position of the telescope about the Polar Axis.

The 1¾in. dia. Declination Axis shaft has an extension at one end to carry the large counterpoise weight (approximately 60lb.) and at the telescope end the shaft carries a rectangular framework of angle iron to which the telescope itself is firmly attached when in use.

The Telescope Tube

This is a square framework construction, 15in. × 15in. × 5ft. 6in. long. The square frames of angle iron were first notched and bent and the longerons and bracing pieces were then bolted or riveted to them. The base of the tube carries three steel plates which are the mounting points for the primary mirror cell.

Primary Mirror Cell and Mount

The cell is an aluminium casting, and the patterning and casting made this a fairly expensive object. The expense was justified, however, as a properly designed cell assists greatly in the circulation of air around the mirror, which means that the figure of the mirror will remain reasonably constant throughout a night's observing.

The method of mounting the primary mirror, as it is rather thin (1¼in.) for its 12in. dia., required some thought, and a nine-point support system was eventually chosen. In this system, the back of the cell is tapped to receive three ball ended adjusting screws and, inside the cell, each of these carries a triangular plate. The size of the base triangles of these plates is dependent on the diameter of the primary mirror.

The plates are dimpled on the underside to receive the ball ends of the adjusting screws and have three dimples on the upper surface to locate small steel balls on which the mirror rests.

The mirror is edge insulated by a ⅛in. thick soft leather band, around which is the steel support ring, which has a soft aluminium ring fitted internally at its upper edge to retain the mirror and three equally spaced bushed lugs affixed to its outer surface.

These lugs slide over threaded rods tapped into the front of the cell and thus locate the

Fig. 8.—Rear view of the primary mirror cell, showing the mirror adjusting screws.

mirror laterally. The lugs have compression springs above them, also sliding on the threaded rods, and these are held in place by knurled nuts, thus allowing for adjustment of the loading on the mirror retaining ring. The loading is just enough to keep the mirror on its support system with the telescope in any position normally used (Fig. 6).

The primary mirror in its cell is thus a complete unit which may be mounted on, or dismounted from, the telescope without disturbing the optical alignment of the instrument (Fig. 8).

The secondary mirror mounting is a similar but simpler cell on a much smaller scale, with the addition of a spigot on its rear face to allow it to be pushed and locked into the cruciform mounted tubular carrier or spider.

(*Concluded on page 562*)

HOME MADE CHEMIC

Constructional details supplement

By
K.
Give

IT is intended in this series to show how a little ingenuity can produce apparatus which will enable the practical experimenter to carry out the experiments listed in any standard chemistry book, for a cost of only a few shillings. Qualitative work will hardly be affected in the accuracy, but naturally quantitative work is bound to have some small error introduced.

Basic Requirements

Very little will be required in the first instance, except a supply of 3, 4 or 5mm. soda glass tubing. It is obtainable from a large chain chemist's store, most chemists if ordered, and any laboratory supplier such as Messrs. Griffin and George, London, W.C.2, or Messrs. Laboratory Glass Industry, 85 Clifton Road, London, E.5. One pound of each of the above would furnish approximately 200, 100 and 50ft. of tubing. This would be enough to last for years. The approximate cost is 5s. per lb.

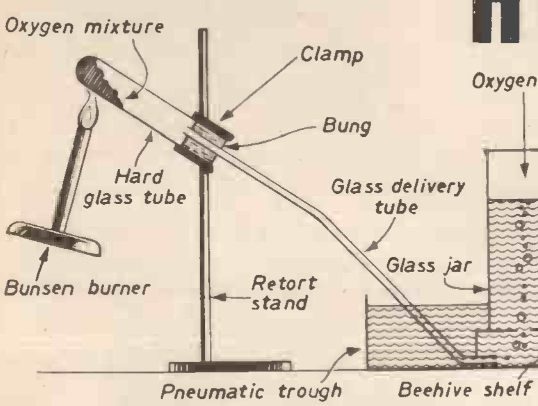


Fig. 1.—Standard text-book arrangement for the preparation of oxygen.

It is not worthwhile to try and make test tubes, especially the larger ones, and these can be purchased from any chemist for a few pence. Soda glass tubes are cheapest, but are the more expensive in the long run as they are very easily cracked and broken. Readers should specify one of the following types of glass when ordering: Pyrex, Monax, Hysil or B.R.G. (British Resistance Glass). A few tubes of 1in. dia. and a dozen of ½in. should be all that is required. Details will be given later showing how to make test tubes suitable for low temperature work.

For the supply of heat the would-be experimenter can use a builder's ½-pint blowlamp. One of these will do all that a bunsen burner will and can be moved about with greater ease. One running on paraffin is safer than the petrol type, and in any case it should be made with a brass reservoir or rust might make it unsafe. Calor gas and a bunsen burner is suitable should no domestic gas be available. A spirit lamp will also do most jobs and the newer "vapour" type spirit blowlamps will probably be far superior. Details will be given later in the series of a suitable spirit lamp and bunsen burner. A camper's primus stove is also useful.

Preparation of Oxygen

Let us consider the basic apparatus required for the standard laboratory method of preparing oxygen from potassium chlorate with the catalyst manganese dioxide. The apparatus, typical of many a text book, is shown set up in Fig. 1. About half a teaspoonful of each chemical is mixed in the tube and gentle heat applied, care being taken that the mixture does not slide down and block the tube. The tube is tilted to stop water running back and cracking it. When the experiment is completed disconnect the bung before removing the heat. Impure chemicals can cause an *explosion* so keep them clean, and if in doubt throw them away. Soot and carbon in any form are particularly dangerous. Bake the manganese dioxide on a tin lid for added safety: a red heat will do no harm.

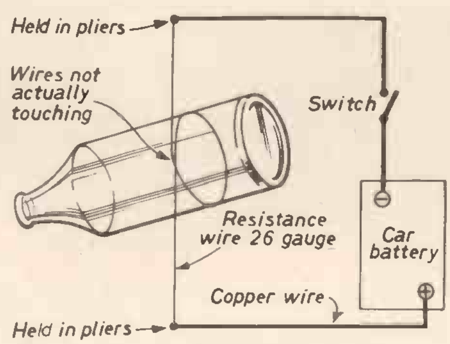


Fig. 3.—Basic method of bottle cutting.

It is now proposed to show how every part of this apparatus may be produced at home.

The Hard Glass Tube

In lieu of this you may use a small golden syrup tin fitted with a push-on type lid and which has been very thoroughly washed free of sugar, washed again and doubly checked for cleanliness particularly under the lid holding rim. A small copper pipe of about ¼in. bore (obtainable from Messrs. Whiston's Ltd., or from model engineering shops) is soldered into a hole in the lid (Fig. 2). A rubber tube (obtainable from motor cycle stores, ironmongers or laboratory suppliers) is slipped over the copper one and acts as a delivery tube. To obviate a kink it is best to soft anneal the copper tube, and bend it as shown. To soft anneal, heat the tube to redness and then plunge into cold water. It will then be very soft and may be bent with ease. During the experiment you cannot see the reaction taking place. Therefore heat very carefully and do not continue with a large flame so as to melt the solder. No harm would be done, however, should you do so.

It is also possible to use a piece of gas or water pipe which has been cleaned out and fitted with a "Cap" which can be obtained from any builder's merchants. A bark cork is necessary and the tube should be at least 8in. long. A copper or glass tube may be inserted into the cork. When put together test for air tightness by plunging under water and blowing down the tube. When heating the tube remember that the bulk of iron is rather large and you cannot easily slow down the reaction should you overheat. On the other hand it is more difficult to overheat as the iron heats up much more slowly than glass.

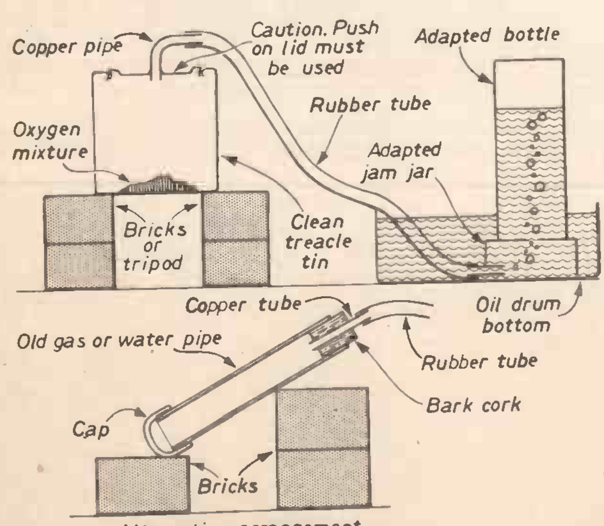


Fig. 2.—Home-made apparatus for the preparation of oxygen.

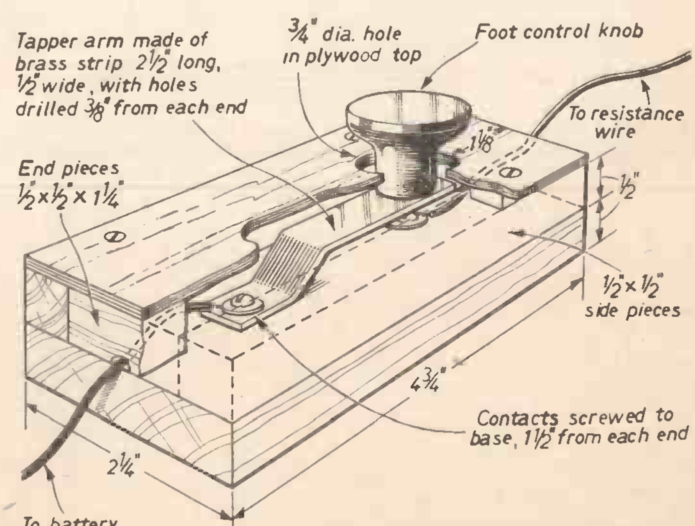


Fig. 4.—Cutaway perspective view, giving details of the foot switch.

The Delivery Tube

Conventionally of glass, this can be rubber, polythene or even some types of draught excluder rubber may be used. Do not try to use cycle valve rubber. A small piece of copper pipe on the free end will stop it floating in the trough.

The Trough

This is best made of glass as it enables clear vision of the complete experiment and is corrosion free (important in some other experiments). A good strong general purpose trough may be made using the bottom of an old oil drum. A line is scribed round it 4in. to 5in. from the bottom and a fine-toothed hacksaw used to cut round the line. The trough is finished by cleaning up with a file,

BEGINNING A NEW SERIES

AL LABORATORY APPARATUS

ed by details of experiments

washing with detergent and testing for leaks from the tap plug (solder if necessary). A coat of white lead paint or cellulose enamel makes it rust proof and gives it a professional appearance. Note that the flatter the bottom of the drum the more suitable it is. The other half of the drum, with the old cap soldered on, when it is painted, makes an admirable waste bin for broken glass.

A more professional trough may be made from the bottom part of a large bottle. The type of 1 gallon jar restaurants buy their lemon squash in is best. Winchester quarts also make nice troughs, but they are rather on the small side. The operation involves cutting the bottle and grinding the crude cuts flat with carborundum.

Cutting Bottles

This operation is easily done with a red-hot electric resistance wire, and after an initial practice period only about 5 per cent. failures will result. Power is preferably obtained from a 12 V. car battery, although with six volts all but the largest bottles may be cut. If a transformer is used for power it must be able to supply 12 V. at 6 A. (Messrs. Radio Supply Co., of Leeds can supply a charger type rated at 15 V., 6 A., this costs 23s. and is quite suitable). The wire is 26g. Eureka or Constantin and is available from laboratory suppliers or Post Radio Supplies, 33 Bourne Gardens, E.14. An ounce is all that is required for a start.

The basic operation is shown in Fig. 3. The car battery, which may be left in the vehicle if necessary, is wired through heavy 10 A. cable with an optional switch to between 1ft. 8 in. and 1ft. 10in. of resistance wire. Half this is used for 6 V. operation. The joins are held in pliers and the wire wrapped once round the bottle. The wire must be held taut and must not quite touch where it crosses. When all is well the switch is put on or the battery plug connected. After about 30 sec. if the bottle has not cracked completely round, remove it and hold it under the cold tap. In most cases a neat crack will form, and if you are not ready one half of the bottle will break in the sink. The lower the ambient air temperature the more likely the bottle is to crack without the water treatment.

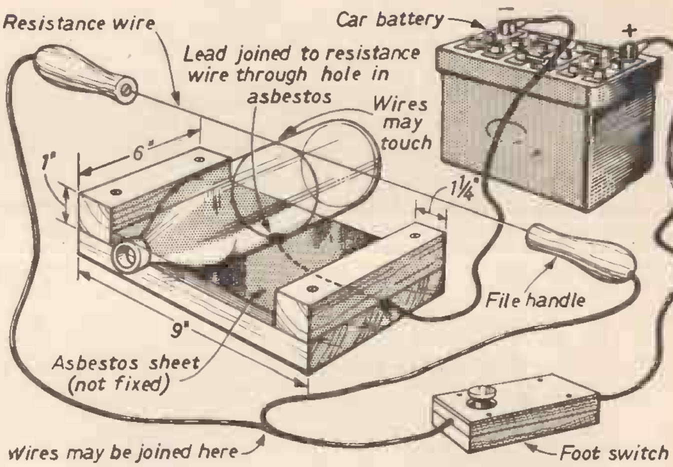


Fig. 6.—Permanent bottle cutter details, showing wiring.

The above operations are carried out much more easily and quickly if a foot-operated switch is used.

Foot-operated Switch

Details of a switch are given in Fig. 4. Although readers can obtain a motor-car foot-operated dip switch from Messrs. Halfords for a few shillings. The one shown is basically a brass strip bent so that when it is pressed it

Fig. 5.—The completed foot switch with cover removed.

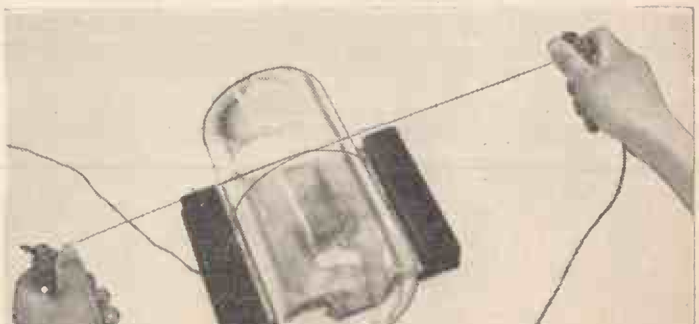


Fig. 7.—The permanent bottle cutter in use.

contacts on to a largish brass screw. A small kitchen cabinet type plastic knob is fitted and the whole is enclosed in a wooden case. The knob should be larger at the top than at the bottom and the hole in the top cover just large enough to allow free travel. No grit, etc., can then get in and stop contact being made. The knob will have to be "threaded" through the cover hole before being fixed to the brass strip.

Wiring must be in heavy gauge insulated cable, capable of taking about 10 A. or there will be too much voltage drop along the length of the circuit and the length of available resistance wire would have to be shortened in order to keep the heat output at a suitable value. With six-volt operation this would mean having a rather useless length for bottle cracking.

The completed switch is shown in Fig. 5.

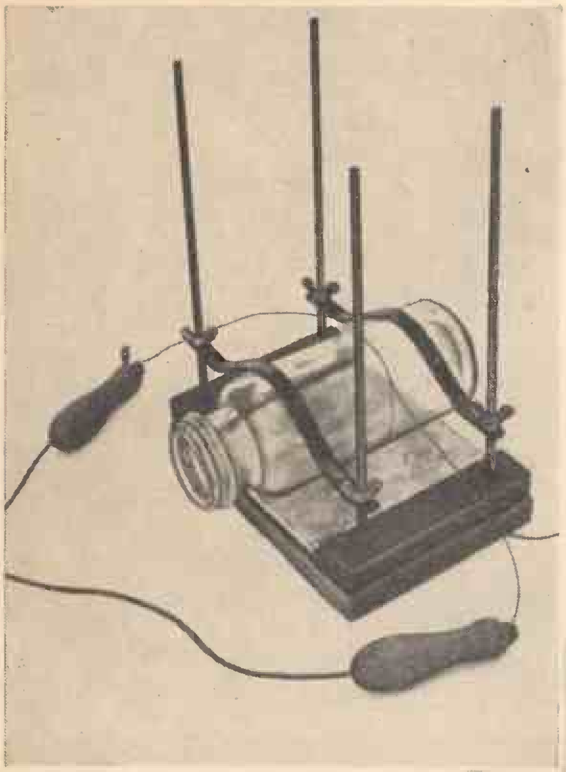


Fig. 8.—An improved version of the permanent bottle cutter.

A "Parallel Wired" Bottle Cutter

Two devices of this paricular type were evolved. The principle behind them is that instead of having one hot wire, two are used and that the connection to one side of the battery is to the join of the two resistance wires (see Fig. 6). The other ends are joined by a long length of copper wire and led to the other side of the battery. Each wire will get hot on its own and when on together they may be wrapped round a bottle as shown and it will not matter if the wires touch, as they are at equal potential all the way along.

To avoid having to hold the hot wires in pliers, file handles may be used with wood screws and washers at the ends to hold the "hot" wires. The copper wire leads may be taken through holes drilled through the handles, they are then less likely to get tangled up in the hot wires and have their insulation ruined.

A base of $\frac{1}{2}$in. softwood is fitted with two small wooden strips and a small sheet of asbestos sheet or cloth (an ironing pad will do) fitted in the centre. The asbestos is not fixed down. In the centre is a small $\frac{1}{16}$ in. hole for the two resistance wires which are anchored below with a countersunk wood or metal screw with a countersunk nut. A lead to the fixing point of the wires is taken by drilling the base along its length or taking out a groove from one side to the centre. Good 10 A. cable is again essential. Readers who are not conversant with electrical wiring should make sure the connection to the resistance wires is absolutely perfect or overheating will fuse the wires. Note also in Fig. 6 that the leads from the two file handles do *not* go to either side of the foot switch but are both connected to one side.

The apparatus thus made will quickly and accurately cut bottles, jam jars, etc., at a speed of about one a minute with very few failures. If the initial 30 sec. does not crack the bottle do not heat any longer, use the cold water tap as stated. If heat is applied for a long time and then the bottle is water treated a nasty serrated crack will result, whereas it should be perfectly clean, but sharp.

The resistance wire will give about an hour's use before it fuses, this could be overcome by using nickel chrome wire, but the expense would be considerably greater and a slight adjustment in length of the heater wires might be necessary. The completed device is shown in use in Fig. 7.

Bottles without a smooth clean outside are not suitable for this method of cutting and should not be used unless readers are satisfied with about 50 per cent. success.

Fig. 9.—Grinding the cut surface smooth using carborundum powder and water on a piece of plate glass.

An Improved "Parallel Wired" Bottle Cutter

Single-handed accurate working of the above apparatus can be a little tricky and it was to avoid a lot of glass having to be ground off in a tedious operation that the improved model was made.

From Fig. 8 it can be seen that two pairs of threaded rods ($\frac{1}{4}$in. Whit.) are fixed into the end pieces of the base. These lengths can be obtained from Messrs. Whistons, but should also be obtainable from good general ironmongers. Long bolts with threads along most of the length or coach bolts with the threads extended would also suit. The actual thread does not matter as long as nuts are obtained to suit. The rods may be bolted into the base strips with two nuts on each or they may be a very tight screw fit into the wood. Four wing nuts are fitted to each.

Two clamps of $\frac{1}{2}$in. × $\frac{1}{8}$in. mild steel strip are drilled and bent to a small radius as in Fig. 8. The holes in these strips should be $\frac{5}{16}$ in. and smooth or the strips will bind in the threads.

In operation the bottle may be clamped exactly where the operator requires. The crack will occur, of course, on a line passing through the centre hole in the asbestos sheet. This can be seen through clear bottles. An ink line across the asbestos sheet and end pieces may also be used as a guide. When clamped, operation is as before. It is an advantage to screw the whole arrangement to the bench and to chamfer off the end pieces so that large (gallon) bottles may fit easily (see Fig. 8).

Throughout this series much use will be made of this apparatus in producing gas jars, bee-hive shelves, Kipp's Apparatus, flasks, troughs, etc.

Grinding the Sharp Cut Surfaces

After experiment the method shown in Fig. 9 was found to be very successful. A sheet of plate glass is wetted and sprinkled with medium carborundum powder. A teaspoonful is made into a paste with water and is placed in the centre of the plate. The bottle which has been cut is placed over the centre pile of paste and is very gently moved round in circles in a spiral "rotary" movement. Not until the glass is touching all over its surface must greater pressure be applied or a crack may start. Keep the surplus paste in the centre and dampen if necessary. About three minutes will grind most cleanly cut surfaces Bad cuts, say, $\frac{1}{8}$in. out, may take 20 minutes or longer to grind flat and if plenty of bottles, etc., are available it is often best to discard "poor cuts."

Carborundum powder is obtainable from ironmongers and probably medium grade valve paste sold by garages and Halfords will suit. Pure turpentine may be used as the lubricant, but the author found water rather easier to use as it does not dry off so quickly by evaporation. Since carborundum powder is so cheap it is best to use another spoonful for each operation as its cutting ability deteriorates with use.

For very fine work such as is necessary on Bell and gas jars three sheets of plate glass should be used. The first for rough grinding, the second for the bulk of the grinding and the third for the final smoothing. The third one should be replaced now and again and the second one moved over to first place.

The author found a square foot of glass suitable for most jobs.

A selection of completed troughs and a commercial type are shown in Fig. 10.

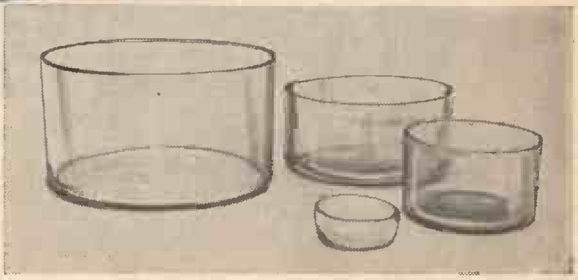


Fig. 10.—A selection of completed troughs. The large one on the left is a commercially produced type.

USING A PORTABLE IN YOUR CAR

Some hints for improving reception

By L. E. Higgs

DESPITE advertised claims to the contrary, few battery portable radios work well in a car. The screening effect of the steel body, reduced signal strength on long journeys between transmitters, fading under bridges, and from the turning of the vehicle, all this, plus the heavy electrical interference from the parent car and surrounding traffic have compelled manufacturers to fit sockets for an external car aerial.

Source of Trouble

This is a great improvement, but still falls short of the noise-free performance of the permanently fitted automobile radio. The trouble is due mainly to the frame or ferrite rod aerials fitted inside the radio. These are still in circuit. Their efficiency, ideal for house and beach use, is now unfortunately picking up much of the vehicle noise missed by the external aerial, and passing it on to the set. The situation is aggravated when the user places it in the dash compartment—only a few inches from some engines, and doubly screened from the transmission.

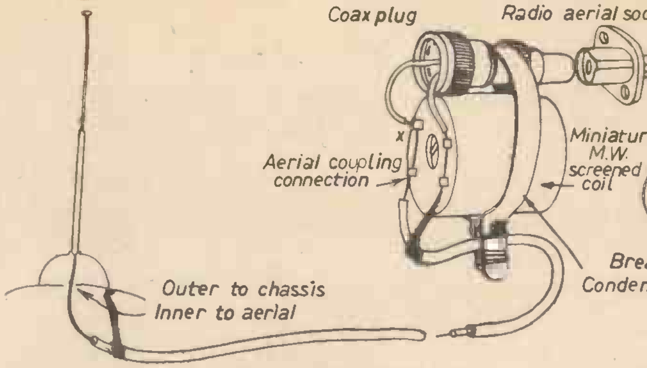


Fig. 2.—Connect the coil to a coaxial lead.

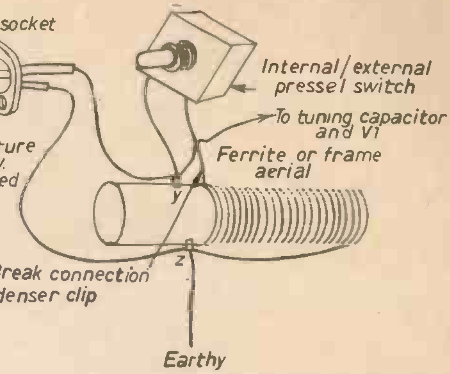


Fig. 3.—The pressel switch—keep the connections short.

The Solution

The logical solution then is to disconnect the internal aerial when the car aerial is plugged in. This means we must replace it with a lumped, screened inductance, of the same value as the removed loop. Simple enough. If however the radio is a miniature, with no room for a normal sized switch, let alone an extra screened coil; if the transition from external to internal is to be quick, and the modification easy, with no disruption of the radio circuit or defacing of the case; if long and medium wave results are to be preserved, and the modification to apply to all portable circuits, then the problem is far from simple.

Two Methods

By keeping to medium wave only, classifying most receivers into two categories, the following pair of simple inexpensive alterations cover nearly all cases, including:

(a) Valve and transistor radios where the medium wave tuned circuit connects directly to the grid or base respectively.

(b) Receivers where a coupling coil exists between the tuned MW circuit and the first transistor (used for impedance matching). Also for receivers with more complex input circuits.

Method (a) requires only a small pressel switch to be added to the set. The extra tuned coil is fitted on the input plug to the external aerial. This is automatically connected across the switched out internal coil, just by plugging in.

Method (b) is more versatile but requires the fitting of a double pole changeover switch, and the adding of an extra screened coil inside the radio. The wiring is a little more involved than method (a). (That only requires one cut connection in most cases.)

Constructional Details of Method (a)

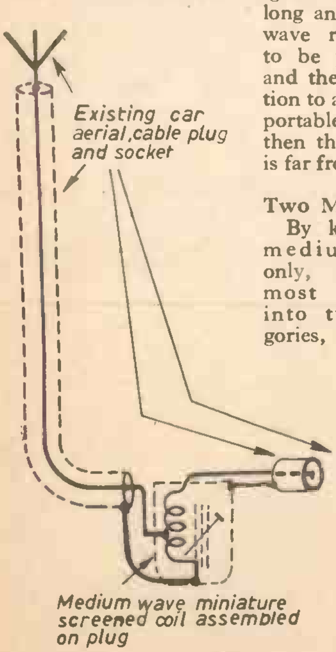
The safest procedure is to experiment first with the loose lead circuit to be described. After satisfactory results have been obtained, the final fixing can be made into the set. This way, should any unforeseen complications arise then the radio can be reconnected as found and not disfigured in any way.

The substitute MW screened coil must be small in size, screened, and with an adjustable dust core. Several types are available in the lists of components makers. The particular coil with which these tests were made was a transistor miniature 465 kc/s. IF transformer with a few turns stripped off until it resonated at 1·5 Mc/s. on its own self capacity. If there is no test equipment handy, then an easy way of checking this is merely to connect it in place of the MW coil of the radio, using short leads, and tune the core, or alter the number of turns until the sensitivity reaches a peak. Loosely couple the aerial to the grid circuit as shown in Fig. 1.

Most purchased coils have a coupling aerial coil or tapping fitted. And if you are winding your own, then copy the type of circuit used by the maker. Where no external provision exists, an overwind of 25 per cent. of the main coil will do. Connect this coil to a coaxial lead long enough to reach the intended position of the car aerial (Fig. 2). Leave two flex leads of 6in. each, from the earth end of the main coil, and the grid or top end.

Open the radio and identify the MW coil aerial. This can be on the ferrite rod, or a few loops of wire forming a frame aerial in the lid or cabinet. It is important that this coil is correctly recognised. Use the circuit diagram if available. Otherwise it is the smaller of the LW and MW pair, usually single layer wound, and not to be confused with coupling windings and tappings. A helpful clue is the effect on the MW results when the "top" end of the coil is touched. This considerably increases the signals, and noise, when tuned to a *weak* station. Once the grid end is found the bottom end can be traced.

Cut only the top end of the MW coil connection, leaving any other leads to the tuning ganged capacitor and switch intact. Solder the flex lead marked x, to the point y, just isolated from the MW coil top end. Connect the remaining lead from the made up substitute coil to the earthy end of the MW coil in the radio. There is no need to disconnect the bottom end.



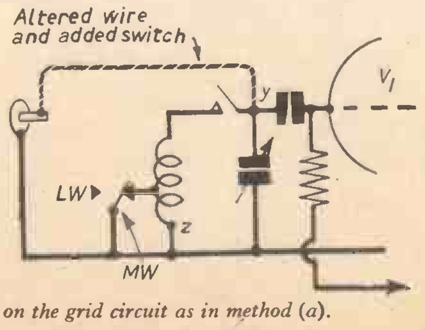


Fig. 1.—Coupling the aerial on the grid circuit as in method (a).

Testing

The radio can now be tested, using the car aerial or a dummy aerial made from 4 ft. of thick cable, connected to the inner of the coax. end, and hung out of the car window. Tuning the substitute coil until maximum sensitivity is obtained throughout the MW band is next, but some may prefer to peak the tuning at a point where the most popular station is heard at best strength.

Testing being satisfactory, during a run in the car, with wipers, high revs., and starter tried, the fixing can begin. The only cut connection in the set (MW top of coil to point y) has to be replaced by a small pressel switch. This was chosen for its small size and easy fixing—one small drilled hole as close to the broken connection as practical, keeping the connections short, as in Fig. 3. The car aerial input socket is usually a coaxial type, making both inner and outer connection. If it is not, or should none exist, then a coaxial chassis type socket will need to be fitted at some convenient point, close to the MW coil and easy led off for the aerial where ever the radio is normally placed. The inner of the coax. socket is taken direct to point y, and any filters or DC bleeds removed. The coax. outer is connected straight to the earthy end of the MW coil (point z).

That concludes the radio work. The practical details of the substitute coil are best understood by studying Fig. 2. The test coil when disconnected from the set, has a coax. plug fitted. Do not mix inner and outer. Short leads are used and the plug clamped to the coil with a condenser clip. Cleat the coax. cable to the clip as shown to stop accidental pulling at the connections, and after satisfactory final test, cement the points where the plug and coil press together to make a solid weld. So, when the radio is taken out of the car, a touch of the switch restores the internal aerial. And when used in the car, a touch of the switch again and just plug in the car aerial.

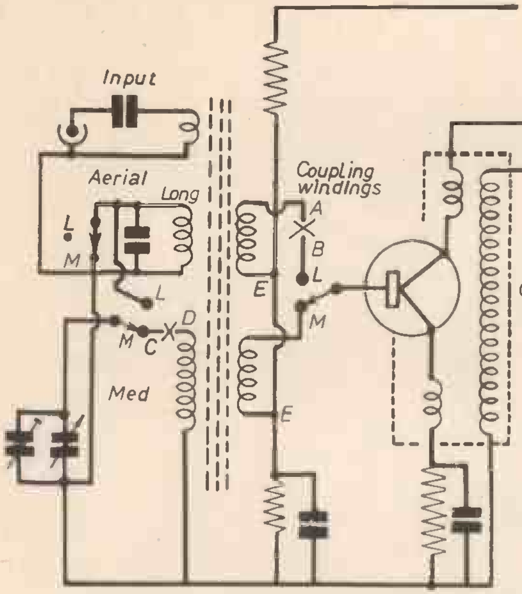
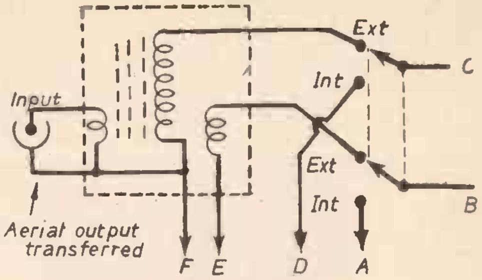


Fig. 4.—A typical transistor input circuit.

Method (b)

Because of the variance of the many input circuits used in portables, the principles only can be given here and the experimenter must refer to the circuit of his own set for exact details and circuit points. Generally, there must be room inside the radio for a screened coil, and the fitting of a double pole changeover switch (quite a large item) of the chassis type, toggle action. All these are close to the MW coil connections. In some cases the external aerial socket will have to be re-routed permanently to the extra MW coil which is generally acceptable in most cases where only vehicle use on MW is required. If other wavebands are to be used on the external aerial, however, then some other way of coupling the aerial to both coils must be devised.



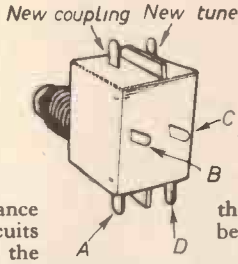


Fig. 5.—How the extra coil and switch are connected to the lettered ends.

Fig. 4 shows a typical transistor input circuit with downmatch coupling windings, and separate aerial coupling winding. First find the two points where circuit breaks are to be made. Cut them and connect short flex leads to the lettered ends shown. Make up the screened MW coil as shown in Fig. 5; wiring to the change over switch with the shortest possible leads. Divert the aerial input socket wiring to the new coil, and then connect the change-over switch to the leads from the lettered end breaks. The car aerial plug is normal and untouched. When satisfactory results are obtained, after tuning up the new coil on the car aerial, the whole assembly can be fixed into the radio wherever most practical, and the leads shortened even more if possible. No further modifications are necessary and the set should now work well.

Buffet Table Accessory

This simple holder for paper serviettes and cocktail sticks can be easily made in an evening

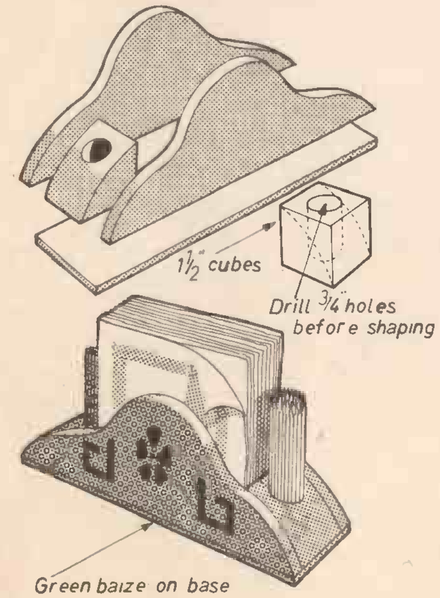
THIS attractive and useful little article holds folded paper serviettes in the centre and cocktail sticks in the small holes on each side.

Materials Used

Half-inch wood or ⅜in. ply can be used for the sides and construction is extremely simple, veneer pins and glue being the media used. The two end pieces are prepared from approximately 1½in. cubes, and note to bore the ¾in. holes for the cocktail sticks before shaping the cubes—the bit will tend to wander down the sloped surface if done after the blocks are shaped. Almost any shape and design may be chosen, and measurements are not given as paper serviettes of the fancy type vary considerably in size.

Finishing Off

The charm of this little gadget appearing casually on the sideboard lies in its finish. The proto-type was enamelled very light blue with the decorative motifs bright red.



Constructional details of the holder and also the finished accessory.

A Rod Grinding and Shouldering Jig

Details for making this useful addition to your workshop

By Jameson Erroll

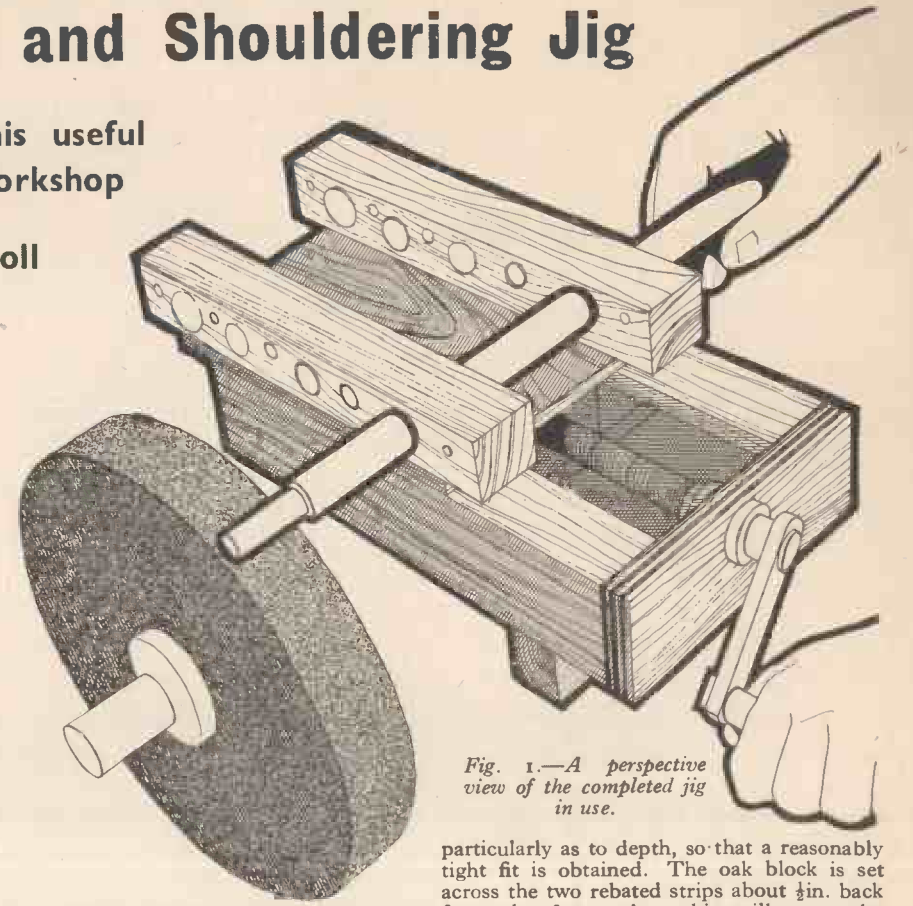


Fig. 1.—A perspective view of the completed jig in use.

ALTHOUGH primarily intended for use with the Multi-Purpose Grinding Rest described in the January 1960 issue, this jig is easily adaptable for use with any grinding wheel furnished with a feed table. It is extremely useful for reducing diameters of rods since it cuts a square shoulder at the same time, and is also invaluable for turning the ends of square metals to accommodate wheels as, for example, trolley and cart axles.

Method of Use

Fig. 1 shows the jig fitted to the table with the work in position and it will be seen that the rod to be reduced in diameter and shouldered, is run into two suitably sized holes in which it can be freely rotated. A collar is grub-screwed to the farther end of the rod in order to regulate width of grinding, and the jig is slowly advanced to the fast-revolving wheel. As it makes contact it, too, revolves, and a slight pressure on the collar keeps the rod in position. If the rod tends to slip, its rotation can be assisted by turning the collar. The jig is advanced until the required diameter has been obtained and, if desired, the wheel may now be changed for a much finer one—or even one of honing grit—to obtain a perfectly smooth finish.

Materials Required

A glance at Fig. 1 will give an idea of the finished article and, in conjunction with the illustrations, should make construction quite clear. A list of materials required is hardly necessary since the unit is comparatively small, but about 4ft. of ¾in. × ¾in. oak will be needed together with a few small pieces of ⅜in. and ¼in. plywood of good quality. An 8in. length of ⅜in. Whitworth rodding plus a collar and flange of the same diameter, and a piece of mild steel for the handle are also needed.

Construction

Begin with construction of the base (Fig. 2), and note that no projecting screws or bolts are permissible. The best method is to use ⅛in. or 4 B.A. counter-sunk bolts with square nuts which are sunk into the plywood by means of a small chisel; this not only brings the nuts level with or slightly below the surface of the wood but also prevents them turning and thus allows them to be thoroughly tightened up. The plywood front, 4½ × 1½ × ⅜in. is drilled with a ⅜in. hole in the centre and near the top to accommodate the Whitworth rodding which, at this stage may be temporarily placed in position while the flange is screwed to the front of the ply. See that this is kept absolutely central so that it does not bind on the rod nor cause it to cant out of square.

Sliding Platform

The sliding platform may next be made and Fig. 3 gives all essential measurements. It should be noted, however, that a check should be kept while constructing to ensure that the platform is just a sliding fit and no more—it can well be on the tight side; any tendency to free play in any direction must be avoided. For example, if the ¾in. × ¾in. oak used is nominal it will be slightly under size and the width apart of the rebated oak strips must be adjusted accordingly. Similarly, the size of the rebate must be regulated, particularly as to depth, so that a reasonably tight fit is obtained. The oak block is set across the two rebated strips about ½in. back from the front edge; this will carry the threaded rod which moves the platform backwards and forwards, but note not to drill the hole at this stage; this has to be done very accurately when the base and platform are assembled.

Drilling Holes

The two top 7in. lengths of ¾in. × ¾in. oak must be accurately bored as a pair, and a good plan is to cramp them together and bore the necessary number of holes but only with a $\frac{1}{16}$in. drill so that they act as centres for later enlargement. The jig being described has eight varying sized holes and their centres are about ⅞in. apart. Note that the holes are not necessarily bored in order of size; it is, in fact, better to stagger them—one large hole and one much smaller adjacent—for in this way too much wood is not cut away at any one point. The largest hole was made to accommodate ½in. rods, and the smallest ⅛in. rods. This is entirely a matter of choice and depends largely upon the type of work likely to be undertaken. If it is thought desirable to allow for possible working on ⅝in. or ¾in. rods, then it would be as well to increase the size of the oak to 1in. × 1in.

When all the holes have been bored, one piece of oak may be screwed to the ¼in. ply top of the platform taking care that it is kept square. Now thread two suitably sized rods through the holes at each end of the oak and cramp the second strip in position. The rods should rotate freely but without undue play; if they do not, readjust until they do and then screw down the second strip *before* removing the cramp.

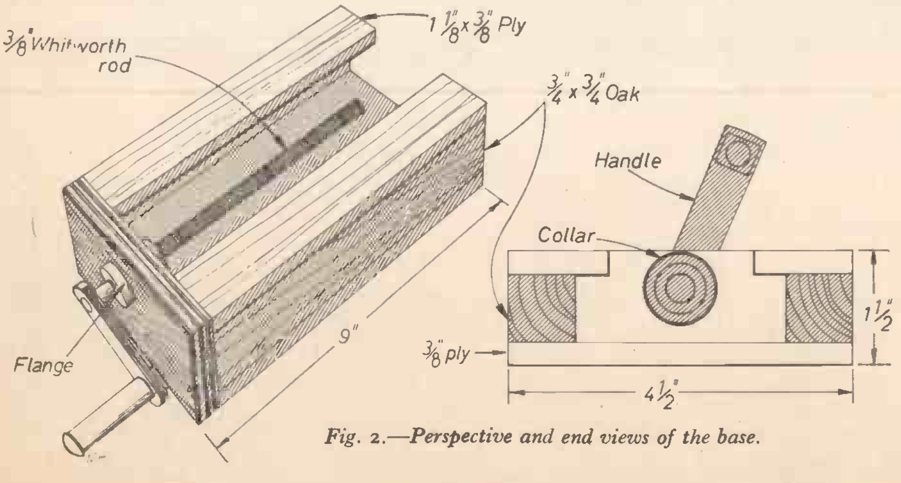


Fig. 2.—Perspective and end views of the base.

The Handle

Before assembling the base and platform the handle should be made, and Fig. 4 gives all necessary details. The 1½in. × $\frac{3}{16}$in. bolt which forms the handle is threaded into the mild steel lever and a square half-nut locks it; the loose sleeve should be just short enough to allow it to revolve freely. The other

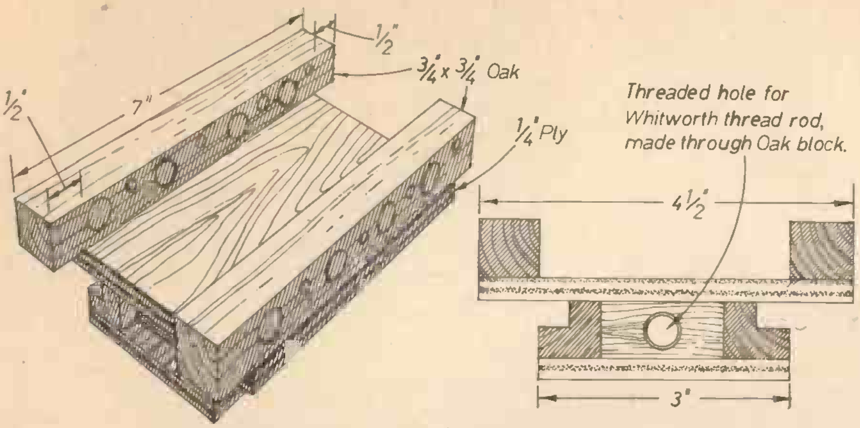


Fig. 3.—Perspective and front views of the sliding platform.

end of the lever is force-fitted over one end of the $\frac{3}{8}$in. rod and also pinned to prevent it working loose.

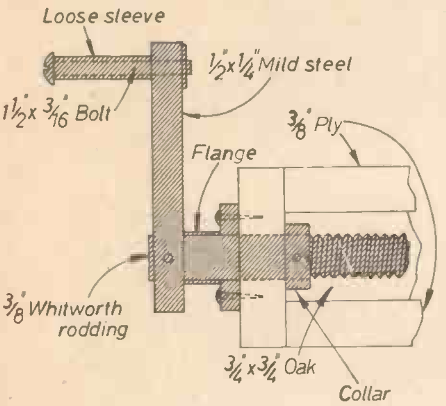


Fig. 4.—Section of front of base showing fitting of handle and Whitworth rod for engaging oak block in sliding platform.

Base and Platform

Assemble the base and platform having first smeared the end of the rod with ink or paint so that when it comes in contact with the oak block it will mark it. With the sliding platform about 5in. from the front of the base, bring the rod into contact with the oak block but be sure that it is perfectly square at all angles. Now withdraw the rod, bring the platform well forward, replace the rod, and see that it aligns with the mark on the oak block, which it should do. The hole in the block may now be drilled and it will undoubtedly be best to remove it for this purpose since it must be accurately done. If you have a $\frac{3}{8}$in. Whitworth tap in your kit, the hole in the block should be made with a $\frac{5}{16}$in. drill; if, however, you have to rely on the rodding itself cutting its own thread, then it would be better to use an $\frac{11}{32}$in. drill. Alternatively, a $\frac{3}{8}$in. nut could be secured at the back of the oak block, but this entails a lot of fiddling and unnecessary work and does not, in the author's opinion, make for so satisfactory a job as cutting the thread in the oak block itself.

Finishing Off

Fig. 5 shows a back view of the assembled jig and, if care has been taken during construction and assembly, there is no reason why a rather tight but nevertheless smooth action should not result. The collar is, of course, grub-screwed to the rod immediately behind the back of the ply front of the base. The author used a piece of $\frac{3}{4}$in. × $\frac{3}{4}$in. oak and a length of flat steel running at right-angles to it, and fitted with a central thumb screw, to set the jig squarely on the grinding table and to lock it in position. Its construction is quite simple and has not been described since the jig can be fitted to any class of table with which the reader's machine happens to be furnished.

Precautions

It is hardly necessary to give any instructions on manipulation apart from those already mentioned except, perhaps, to stress—as with all grinding jobs—do not try to take off too much material at one go! It invariably results in such heat being generated as will destroy the temper of the metal being ground. Turn the handle slowly and be sure the work is completely rounded before advancing further. It may also be well to mention that since the action of the machine is to force the work in an upward direction, care should be taken to ensure that, in the case of an adjustable table, it is immovably fixed in position before grinding is commenced.

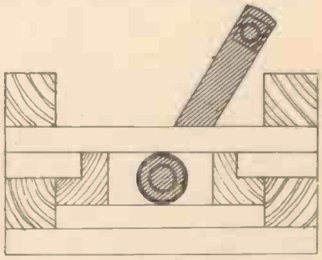


Fig. 5.—Back view of base and sliding platform assembled.

Contest Model Glider

(*Concluded from page 523*)

The outer panels of the wing can now be made. Glue the ribs in the same manner as the rest of the wing and check that the inner ribs are at 10½ deg. with the appropriate template. Spars should be fitted as for the rest of the wing.

The wing tips each consist of two laminations of $\frac{1}{8}$in. balsa, shaped to the same contour as the wing ribs, glued in place and rounded off. Cap the centre section with $\frac{1}{4}$in. wide strips of $\frac{1}{32}$in. sheet balsa, with the grain running across the wing. Sand the whole wing to a smooth finish. This stage is shown in Fig. 13.

Tailplane

This consists of $\frac{1}{8}$in. × $\frac{1}{8}$in. leading edge and main spar and a $\frac{1}{4}$in. × $\frac{1}{8}$in. trailing edge. Cut all the ribs from $\frac{1}{16}$in. sheet balsa. The shape of these is shown in Fig. 10 and this will have to be scaled up to twice the size shown. Glue the ribs to the main spar and trailing edge, which have been pinned to the building board, and insert the leading edge and glue. Cap the centre with $\frac{1}{32}$in. sheet balsa top and bottom. Sand the whole tailplane smooth, tapering the trailing edge and rounding the leading edge as shown in Fig. 12.

Covering the Wings

Start with the two inner panels. Cover the top of one panel first, using one piece of tissue. Turn the wing over and repeat. Next cover the other inner panel both sides, then the two outer panels. Allow the paste to set, then spray with water and leave to dry in a fairly warm atmosphere. Finally apply two coats of clear dope or banana oil.

Covering the Tailplane

Two pieces of tissue are used for this. Cover the top first then the bottom. Spray with water, allow to dry and then apply two coats of dope or banana oil.

Cut the fins from $\frac{1}{32}$in. sheet balsa, cover both sides with tissue, dope and then glue in place on the tailplane.

When covering is completed, the skid is glued on in the position shown in Fig. 10. The tow hooks are formed from 22 s.w.g. model wire and fixed in position as shown.

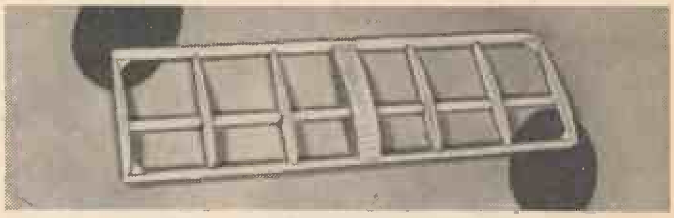


Fig. 12.—Complete tailplane framework.

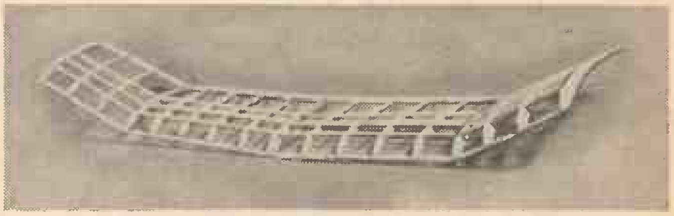


Fig. 13.—The completed wing ready for covering.

WAVES AND TIDES EXPLAINED

Read this and you will understand why the sea behaves as it does

by E. Rolfe Hunter

LIVING on an island as we do, many of the British people are directly concerned with the sea. The rest of us, while not depending on the sea for our living, are affected by its fascination to a lesser degree. While watching the waves over the pier rail or contemplating the tide as it creeps towards your deck chair, your interest will be heightened if you know what makes the sea behave as it does.

Let us consider first the mechanics of ocean waves.

Length of Waves

The length of deep-sea waves, i.e., the horizontal distance between each crest, varies to a considerable extent. The longest ever recorded appears to have been one of 2,600ft. in the Pacific Ocean, and waves between 500 and 600ft. long have been met in the Atlantic. Usually, however, " long " waves vary between 200 and 400ft. The actual height of waves has been difficult to determine but is believed to lie in the ratio $\frac{\text{Height}}{\text{Length}}$ from $\frac{1}{50}$ to $\frac{1}{30}$ in the case of long waves, and from $\frac{1}{5}$ to $\frac{1}{6}$ in the case of waves in shallow water. Travellers' tales of gigantic waves are not always to be relied upon, for the simple reason that the apparent elevation of a wave crest increases with the descent of a vessel into the trough (Fig. 1).

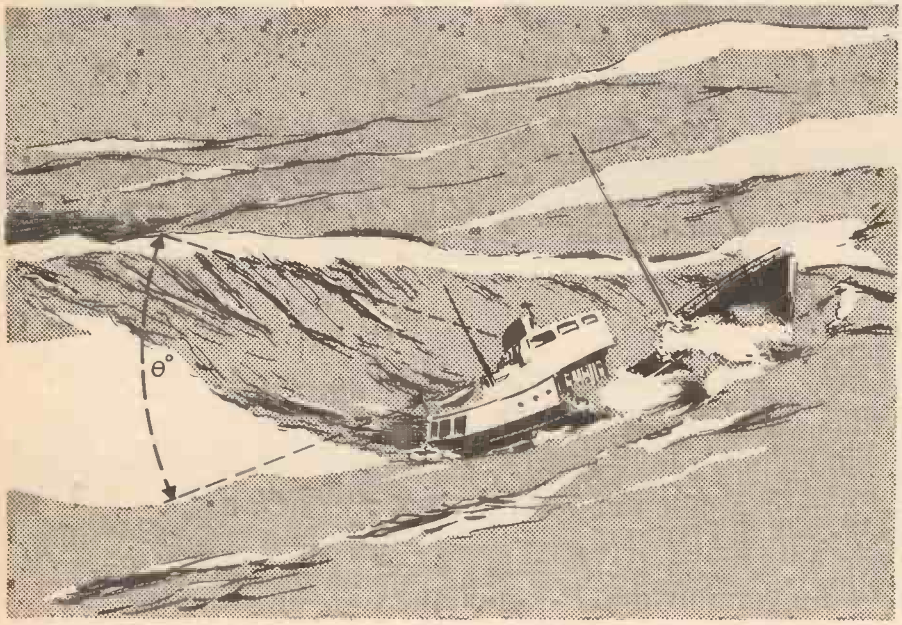


Fig. 1.—The elevation of a wave crest increased with the descent of the vessel into the trough.

Measuring the Length of Waves

One method is to measure the distance apart of each crest from positions on the deck of a ship. If the vessel is steering obliquely across the line of advance of the waves, the length thus obtained is multiplied by the cosine of the angle between the line of advance and the ship's course. The length " L " having been established, the " period," or the time elapsing between the passage of successive crests, is measured with a stop-watch and the forward velocity $\frac{L}{T}$ readily determined (Fig. 2).

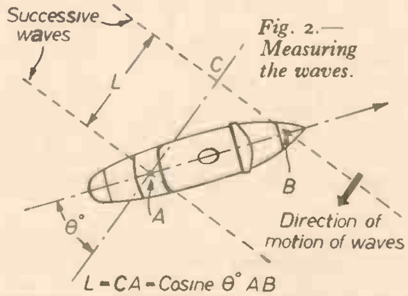


Fig. 2.—Measuring the waves.

The Trochoid

Before going on to a brief analysis of wave-motion, it is suggested that the reader might care to make the following experiment with a cardboard disc, in which a hole big enough to admit the point of a pencil has been pierced somewhere within the circumference. If the disc is rotated along the bottom edge of a ruler firmly held against a sheet of paper, the pencil point describes a curve similar to that shown in Fig. 3. This curve is called a " trochoid " and is, incidentally, one of a rather remarkable family of curves which can be produced by altering the position of the rolling point in relation to the centre of the circle.

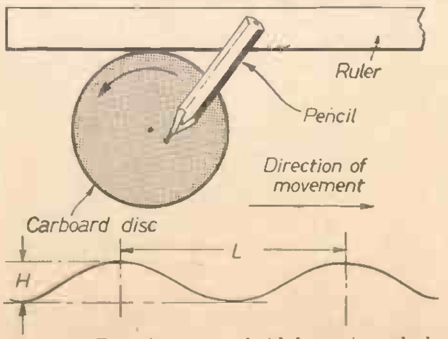


Fig. 3.—Drawing a trochoidal curve and the completed curve.

The Shape and Motion of Deep-Sea Waves

The resemblance between the trochoid and a wave cross-section gives rise to the trochoid theory of waves. This theory states that the form of an ocean wave is in fact a curve traced out by a point inside a circle which rolls along a straight line. In this case, the circle rolls with its circumference moving along the

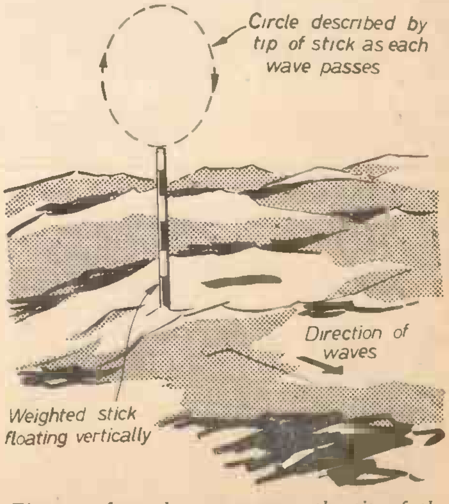


Fig. 4.—As each wave passes, the tip of the stick describes a circle in the air.

underside of the line and in making one complete revolution moves through a distance equal to " L," i.e. the distance between perpendiculars drawn through each successive wave crest. " L " having been determined by observation, the radius of the rolling circle is evidently $\frac{L}{2\pi}$, and the distance of the tracing point, as will be seen from Fig. 3, is $\frac{H}{2}$, or half the wave-height from the centre.

Orbital Motion

With the passage of each wave crest, every particle of water affected by the wave moves in a circular orbit with a uniform velocity equal to " T," the wave-period, reaching the highest point in the circle with the passage of the crest, and the lowest with the arrival of the trough. This circular motion can be shown to be present if a stick, about equal in length to the wave height, and weighted at one end, is dropped over the side of a boat.

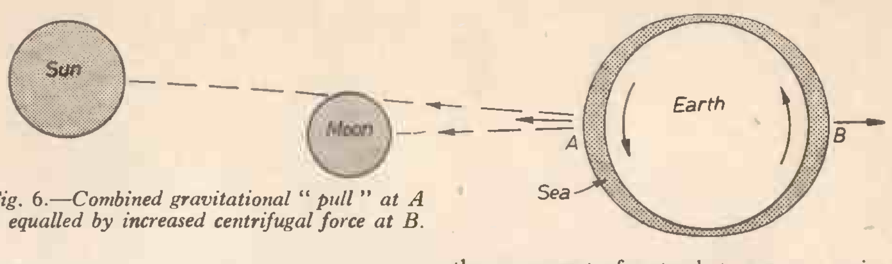


Fig. 6.—Combined gravitational " pull " at A is equalled by increased centrifugal force at B.

Accidents which sometimes happen to lifeboats (which frequently are called to operate in this kind of shallow-water wave) are caused by the actual momentum of these *moving* masses of water, coupled with the fact that steering becomes almost impossible when boat and sea are moving with the same velocity. Similar conditions occur amongst deep-sea waves when the crest acts under the acceleration of strong winds and is thrown forward into the trough.

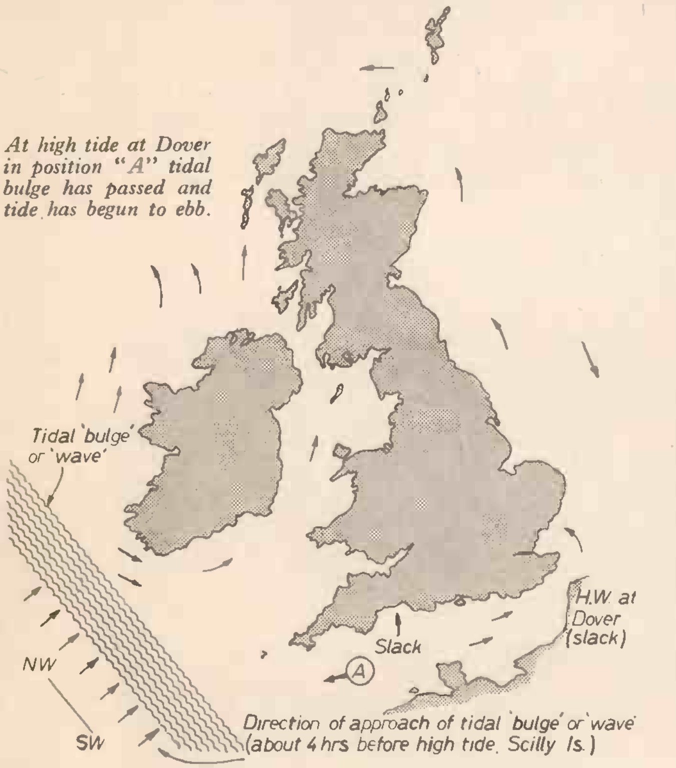


Fig. 5.—Direction of tidal streams around the British Isles at the time of high tide at Dover.

Formation of Tides

Most people are vaguely aware that the moon has something to do with the tides, but few notice that high (or low) tide at Oozington-on-Sea—or anywhere else along our coastline—occurs at more or less the same time on those days when the moon is either " new " or " full," and on each subsequent day a mean of 50 minutes later.

Seamen are usually concerned with the incidental behaviour of tides, i.e., with the direction in which tidal currents are moving and with the times of high and low tide. These vary from place to place because of the intrusion of the various land masses irregularly distributed on the earth's surface, which have the effect of diverting or retarding the movement of water between one region and another (Fig. 5).

The Moon as a Tide-Causing Agent

Newton's law of gravitation states that the attraction between two masses is directly proportional to their mass and inversely proportional to the square of the distance between them. This attraction is therefore mutual; all bodies attract one another. Furthermore, an orbiting body remains in orbit around a parent body because gravity, acting inwards, is balanced by centrifugal force, acting outwards. Thus gravity is least in that part of the satellite farthest from the parent body. Centrifugal force, on the other hand, is here greater because of the greater velocity, in orbit, of this part. But gravitational attraction by the parent body is greater on that side of the satellite nearest to it, and least on the most distant side. Since the gravitational and centrifugal forces are equal, and opposite in " sense," a heaping-up of the oceans occurs on each side of the earth. These masses of water may be regarded as remaining in the same position relative to the moon, with the earth performing its daily revolution under them (Fig. 7).

The Sun as a Tide-Causing Agent

Although the moon has the greater effect because of its comparative nearness to the earth, the sun, some 400 times farther away, has an immensely greater mass and exercises about one-half the tide-raising force of the moon. It is interesting to note, that if the earth were covered with water to a uniform depth, the combined effect of sun and moon would cause a rise of only 2ft. at the highest fortnightly (spring) tide. Of this, the moon would be responsible for 16in. and the sun 8in.

As each wave passes, the tip of the stick describes a circle in the air whilst retaining its position relative to the sea bed (Fig. 4).

Weight and Centrifugal Force

An interesting conclusion arising from the trochoid theory is that the weight of a floating object is less at the crest of a wave than at the trough. This is because the centrifugal force of each water-particle acts upwards at the crest, and the weight, always acting vertically downwards, is therefore less. In the trough, however, the centrifugal force acts in the same direction as the weight and therefore increases it.

Shallow-Water Waves

In shallow water, due to friction with the sea bed, the circular orbits referred to become ellipses and the forward velocity decreases. As the depth decreases even more, the motion of the particles through the bottom of the ellipse is retarded to such an extent that the equilibrium of the mass of water forming the wave is destroyed and the wave collapses to form what is called " surf " or " breakers."

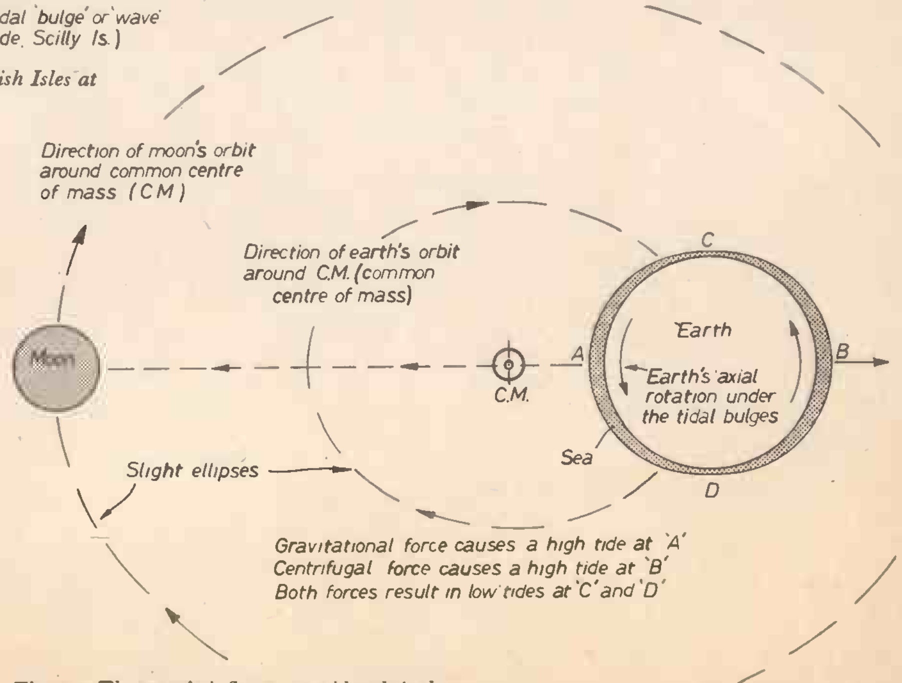


Fig. 7.—The moon's influence considered singly.

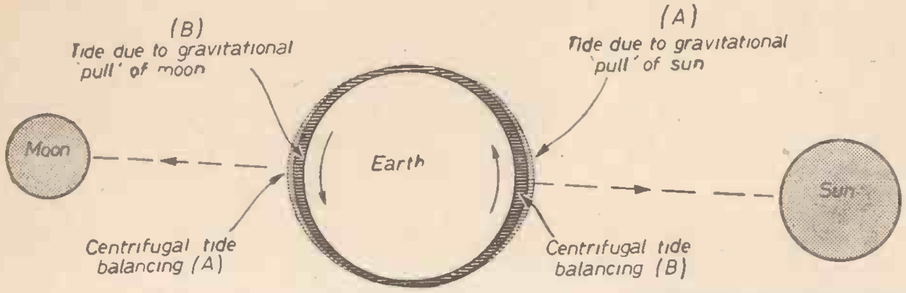


Fig. 8.—Spring tide, sun and moon in opposition.

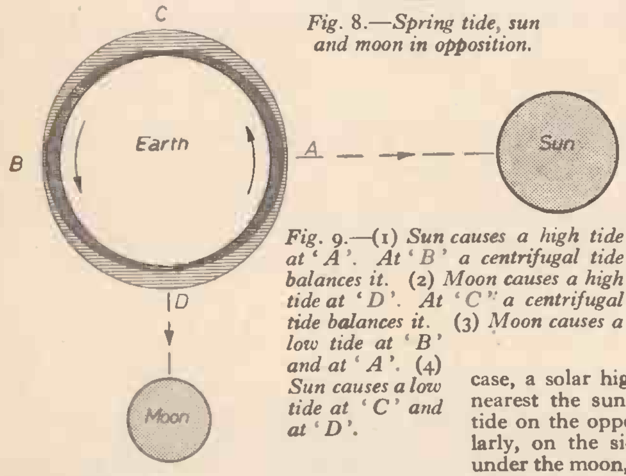


Fig. 9.—(1) Sun causes a high tide at 'A'. At 'B' a centrifugal tide balances it. (2) Moon causes a high tide at 'D'. At 'C' a centrifugal tide balances it. (3) Moon causes a low tide at 'B' and at 'A'. (4) Sun causes a low tide at 'C' and at 'D'.

Spring Tides

Once in the course of every lunar month, at the time of the new moon, the sun and moon are in line on the same side of the earth (in Conjunction). In this case the tide-raising force due to gravity is equal to their combined "pull." But, from what has already been said, centrifugal force on the other side of the earth increases with the gravitational pull, since the earth and moon remain in orbit about a common centre of mass, and a similar tide occurs on the side opposite to the sun and moon. See Fig. 6.

Again, once in every lunar month the sun and moon are on opposite sides of the earth, and in line. (In opposition.) In this case, a solar high tide is formed on the side nearest the sun and a balancing centrifugal tide on the opposite side. See Fig. 8. Similarly, on the side of the earth immediately under the moon, a lunar high tide occurs, with a balancing centrifugal tide on the side opposite. Fig. 7 shows that the heights of these tides are equal to those caused when sun and moon are in conjunction as described in the preceding paragraph. Spring tides therefore occur twice in every lunar month.

Neap Tides

"Neap" is derived from the Anglo-Saxon "nep," meaning "scanty." Neap tides are those tides which, twice in every lunar month, rise least at high tide and fall least at low tide. In this case sun and moon are each causing their own high tides in separate areas independently of the other (Fig. 9). Thus a "low" tide at the time of the moon's "quadrature" (the moon's first and last quarter) is virtually a solar *high* tide (one half the height of a lunar "high") added to a lunar *low* tide, and a *high* tide is a lunar high tide added to a solar "low."

Other Factors Affecting Tides

Since the orbit of the moon is an ellipse, it is nearer to the earth (perigee) at one time than another. (Apogee.) Gravitational attraction therefore varies. The earth also moves in an elliptical path around the sun, being nearest to it at the time of the equinoxes. Declination, or angular distance north or south of the equator, also varies and causes a variation in the times of tides. All these factors vastly complicate tidal-prediction in the preparation of tide-tables.

The Common Centre of Mass

Reference to this was made in an earlier paragraph. Tide-raising *centrifugal* forces on earth are caused not by the earth's axial rotation, but by its orbiting motion in company with the moon round a point which is their common centre of mass. See Fig 7. The earth's axial rotation causes *currents* of a non-tidal nature between the poles and the equator in both hemispheres and a permanent equatorial "bulge" of about 25 ft.

A Spray Gun

(*concluded from page* 526)

swing without stickiness. Braze the parts together.

The centre sliding member "K" is best turned from a piece of round bar—admittedly there is a considerable amount to file or machine away to create the ½in. dia. boss, but it is not really worth while to braze these two pieces. Tap right through the boss and then again run the reamer through to clear off any burrs that the tapping operation throws up. Once this detail is made a trial with the trigger "U" piece is an obvious course and for this reason a slight amount left on the length of the boss on "K" is preferable as this allows an adjustment with a fine file until all parts fit without undue shake.

Assembling

Before attempting the assembly of this gun, a few minutes spent in checking to see whether the fitting bolts slide into their particular holes without a suspicion of slackness, is essential. Clean off all the sharp edges.

It is suggested that a reader concentrates on obtaining a good sliding action of the pin "G" when the trigger is operated before attempting to fit the handle to the body as this is a vital factor in the successful working of the gun. Once this has been achieved then sub-assembly of the handle details is possible. Operate the trigger mechanism back and forth a few dozen times before attempting to fill the container with paint to ensure an easy action is forthcoming. A complicated assembly of this type usually manages to produce one or two sticky places which present problems in finding out exactly where they are and how to cure them, and one of the best cures is to work the mechanism about until the tightness is gradually eased off. The using of a lapping compound is not advised.

MAKE THIS ACROBATIC MONKEY FOR YOUR CHILD

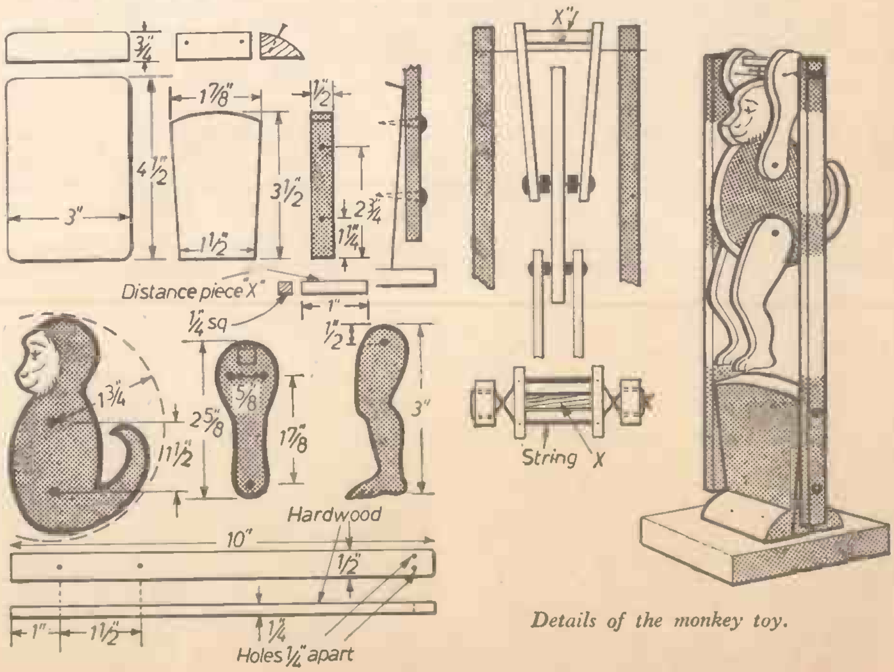
THIS is an old but ever popular toy and causes endless fun and laughter. Its action depends on compression of the two sticks against the base support; this causes the string at the top to tighten and, in so doing, it uncrosses and thus causes the monkey to turn a somersault. Relaxing the pressure results in another acrobatic movement when the string re-crosses.

Method of Construction

The illustration gives all the necessary measurements and explains method of construction. The joints must work loosely; they are made of wire slipped through the small holes in the arms, legs and body of the monkey, and turned over at each end. The insertion of small spacing washers will assist easy movement.

Finishing

Finish the toy in bright high-gloss colours, painting the monkey as realistically as possible.



Details of the monkey toy.

RADIO LINK WITH OTHER WORLDS

This controversial subject is discussed
by D. A. Watt

Fig. 2. — The Jodrell Bank radio telescope.

TWO American scientists are making preparations for what may well make 1960 one of the greatest and most exciting years in modern civilisation, and could have a profound effect on the lives of us all.

These scientists plan to use a radio telescope to monitor radio signals coming from interstellar space in the hope of detecting signals transmitted by intelligent beings for the purpose of establishing interstellar communication. They have called the plan "Ozma," after the fairy-tale queen of the far-off land of Oz.

The scientists reason that as there is life on Earth, and possibly some form of life on Mars, it is highly probable that near one of the many stars similar to our Sun there could be civilisations similar to our own. Further, it is very likely that one or more of these civilisations is more advanced scientifically than we are and may even have been watching for many years for signs of scientific development near our Sun.

Assuming this were the case, the beings of such a society might well have sought and established a channel of communication and are now waiting patiently for answering signals which would tell them that intelligent life exists near our Sun.

Radio Waves

This leads to the question how would this channel of communication be established? The only way we know is by radio waves, and since we are assuming that those who are operating the source are looking for a newly developed society we can assume that their signal will be beamed directly at us, and the frequency will be selected so that it can be detected with the minimum of effort.

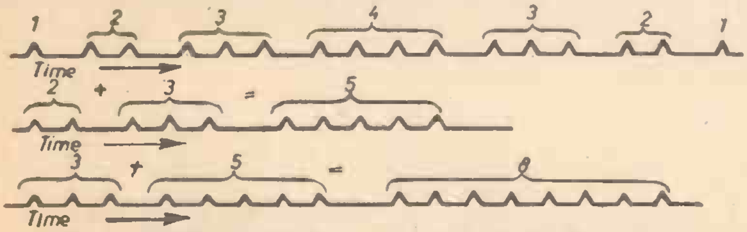


Fig. 1.—Possible signal patterns. Peaks indicate duration of signal.

Fortunately in the most favourable radio frequency region there is a unique frequency called the hydrogen line and is 1420 megacycles (wavelength 21 cms.). This is the wavelength of radio waves emitted by neutral hydrogen and since most of the matter in space is neutral hydrogen, any observer in the universe will be familiar with this frequency.

The power of the signal will have to be such that it will overcome the background due to the emission of its own star and also the galactic emission. Although sending such a signal with our present equipment would require excessive power and would tax our facilities to the limit, it is reasonable to assume that a more advanced society would have more highly developed equipment and could easily maintain say 100 different beams each aimed at a likely star.

Having established the frequency and direction of the radio signal all that would be left would be to determine what signal to transmit. The most logical would seem to be either a series of prime numbers in sequence, or perhaps in the form of simple sums. Doubtless it will be some sort of pattern readily recognisable as an artificial signal; some possible patterns are shown in Fig. 1.

The scientists will first examine the nearest likely stars, that is those within 15 light-years of the Earth. (A light-year is a measure of distance and equals the distance that light waves travelling at 186,000 miles per second cover in a year.) Among these stars there are two very much like our Sun and are called Tau Ceti and Epsilon Eridani. These two are 11 light-years away and lie in the direction of least background.

Radio Telescopes

Initially the Green Bank telescope will be used. This telescope has a diameter of 85 ft. and is really only suitable for signals up to 8·5 light-years away, but near it a 600ft. telescope will soon be built in West Virginia which should be capable of picking up signals from 60 light-years away.

These radio telescopes are very similar to the one at Jodrell Bank in this country which was the first of its kind ever to be built. The Jodrell Bank telescope has a diameter of 250 ft. and is illustrated in Fig. 2.

The principle on which a radio telescope works is very simple as it is really just a special kind of aerial for collecting radio waves. A radio telescope capable of detecting signals from stars must have a high gain and also be capable of determining the accurate position of an object; also for weak signals a large collecting area is required. These requirements are best achieved by the use of a giant parabola which focuses incoming waves at a central point at which the receiving aerial is placed as shown in Fig. 3.

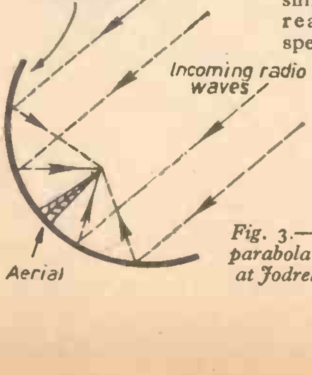


Fig. 3.—A giant parabola as used at Jodrell Bank.

Jodrell Bank Telescope

The construction of the Jodrell Bank radio telescope was in itself quite a considerable feat. The reflector bowl and bowl framework alone weighs 700 tons, and the total weight of the steel structure is 2,000 tons. The paraboloidal bowl is mounted on a central pivot which is mounted on a cross girder carried by two towers each 170 ft. high. It is rotated to achieve elevation by four 25 h.p. electric motors situated in the laboratories at the top of the towers. The drive is transmitted to the central pivot through 25ft. racks taken from the gun turrets of the battleship "Royal Sovereign." The towers are mounted on bogies which run on a 17ft. gauge double railway track, the inner bogies being driven by 25 h.p. motors.

A complete electrical control system has been developed so that the telescope can automatically follow the path of the object under observation. This uses magslips to give signals proportional to the sine and cosine of an angle, in servo loops to solve the fundamental equations of spherical geometry. The range of speeds required varies from about 10 deg. per hour for a star near the southern horizon to infinity for a star passing through the zenith.

To some readers the idea of seeking interstellar signals will sound like "Science Fiction." Nevertheless there is a strong argument that if our star, the Sun, was able to produce the Earth, which can support life, then why should not other stars of similar lifetime have produced other planets able to support life? If there is the possibility that such planets exist then there is also the possibility that civilisations more advanced than our own exist on one or more of them.

HANDLING SHEET GLASS

In this second article, S. M. Charlett deals with bevel grinding and the permanent and temporary marking of glass, etc.

Fig. 7.—A combined abrasive and cooling agent being used whilst drilling plate glass.

Drilling Sheet Glass

NUMEROUS devices and techniques have been described for the drilling of holes in glass, including copper tubes, special drills, slow moving bits and many other devices, but the writer has yet to find anything more effective than the ordinary high speed steel drill, lubricated with a suitable abrasive agent. Essential points of the technique are not to hurry, and to regulate the speed or rotation of the drill in accordance with the size of the hole being drilled. The smaller the hole the faster the drill may be turned, the larger the hole the slower must be the drill. The prime reason for this ruling is that the operation of drilling will generate a fair amount of heat which cannot be dissipated entirely by the method given below, if a large drill is used at high speed. The result will be that the glass will get hot, and either crack during drilling or upon cooling.

Maintain a constant supply of abrasive agent to the operational area. Attempting to drill without the abrasive supply is a waste of energy, and may result in excessive heating with subsequent damage.

Finally, the area of operation must be kept as cool as possible to avoid setting up undue strains in the glass which will cause splitting.

The first of these factors is dependent upon the operator for its reduction to minimum of damage. The drill should rest upon the point at which drilling is being performed, and the weight of the brace should be the only pressure upon it, no excess pressure being exerted by the operator. The speed of rotation of the drill itself, in relation to the driving wheel of the brace, may easily be ascertained. This should be regulated during drilling to avoid the heating effect noted above, and the writer has found that the best speeds for drilling range between 120 r.p.m. for holes of about $\frac{1}{16}$in. dia. to 40 to 50 r.p.m. for holes of about $\frac{1}{2}$in. dia. Holes larger than $\frac{1}{2}$in. but less than about 2in. dia. are too big for cutting and too small for direct drilling, and these may be cut by the method described in the next column under "Drilling out larger holes."

The technique of drilling is similar to that with metal, with one or two points of note. The points to be drilled should be marked, and then well roughened by lightly scratching with the tip of a marking diamond. This breaks the outer skin of the glass and allows the drill to commence biting as soon as it turns, thus avoiding the annoying tendency of the drill to "wander" before biting. The drill may now be turned at a constant speed, in accordance with the size of the hole, until penetration is almost complete, when speed should be reduced to about a quarter of that suggested above until penetration is made. During this operation it is necessary to ensure that the other two factors in the earlier list are duly considered, i.e., that a constant supply of abrasive is maintained, and the area of drilling is kept cool. Many workers have suggested a solution of camphor in turpentine as a cooling agent and the writer has found that a mixture of two parts coarse carborundum paste and one part camphor in turpentine will serve as a combined abrasive and cooling agent. This mixture should be liberally applied to the drilling area, and should be continually heaped up around the drill itself as it is rotating. (See Fig. 7.)

Fig. 8.—Grinding, using a piece of flat plate glass.

The Drilling Out of Larger Holes

The term "drilling out" is quite distinct from "drilling" and its application to the making of larger holes in glass is quite simple. The actual hole is marked out on the surface of the glass with a diamond. Inside the circle a number of points are marked in such a way that if a hole is drilled it will just touch the outer circle. Such holes are drilled with a small drill, about $\frac{1}{8}$in. is a suitable size, around the inside of the circle, all touching the circle itself and almost touching each other. When they have all been drilled it is a simple matter to tap the centre of the circle out, and to grind the edge smooth and free from irregularities by one of the following methods.

Flush Grinding and Edge Polishing

After cutting, a sheet of glass has a very sharp edge which can prove dangerous on handling. In addition, some irregularities may be left in the edge due to bad cutting, or the drilling out of holes as mentioned earlier. It is possible to bind edges by the method known as passe-partout but this is not always convenient and it is far better to render the edge smooth by grinding or polishing. This operation is quite easily carried out with the aid of an abrasive agent similar to that used for drilling. In the case of a straight edge or the edge of a disc the grinding is best carried out by obtaining a piece of flat plate glass, preferably about $\frac{3}{8}$in. thick. The surface of this is liberally coated with a coarse carborundum paste and the edge to be polished is simply rubbed to and fro on the plate until any irregularities have been removed (see Fig. 8). The piece of glass being polished should be kept at right angles to the polishing plate until the edge is perfectly flat, it should then be held at an angle of about 75 deg. to the grinding plate and the very sharp edge should be removed with a few strokes to and fro. All sharp edges should be smoothed and rendered harmless in this way, taking care not to grind a bevel on the edge, but merely to smooth it. In the case of a disc, of course, care must be taken not to produce an erratic curve in the course of polishing the edge, and practice will be needed to ensure this.

Where the edge to be polished is on a sheet of glass too large to handle as above, a different technique must be adopted. The following method can be used. A small piece of plate glass about 3in. × 1½in. × ¼in. thick is stuck to a block of wood of similar dimensions and about 2in. thick, by means of Bostik or a similar adhesive. This is then liberally coated with the grinding agent and used to polish the edge of the glass concerned (see Fig. 9). A little practice will enable the reader to produce an evenly polished and smoothed edge, at right angles to the plate.

Bevel Grinding

Where it is desired a bevel may be quite simply put on a sheet of glass. The method is similar to that for polishing edges with the difference that the edge, after being ground flat and straight, is then finished at a chosen angle to the surface of the glass. The two most common bevel angles are 60 deg. and 45 deg. to the plate surface. The glass to be ground should be held at the chosen angle and the edge then ground down as far as is required. It is sometimes useful to support the work by means of wooden blocks, the sides of which have been cut to the required angle.

Where the work is too large to handle as above then the glass plate mounted on a wooden block may be used, and the writer has found it possible to produce very good edges by this method.

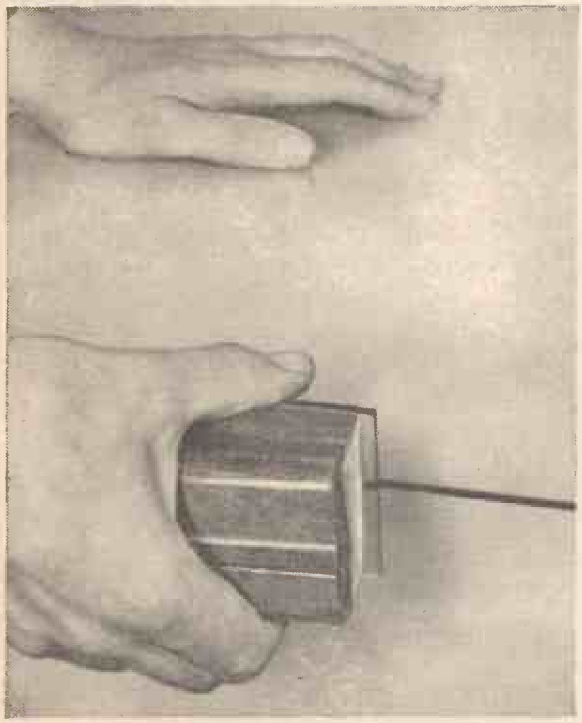


Fig. 9.—Polishing an edge by using a piece of glass stuck to a block of wood.

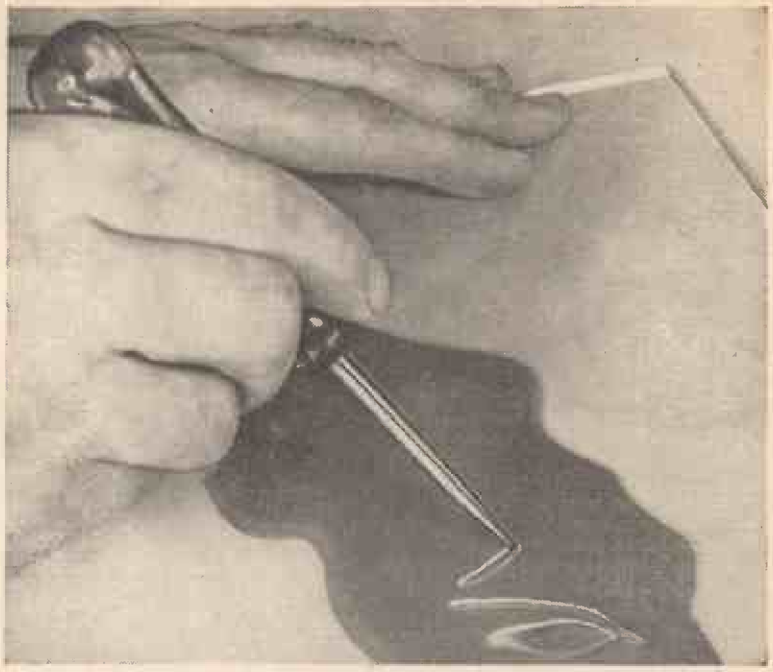


Fig. 10.—Method of temporarily marking glass.

The Marking of Glass

Glass may be marked for various reasons, and upon the reason will, to some degree, depend the method of marking to be used. For permanent markings, methods which actually penetrate the glass and leave a mark are used. For non-permanent markings agents are used which stick to the surface but are easily removed without trace afterwards. These methods will be considered separately.

Permanent Marking of Glass

The most usual way of marking permanent marks on the surface of sheet glass is to use a diamond mounted in a wooden pen-type holder. This instrument makes only comparatively shallow markings, and can be used to write, draw or paint on glass surfaces.

Where drawings or writing of a deeper nature than that of the diamond are required the following glass marking ink may be used, either with a sharp pointed stick or with an ordinary steel pen nib. The latter will rapidly corrode.

Formula:

Glycerine	40 g.
Barium sulphate ..	15 g.
Ammonium bifluoride	20 g.
Ammonium sulphate	15 g.
Oxalic acid ..	8 g.
Distilled water	100 ml.

Dissolve all the solids in water, then add the glycerine. Use waxed or gutta percha containers for mixing and storage.

For very deep etching of glass, for example, with graduations or scales, it is possible to use the formula given below. It must be stressed, that this is an extremely corrosive reagent, and that great care must be taken to avoid splashing skin or clothing. Any splashes on the skin should be dealt with immediately by thoroughly washing under running water and then dressing with a thick paste of sodium bicarbonate until medical attention is obtained.

Formula:

Potassium bifluoride	250 g.
Concentrated hydrochloric acid	250 ml.
Potassium sulphate	150 g.
Distilled water	750 ml.

The salts are dissolved separately in some of the water, and the solutions then mixed together, the remainder of the water then being added. The container is stood in a bowl of cold water, and the hydrochloric acid added very gradually with constant stirring.

All mixing and storage should be carried out in waxed or gutta percha containers.

With both reagents similar techniques are employed. The plate of glass to be etched is first thoroughly cleaned with a detergent such as Teepol, and finally well washed with distilled water. It should be allowed to air dry, and the surface to be etched, well coated with paraffin wax. The graduations or other design to be etched are marked into the wax with a sharp pointed tool (see Fig. 10), taking care that the glass is exposed and free from wax. The chosen reagent should then be run on to the surface, taking care not to get any on any exposed surface other than the etch marks. The reagent should be allowed to act until the markings are of the required depth, the time required being a matter of experience. After the estimated time has elapsed the reagent should be well washed away with water and the markings examined. If they are not deep enough the process should be repeated; if they are deep enough the wax should be removed and the plate cleaned with hot water and a detergent.

Temporary Marking of Glass

For general purposes glass may be marked by the normal grease pencil obtainable from most stationers. For the best results the pencil should be well sharpened and the surface to be marked should be thoroughly cleaned and free of grease.

For more accurate purposes the following simple temporary marking ink may be used with an ordinary steel pen nib.

Formula:

10 per cent. solution of gum arabic	10 ml.
Indian drawing ink	90 ml.

Mix well together. This, when used to write or draw on glass and allowed to dry, forms a tough, durable, temporary mark which is easily removed with hot water. It will withstand normal handling which does not involve excessive rubbing.

Where it is desired to use a stencil to produce a pattern on sheet glass the following formula provides a suitable stencil wax.

Formula:

Paraffin wax (high melting point)	98 g.
Stearic acid	2 g.

Melt on a water bath and mix well together.

If desired a small proportion of an oil soluble colour, or of carbon black may be added to the molten mix and well dispersed by stirring.

This should be applied to the stencil with a soft brush while still molten, and then allowed to become almost set before removing the stencil from the glass surface. The wax is easily removed with hot water and a detergent.

Next month's instalment will deal with the making of mirrors.

DC-8 Flight Simulator

This and some of the ground handling and servicing equipment for Canada's new jet service are described by Donald S. Fraser

TRANS-CANADA Air Lines' pilots are " flying " sleek, 550-mile-an-hour Douglas DC-8 jetliners without becoming airborne.

It's being done in a DC-8 flight-simulator, a million-dollar electronic mock-up of the DC-8 cockpit, complete in every detail and capable of doing anything the aircraft can do—except to leave the ground.

Built by Link Aviation Company, of Link Trainer fame, the simulator has been installed at TCA's new $20,000,000 maintenance and overhaul base at Montreal Airport in an air-conditioned and temperature controlled training building where it will soon be joined by " Viscount" and " Vanguard " simulators.

It costs close to $1,200 an hour to fly the DC-8 jet; approximately a quarter of that to fly the simulator.

Instructor (seated) and pilot trainees' test flight deck mock-up of DC-8 which is used for cockpit familiarisation and class-room instruction. Veteran pilots undergoing conversion course to " jet flying " also train on a million-dollar electronic " simulator " capable of doing everything the aircraft can do—except leave the ground.

Simulator Details

The DC-8 simulator is fully electronic, employing many of the same principles used to guide moon rockets into outer space, including a magic brain of multiple computers, digesting information and resolving it into the form of instrument readings and machine reactions. It has been called the largest analogue computer in the world.

The DC-8 machine simulates any aircraft action down to the last perfect detail, even to random passenger movement; while in " flight," simulator trim alters as hypothetical passengers walk up and down the aisles. This action automatically ceases when the seat-belt warning lights are turned on.

Control Cabinets

The simulator receives its life from 21 control cabinets containing fantastically complicated electronic and hydraulic equipment.

There are ten electronic cabinets, each with four racks, containing more than 4,000 vacuum tubes, 500 amplifiers and 250 servo-motors; two power cabinets; four radio-aid cabinets; three air-conditioning and blower cabinets to cool the simulator and ancillary electrical equipment; a dual-refrigeration and air-conditioning cabinet for the flight deck of the machine and a 3,000 p.s.i. hydraulic package.

Power Supply

Most of the power for the machine comes from five generators driven by three 15 h.p. electric motors, each generator supplying a different current. There is a plus 300-V. generator, a minus 300-V. generator, a plus 28-V. generator, a minus 28-V. generator, all direct current, and a 110-V., 400-cycle alternating current generator. Together, they supply enough power to satisfy the electrical needs of 50 average-sized homes.

The hydraulic system actuates the simulator, nosing it up on take-off and climb, down on descent, and banking it on turns.

Electronic noise generators duplicate the engine noise inside the cockpit, altering the roar of the engines with the movement of the throttles.

Operation of the simulator is monitored on two control panels, one a long-range panel for complete point-to-point flights, the other a local panel for airport operations.

The instructor can simulate in-flight incidents, such as loss of an engine in flight, failure of an electrical system and the like, and can monitor the flight crews' corrective action.

The flight-deck instruments, duplicated on the control panels, respond to every action of the simulator.

Looking faintly like a ship from outer space, this nose-up view of the giant DC-8 shows the air liner with air starter connected prior to starting up the four powerful engines.

Ground Equipment

Flight crews and ground crews have other things to learn besides " flying " the DC-8 simulator. Mobile-ramp equipment for Trans-Canada Air Lines' new Douglas DC-8 jets will cost more than did a " Super Constellation " to the pre-turbine era.

TCA has ordered more than $2,000,000 worth of self-propelled machinery for between-flights servicing of the giant aircraft.

A single DC-8 requires 26 pieces of major ramp equipment of a dozen different types just for handling on the ramp and for movement in and out of maintenance and overhaul hangars. One " set " of 26 units cost over $210,000.

First, there's the ground power unit, which supplies electricity to the immobile aircraft. Twenty-two of these self-propelled units have been ordered at a cost of $14,000 apiece. In addition, six trailer-type ground-power units, costing $10,000 apiece, and four tractor-mounted units, costing $5,500 apiece, are scheduled for delivery to the airline.

Fifteen self-propelled air starters, each worth $20,500, and three $12,000 " fly-a-way " starters have been purchased.

Each of the 23 mobile staircases ordered by TCA costs $10,000. And each DC-8 requires two of these units for loading and off-loading passengers.

Three combination heaters/air conditioners have been bought by the airline for $23,000 apiece, as well as 21 mobile heaters, each costing $6,000.

Nineteen baggage handlers are on order at $12,000 each. The big jets will require two of these units each, along with two $16,000 food trucks, of which 10 have been ordered.

Then there are six $11,000 lavatory trucks; five $9,000 water trucks, and four new baggage tractors, each worth $4,500. A DC-8 on the ramp will be serviced by three baggage tractors and 10 cargo carts, but these units are interchangeable for all types of aircraft.

In addition, four giant towing tractors, costing $30,000 apiece, have been purchased, while orders have not yet been placed for cabin trucks that will cost about $14,000 each.

All these highly mobile machines are able to move quickly from one aircraft to another as required, servicing one, then moving on to the next.

This is the type of electronic instruction and modern equipment that will aid commercial jet pilots of the future, and enable Canada to run a jet service throughout the air lanes of the world.

An EASILY MADE PRINT DRYER

by E. W. SUMMERS, B.Sc.

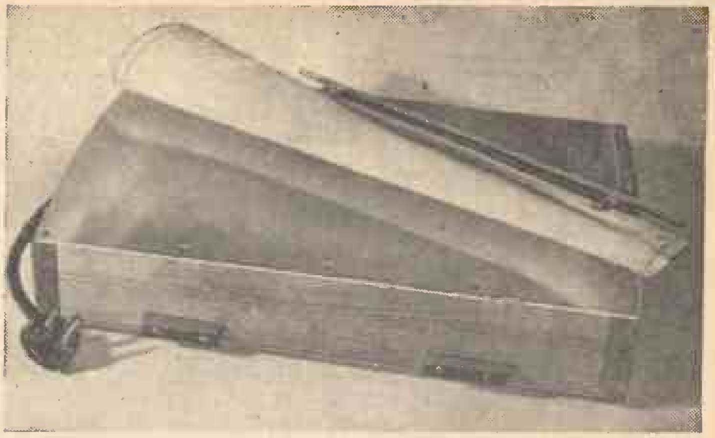


Fig. 1.—The completed dryer with the apron turned back.

This unit costing approximately 10s. will ensure that your prints do not curl.

THE drying of prints after they have been thoroughly washed is often neglected by the amateur photographer. They are either allowed to dry overnight on a flat surface or force-dried in front of a fire. Both methods result in a badly cockled print which is difficult to flatten.

The use of a print dryer will obviate this trouble and also speed up the drying so that a flat dry print may be had within a short time after removal from the wash. To the amateur who does not turn out many prints the expenditure of several pounds on a commercially produced dryer may seem unjustified, but the unit described here is constructed from easily obtainable materials and will cost little more than 10s. It is shown in Fig. 1.

Materials Used

The main part of the assembly is a wooden box in which is contained the heating element. The curved lid is of aluminium sheet and the apron is a piece of stout canvas. The finished size of the dryer is immaterial and can be made to suit individual requirements, although it is a wise plan to adhere to the standard sizes of commercially available models. A glazing sheet can then be added at a later date if required or desired. The author's own equipment is 11in. × 15in., which will accommodate a standard 10in. × 14in. glazing plate.

The box is made from ½in. planed wood and, as can be seen from the illustrations, the shorter side-pieces are curved to ensure a slight tension on the apron when in position. The exact amount of curvature is not critical, but both ends should be the same to prevent buckling of the aluminium sheet and so they should be shaped with a spokeshave or plane whilst clamped together in the vice. The upper edges of the longer sides of the box are bevelled to follow this curve. Wooden battens—or, better, ¾in. angles—are screwed to the inside of the curved end-pieces and these act as a support for a piece of ¼in. plywood. This holds a sheet of asbestos on which the heater is arranged. The latter is a 200 watt coiled element costing about 1s. 3d. which is intended for winding on to the ceramic former of an electric bowl fire; it can be stretched to any length.

This is arranged on the asbestos in a pattern which will give a uniform distribution of heat, and the "gridiron" design is best as it allows the terminal points to come together. (See Fig. 2.)

Making-up

The design can be sketched on the asbestos sheet with pencil and then pairs of holes are made along it at suitable intervals with a sharp-pointed instrument. The element is stretched to the required length and held in position with 28 g. wire pushed through the holes in the asbestos and the ends twisted together underneath. The asbestos is pinned down—drawing pins or large-headed tacks will do—and the ends of the element are brought to a terminal block. A three-core cable is attached to the other side of this block, entry being made through a ⅜in. hole drilled for the purpose in one of the side pieces.

The Top

The top of the box is of 20 g. aluminium, the actual size being slightly larger than that required to allow for finishing off. The aluminium sheet is secured with c'sk. screws along the top of one of the long sides, but it is essential to earth this before finally screwing down: as wet prints will be placed on it by hand it is imperative to eliminate any possible danger from electric shock. The aluminium is next screwed down at either side on the highest point of the curved side pieces and finally along the other long side. No attempt should be made to actually *bend* the aluminium or else deformation will occur; it will readily assume a satisfactory curve when hot. The overlapping edges of metal can now be trimmed off and smoothed down with a file.

A hardboard base and rubber feet complete the box.

The Apron

This is made from porous canvas—old raincoat material will do, but if buying deck-chair canvas it is important to ensure that it is *not* of the waterproof variety. One end should have at least a ½in. hollow hem sewn on it and both edges should be hemmed to prevent fraying and to keep the canvas taut when under tension. A piece of brass valance rail is passed through the hollow hem and two strong extension springs bolted on as shown. To the other ends of these springs is fixed a length of 3/16in. brass rod, notched to prevent the springs slipping. The apron is stretched over the top of the dryer and the free end pinned to the back with drawing pins.

When in use, the 3/16in. rod clips under two cycle brake blocks screwed to the front of the box and grooved along their length on the underside for this purpose. (See Fig. 3.) Two small ventilation holes bored at each end of the box complete the job, no painting or varnishing being required or even desirable.

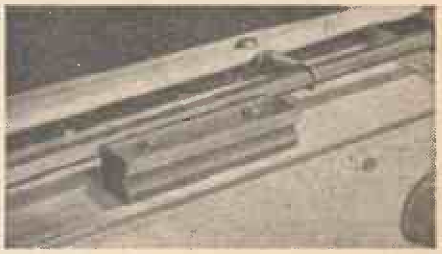


Fig. 3.—One of the brake blocks under which the rod clips.

How to Use

In use, the unit is plugged into the mains for about ten minutes before drying is to commence, and the prints—after being washed and then drained for a moment—are placed face-upwards on the aluminium cover. The apron is pulled over and tensioned by placing the rod under the brake blocks. Drying takes about four minutes for double-weight paper and about ten minutes when using a glazing sheet. A dryer of this size will accommodate six ¼-plate prints, five postcards or two whole-plates. The prints are dried with a very slight convex curl due to the curvature of the dryer but on laying on a cool surface soon flatten themselves out. They are then immediately ready for mounting and finishing.

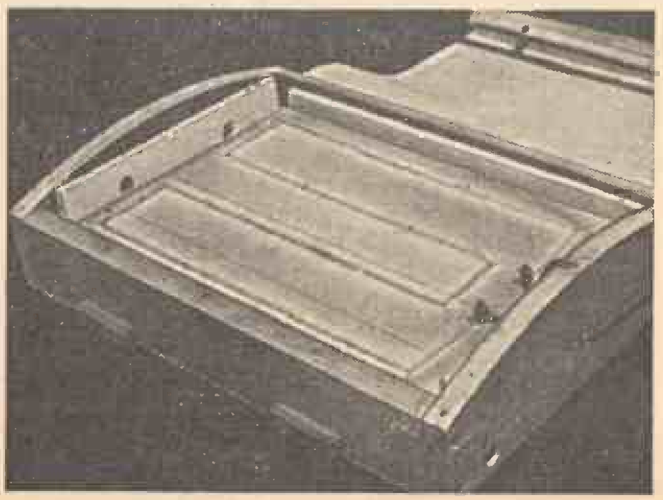


Fig. 2.—Arrangement for laying the element on the asbestos.

LETTERS to the EDITOR

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

Life Spheres

SIR,—Twice during the second world war while serving aboard merchant ships, I was torpedoed and forced to take to a lifeboat. On one of these occasions, it was several days before we were picked up and the privations endured while exposed to all the vagaries of sun and weather I will never forget. Some of my shipmates were doubly unfortunate in that they were injured and shocked and we had no means of preparing hot food for them or of providing the warm beds and shelter which they needed. My story is not unique and hundreds of others endured similar and in many cases much worse privations in open lifeboats. My own experience and the knowledge of many others prompts me to heartily endorse Mr. Karl Albert's statement in the July issue to the effect that the lifeboat as we know it is obsolete and that something more efficient must be found to replace it.

I am not an engineer and have no way of knowing whether the life spheres he proposes are a practical proposition, but I do know that, looking at the protection and facilities offered and comparing them with what is available in a present day lifeboat, the life sphere, by comparison, looks very attractive indeed.—W. J. Toms (Liverpool).

Why More Speed?

SIR,—I read recently that it is visualised that aircraft will be travelling across the Atlantic at speeds in the region of 2,000 m.p.h. in the relatively near future. I notice too that Donald Campbell is preparing for another attempt on the World's Land Speed Record in his new £1,000,000 "Bluebird." Ocean travel, I hear, is about to be revolutionised by a new type of liner in which the hull is raised above the water on stilts—the main advantage being again an increase in speed. Is all this striving to travel around the world faster, I wonder, really worth while? Would there be any real advantage in being able to cross the Atlantic a few hours quicker and would not a return to the old more leisurely methods of travel be of benefit to everyone? At one time the prospect of a journey was looked forward to as a relaxation, but now so much rush is involved and it is over so quickly that its only effect is to quicken the already too fast tempo of living.

I mention speed particularly, but this is only one facet of progress, the whole of which is, in my opinion going too far too quickly. Scientists are already discussing interplanetary travel. Why travel to other planets, when we are making such a poor job of managing our affairs on this one? Why don't we all slow down and take a good look at ourselves and then use the money now being squandered on extravagant and far fetched research to ensure that all the peoples of the world are properly fed, housed and educated and enjoy a reasonable standard of living. When this has been achieved is the time to start looking into space.—S. D. J. (Bristol).

Bering Dam Scheme

SIR,—The article in the May issue of Practical Mechanics on the Bering Dam Scheme seems to me nothing short of madness. Has any consideration been given to the rise in the sea level due to the melting of a vast amount of ice? I doubt very much if the Gulf Stream would continue to heat Europe and Britain and, further, the scheme might well have a very unbalanced effect on the rotating earth and quite easily cause an alteration in tilt and rotational position. I hope I will not be present when, if ever, it eventuates.—R. F. MacDonald (Johannesburg).

Author's Comments:

I think that Mr. MacDonald's objections to the Bering Dam scheme are quite valid, and if it were ever decided to go ahead with the project very careful consideration would have to be given to all the possible side effects.

The article described the Russian proposals only and no attempt was made to investigate the possible undesirable side effects. For myself I am inclined to think that the scheme might cause some very drastic upheavals in the world's climate, but this does not imply that it is not worthy of the very closest consideration by all the countries concerned.

Leclanche Cell

SIR,—As a regular reader of this journal and a keen amateur in chemistry and electricity, I was very interested in Mr. Sutton's article on "The Evolution of the Fuel Cell," which appeared in the July issue. While reading it, I was very surprised to find a mistake in the diagram of a Leclanche Cell: The carbon being the positive electrode, not the zinc. When zinc is employed in a primary cell, it will be nearly always the negative electrode, as aluminium and magnesium are the only metals more electronegative than zinc that are likely to be used in a cell.—D. C. Long (Harrow).

Mr. Sutton's Reply:

Your observations regarding the marking of the electrodes in the illustration is perfectly correct. Of course the carbon electrode is the positive one and the zinc the negative electrode. This error should have been noted when passing the proofs but we regret that it was overlooked.

Thermometer Modification

SIR,—One of the most irritating things that happen in the darkroom is the sliding of the thermometer, resting on the edge of the dish, into the developing or fixing solution necessitating the washing of the hands after its retrieval, before paper or film can be handled.

To eliminate this trouble, the rubber top of a disused eye dropper was pressed on to the top of the thermometer (right). The ridge formed at the base of the rubber grip effectively prevents the instrument from slithering down into the bath and the top makes a convenient and clean grip to handle. It can be left in position permanently.—W. A. Agnew (Glasgow).

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

The Stanley "Senior" tool chest.

STANLEY "SENIOR" TOOL CHEST

THIS latest Stanley tool chest contains a complete 52 piece outfit of craftsman-quality woodworking tools, including combination and rebate planes. The chest is finished black on the outside with a pale blue interior and bronzed hardware has been used for the hinges, handles, and catches. There is an upper storage tray with hinged flap, two sliding trays and spare storage space at the bottom for electric tools or any additional items. The dimensions are 27in. × 16¾in. × 13in. and the total weight is 72lb. The price is £43 16s. and the manufacturers are: Stanley Works (G.B.) Limited, Rutland Road, Sheffield, 3.

Additional news from Stanley's is that three new lightweight models have been added to their range of hammers. They are a 6oz. Warrington pattern hammer (No. W.00, price 7s. 3d.), a 3½oz. Warrington pin hammer, sometimes known as a telephone hammer (No. CP/3½, price 6s. 9d.) and a 4oz. ball pein pin hammer (No. B.P./4, price 6s. 6d.).

BRIDGES HOME DECORATING SET

PREPARED specially for the home decorator, this kit is designed to eliminate much of the hard work involved and to help obtain a professional finish. A 6in. sander polisher is included for use on woodwork, floors, walls, and windows, a 3½in. wire cup brush for treating metal window frames, etc., and the Nu-sander attachment for finishing flat surfaces. Also part of the kit is the Bridges paint spraying attachment for use with paint, distemper and varnish; a handy paint stirring attachment is also included. The price of the kit is £12 18s. 2d., including the wall panel, but the drill is extra.

THE KITKART

THIS kart has live axle driving both rear wheels giving maximum traction and complete control at all speeds. The "Build It Yourself" component parts of the Kitkart are made and designed by Hayters Limited, of Spellbrook, Bishop's Stortford, Hertfordshire. There is a choice of two engines: The Clinton A.490, 98 c.c. with centrifugal clutch and rewind starter, or the JLO 98 c.c. with direct drive. The Kitkart is on view at the above address, from where also can be obtained full details regarding prices, etc.

GLASS FIBRE REPAIR KIT

A NEW plastic repair kit now on the market makes it quicker and easier than ever before to repair damage to cars and caravans with glass fibre bodies. The instructions on the box are simple to understand and easy to carry out. The kit includes a tin of laminating resin, a tube of hardener paste, a packet of inert filler powder and supplies of glass fibre mat, tissue and ribbon. This can also be used for carrying out all kinds of glass fibre repairs, including furniture, kitchen equipment, etc. The retail price of the kit is 8s. 6d. and it is available from most motor accessories stores and caravan suppliers. The manufacturers are Holt Products Limited, New Addington, Surrey.

(Above) Bridges space saving wall panel.

(Right) Solderless terminal crimping set.

(Below) The "Sunrise" light-driver.

COLLETT SOLDERLESS KIT

A CLEAN fast economical method for joining terminals to wire is obtained by using the Collett de Luxe S-17 solderless terminal crimping kit. This contains a general purpose assortment of two gross of solderless terminals together with lengths of special sleeving and a Collett crimping tool. This is a 3-way tool and enables wire cutting to be carried out with a special blade in the shank, wire stripping by using one of the six positions and crimping by placing the terminal in the correct crimp channel in the nose of the tool. The kit is housed in a very strong steel box with a hinged lid and costs £5 18s. complete. The manufacturers are Collett Manufacturing Co. Ltd., of 347 and 349 Goswell Road, London, E.C.1.

SPOT LIGHT SCREWDRIVER

THE problem of trying to screw (or unscrew) a screw in a dark corner has been solved by the introduction of a screwdriver with a light in its handle. A chuck in the centre of the reinforced plastic base of the chromium plated handle securely holds any one of the four sizes of screwdrivers that are supplied with the light-driver. You simply switch on the light and use as an ordinary screwdriver. The "Sunrise" comes in a plastic case that houses the light-driver and four different sizes of screwdrivers and costs 10s. complete (excluding battery). It is marketed by G.B.C. Electronics Limited, 121 Edgware Road, London, W.1, and is available from most electrical stores and car accessory shops.

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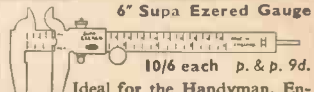

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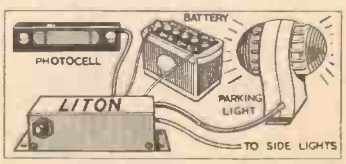

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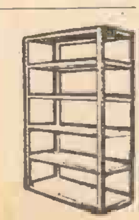

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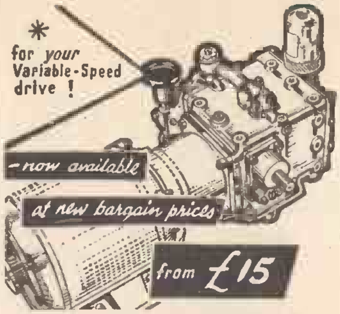

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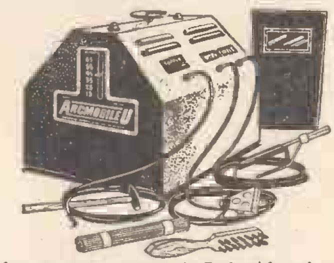

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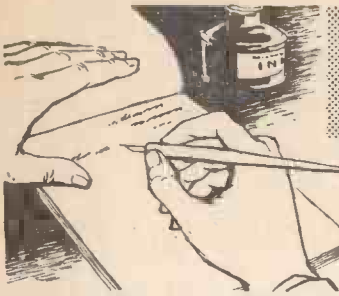
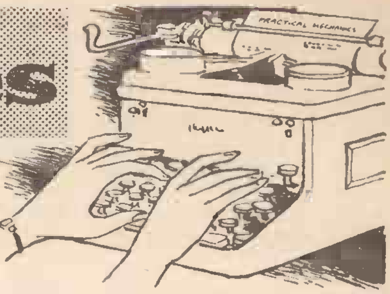


Your Queries Answered



Descaling Kettles

WE have always been troubled in this area with cooking vessels furring over with scale. Please give a remedy. —A. Walker (N. Ireland).

THE usual way of removing the " scale " from kettles, etc., is to treat them with fairly strong hydrochloric acid (known commercially as " spirits of salt "). But this will damage the vessel if used carelessly or improperly.

Make up a solution of hydrochloric acid in water in the proportions of one part acid to three parts water. Most of the scale deposit will be on the bottom of the kettle and around the base of the spout and partly up the sides. Pour your solution into the kettle and make sure that the level of the acid solution is well below the top line of " scale " that is deposited upon the *sides* of the kettle; for you must not have this solution in contact with any part of the vessel that is not covered with " scale." As soon as the acid solution is poured in there will be a vigorous chemical action as the acid dissolves away the " scale." Carry out this process cautiously. Let the reaction continue for a few minutes and then pour the solution out of the vessel into a glass or earthenware jug. Immediately rinse out the kettle with water and inspect. Repeat this process until the " scale " flakes, or dissolves away. If done carefully there will be no damage to the kettle.

Renovating a Brass Plate

I WISH to renovate a brass plate which has inscribed lettering. The lettering has been cut into the brass to a depth of about $\frac{1}{16}$in. and then filled in flush with the surface of the plate, with some compound. Most of the letters are black, but some are red. Please advise me what compound may be used to repair or renew the lettering?—J. T. Griffiths (Cumberland).

AFTER scraping out the old filling use the following mixture: Asphaltum, brown japan and lampblack. Mix to a putty-like consistency. Turps will help to clean out the old material from the inset.

If red lettering is required, make a putty of dry white lead with equal parts of coach japan and rubbing varnish. After this is filled in and hardened, apply a coat of flake white in japan thinned with turps. This mixture (white) can be tinted as desired by earth colours ground in japan.

Hectograph Pad Paste

CAN you please tell me the composition of paste used in the jelly hectograph. —E. Blundell (Mon.).

THIS is a mixture of gelatine and glycerine:

1 part glue
2 parts water
4 parts glycerine

all by weight. Skim off air-bubbles when mixing gelatine pad.

Ink

Methyl violet	2 parts
Alcohol	2 parts
Sugar	1 part
Glycerine	4 parts
Water	24 parts

RULES

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

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

Dissolve the violet in the alcohol with glycerine; dissolve sugar in water; then mix both solutions and ink gelatine pad.

Diecasting Alloy

I AM building a model railway lay-out and I wish to build most of the rolling stock myself. Can you please tell me if I can make up a suitable alloy for diecasting bogies, etc., out of zinc and lead, or zinc and antimony; also what would be the proportions of each? Rare alloys are hard to come by in this district and I propose to make the dies out of stainless steel. Would this be suitable? Also can you give me details of a plastic that could be moulded without heat. Something that could be poured in a liquid state into a metal mould and left to harden.—J. McGill (East Lothian).

IT is no easier to get pure zinc or antimony than to obtain alloys, so it would be pointless to give alloy compositions when, presumably, only scrap material of unknown composition is available to you. Your best plan would be to approach your local printer and ask him to sell you a few pounds of worn out founders' type. This is a rather hard typemetal well suited to your needs.

Stainless steel dies should be quite satisfactory if of fairly thick section, but aluminium would do just as well.

There are several plastic materials of the sort you specify: for details, write to I.C.I. Ltd., Plastics Division, Black Fan Road, Welwyn Garden City, Herts.

Liquid Washing-up Products

I INTEND making a liquid washing-up product, provided the various chemicals are available. Could you supply me with a formula?—G. T. Evans (Staffs).

ALL proprietory washing-up or detergent fluids are a sulphonated product of some organic base such as alcohol. There is very little to choose between the lot.

A useful domestic washing-up compound can be made as follows:

Sulphonated alcohol	5 parts
Trisodium phosphate	60 parts
Tetrasodium pyrophosphate	35 parts

A product for the hands:

Sodium alkylarylsulphonate	2 per cent.
Soap chips	8 per cent.
Water	90 per cent.

Experimental Balloons

HAVING in mind building an experimental balloon for practical use I would be greatly obliged for the following information: How big (cubic feet), should a balloon be, providing that the most economical gas is used, to lift up to 50lb.? What gas is generally used for meteorological experimental balloons and where could they be acquired? What material is used for the sphere with consideration for the durability, also netting and cordage?—F. Buther (Herts).

HYDROGEN is the most economical gas to use: and this can be obtained in cylinders from any of the branches of the British Oxygen Co. Ltd. Your nearest depot would probably be North Circular Road, Willesden, N.W.

The " lift " of hydrogen can be taken as 70lb. per 1,000cu.ft. at ground level and 50lb. per 1,000cu.ft. at 10,000ft.

Free meteorological balloons are spherical in shape and may expand to 30ft. dia. at 90,000ft. altitude. The weight of this balloon is approximately 2 lb. and can be inflated to lift say 70lb. on the ground to give the necessary ascentional lift. Its diameter would then be about 12ft., this would increase to about 21ft. at 10,000ft. altitude. It has not yet been found possible to make a balloon float at a constant altitude.

You can obtain information regarding

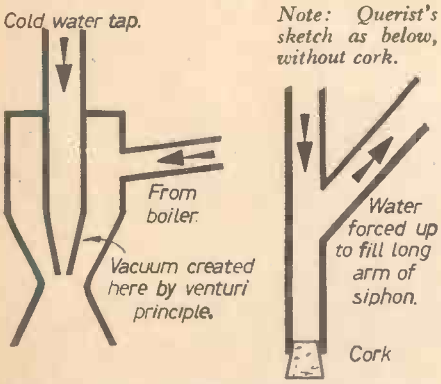
where the envelope and cordage can be purchased by writing to: The Director, Ministry of Aviation, Research & Development Establishment, Cardington, Bedford.

Siphon from Tap

COULD you please let me know how to make a siphon, to work off a cold water tap to empty a boiler. I made one as per my diagram (see (b) below) but unfortunately it did not work.—W. E. Stamp (Purfleet).

WE presume you want to instal a permanent siphon system to your tank. From the diagram you show in your letter you have clearly failed to obtain a partial vacuum and so you were unable to start the siphon. This can be accomplished in two ways:

You can adhere to your original design in principle, but you must modify it so that the bottom orifice is constricted; see diagram (a). It may be possible, on the other hand, for you to use your present installation by bunging up the bottom orifice with a tight cork (b) and, by turning on the cold water tap, forcing the water up the standard pile (which presumably your side tube is attached to) you would fill the system. Upon shutting the cold water tap and simultaneously removing the cork from the bottom orifice of your siphon we feel sure you would be able to start off the siphoning action.



Two methods of starting a siphon (a) left and (b) right.

Bending a Metal Bar

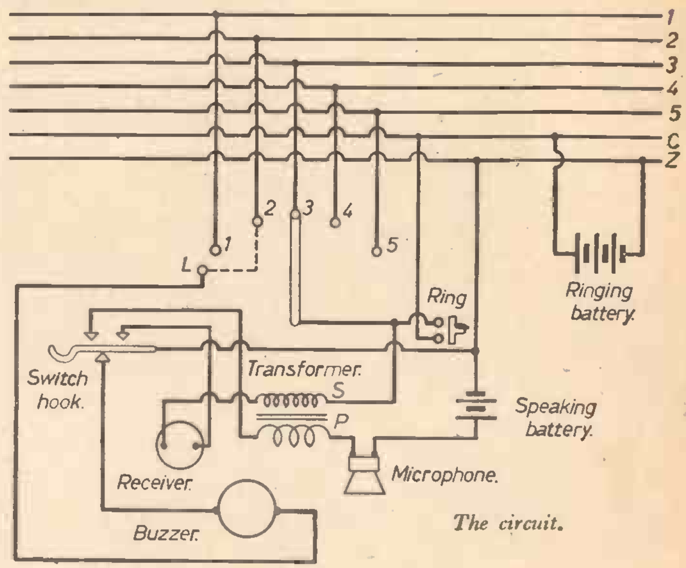
CAN you please tell me the best way, or the safest way, to bend a Noral 75 ST extruded flat bar, used for bow making. Is it safest to use heat or bend it cold?—E. J. Martin (Sussex).

THIS material should bend satisfactorily when in the cold condition and the maximum stress imparted to it is unlikely to cause it to fracture. Commercial bending would be performed with the aid of a suitable fixture—possibly a roll to give the necessary degree of curvature before anchoring the second end. It is feasible to make a simple holding device of this type from two or three thick pieces of wood. Cut one board to the shape of the bow and provide an anchorage, then make up a roller pivoting from the centre of curvature and use this to pull the rod to the desired shape.

House Telephone Circuit

I WISH to construct a house telephone circuit of five handsets for which I have obtained several ex-G.P.O. handsets of the carbon microphone type. I am told that I will have to have a microphone transformer for each handset, but as I have been unable to clear this point up locally, I would be pleased if you could help me in this matter. Also I should like a wiring diagram if possible please. —J. H. Morris (Crewe).

IN our opinion best results would be obtained by using a transformer for each handset. Our diagram shows the connections which could be used at each station, the terminal L being connected to the appropriate contact stud for that station; i.e., at station 2 L should be connected to No. 2 contact stud. A speaking battery is to be used at each station, together with a common ringing battery connected between lines C and Z.



The circuit.

Steering by Radio Control

(Concluded from page 528)

frequencies produced will depend on the battery voltage, and types of valves and chokes, and can be modified, if necessary, by changing the values of C1, C2 and R1. For the modulator choke, a small mains type smoothing choke will do.

To set up the equipment, the receiver is adjusted to give the loudest possible signal, the frequency obtained from the modulator not being important at this stage. In order to hear the signal, a speaker or phones can be wired to the receiver. The three-way switch is then set to one position, and the potentiometer adjusted until the note is such that one tuned reed responds. The other potentiometers are similarly adjusted to allow either of the other two tuned reeds to be set vibrating.

The reed contacts circuits are wired to small relays which relieve the reed contacts of current, and which remain closed under the interrupted reed current. It is then possible to close any of these three relays by setting the three-way switch to the correct position and keying the transmitter. One relay may be used for motor speed control and reversing, and the others for steering. In large models, one channel may be used for features such as rotating guns, etc.

Magnets, etc.

The actual mechanisms used must work freely, or very strong electro magnets will be needed. Current consumption is then rather high. With light, free-working mechanisms, the magnets can usually be wound with 24 or 26 s.w.g. wire, for 4½V or 6V operation. Several hundred turns should be used on each magnet. Old bell magnets are often suitable. With some circuits, current can be drawn from the battery which also drives the propulsion motor. The aim should be to have the mechanism work very freely, and then use as may turns, or as fine a gauge, of wire as will give reliable working. This is particularly important when only one small dry battery powers the whole model.

A Compound Astronomical Telescope

(Concluded from page 539)

Diagonal

As the primary mirror is not perforated, a diagonal mirror (flat) is fitted to bring the cone of rays out to the eyepiece position at the side of the telescope tube opposite to the Declination axis. This gives a comfortable observing position. The astronomer can be comfortably seated whilst observing South and up to the Zenith, and a normal standing position, without acrobatics, gives access to other portions of the night sky.

The diagonal and eyepiece drawtube are fitted in the normal manner, but the writer has a 2¼in. dia. drawtube for wide field low power eyepieces (low power on this instrument is 120x) and an adaptor tube to take 1¼in. standard R.A.S. thread eyepieces.

The finder telescope is an ex-government variable power gunsight, graticuled, and with the power continuously variable between 5x and 15x.

For objects beyond the grasp of the finder, the Right Ascension and Declination setting circles, fitted to the Polar and Declination axes respectively, are used in conjunction with a Sidereal clock.

The instrument has proved itself to have been well worth the time and effort involved in its construction. Powers of up to 960x have been successfully used for lunar work, although naturally the field of view is very small at this power. For planetary work, powers of 120x to 720x give an adequate field and plenty of detail.

Information Sought

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

Trampoline

I wish to make a trampoline on a small scale to be used by children. Could you give me sources of supply for the various materials and details of construction?—J. Crawford (Yorks.).

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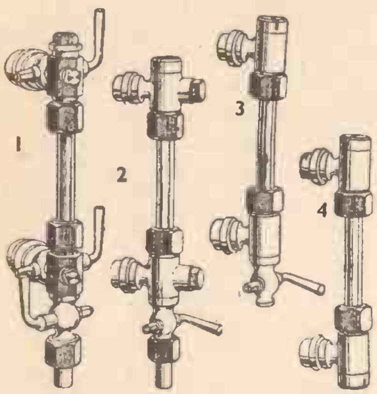

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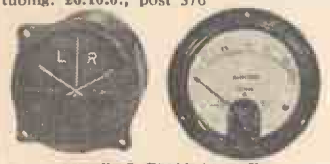

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1 Milliamp		2½in.	MC/FR	35/-
5-0-5 "		2½in.	MC/FR	20/-
30 "		2½in.	MC/FR	12/6
100 "		2½in.	MC/FR	15/-
200 "		2½in.	MC/FR	15/-
3 Amperes		2½in.	MC/FR	35/-
3 "		2in.	MC/FS	27/6
5 "		2in	MC/FS	27/6
15 "		2in.	MC/FR	12/6
25 "	D.C.	2½in.	MI/FR	7/6
30-0-30 "		2in.	MC/FR	15/6
50-0-50 "		2in.	MC/FS	12/6
10 Volts		2in.	MCR/FS	25/-
50 "		3½in.	MC/FS	45/-
300 "	A.C.	2½in.	MI/FR	25/-

(post 1/6 on all meters)

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

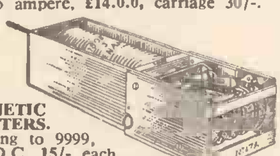
METER RECTIFIERS, 250 μA., 1 M.A., 5 M.A., F.W. bridge, 8/6, post 6d.

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

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

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

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



MAGNETIC COUNTERS. Counting to 9999, 6 v. D.C. 15/- each, cost 1/6. **HIGH SPEED TYPE No. 160C.** 35/-. Post 1/6.

VACUUM PUMP. Brand New. 7 cu. ft. per min. 10 lbs. per sq. in. at 1,200 r.p.m. Rotary Vane type 35/-, post 3/-.

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GEARED MOTORS for the model maker, small but powerful 12/24 volts D.C. 4/8 r.p.m., 35/-, post 2/6.

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GEARED CAPACITOR MOTORS, 220-240 v., 50 cy., 30 w., 300 r.p.m., also spindle for 1425 r.p.m. A very powerful and useful motor for only 75/-, post 3/6.

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1"	2/3 per foot	⅜"	1/2 per foot

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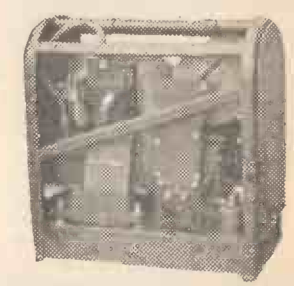

80 WATT LIGHTWEIGHT CHARGING SETS, as used to make a motor lawn mower described in July *Practical Mechanics*. Brand new models. Complete with spares, £10.10.0. Slightly used models, £7.0.0. Carr. 12/6.

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