AN ELECTRONIC 'BRAIN'

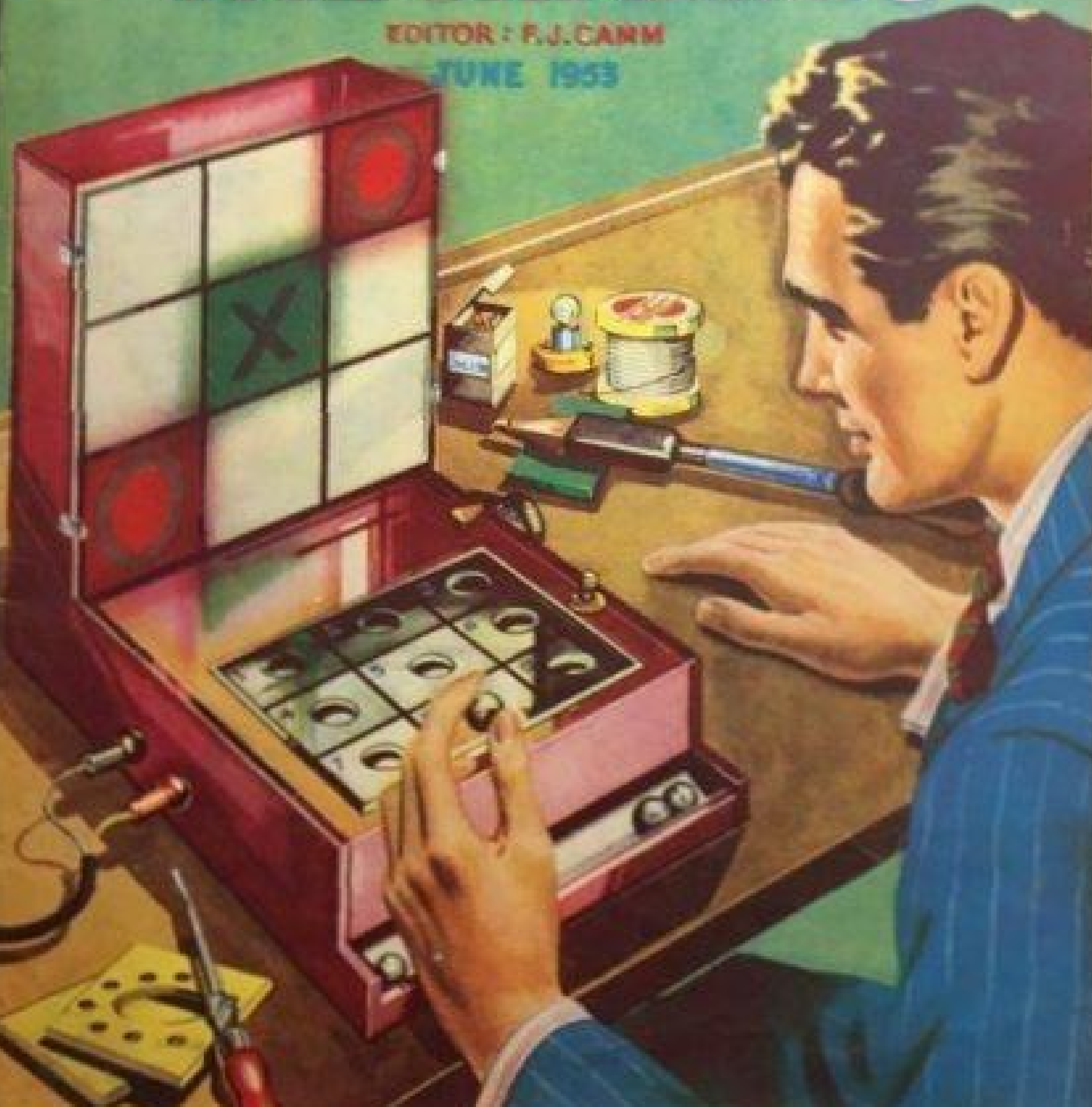
NEWNES

PRACTICAL MECHANICS

1/-

EDITOR: F. J. CAMM

JUNE 1953



JUNE, 1953
VOL. XX
No. 234

PRACTICAL MECHANICS

EDITOR
F. J. CAMM

The "Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

By The Editor

Fair Comment

FLYING SAUCERS AGAIN

RESULTING from a paragraph in one or two Toronto newspapers, world-wide prominence has been given to a report that Avro Canada, North American branch of the famous British firm, is working on a flying saucer project. Even Reuter reported that Field Marshal Montgomery inspected a model of the machine when he visited Avro Canada's plant at Malton. Some of the reports have been accompanied by full descriptions and even illustrations. The British Press were not slow to give further impetus to the belief that flying saucers are in course of production.

Daily newspapers are always seeking something sensational for their headlines, and this news was seized upon with avidity by news editors, groping amongst tape reports at a time when there was nothing spectacular going on in the criminal courts, political pyrotechnics had temporarily abated and news generally was flat. Technical journals, however, need to be more cautious before they hallmark such reports by publication of articles which might give the impression that the information was fact. This journal is constantly searching the world for news of the latest scientific developments and inventions to keep its readers' knowledge up to date. When we read the report of the flying saucer project in the American Press we adopted the usual cautious editorial policy of accepting it *cum grano salis.*

That does not mean that we entirely rejected the report as being a further example of the usual sensational American journalism, for often there is a scintilla of fact buried in their quagmires of imaginative writings. Accordingly we wrote to A. V. Roe, Canada, Ltd., and we are able to say on the authority of that company that the flying saucer reports are largely imagination. The company wrote to us as follows in reply to our letter: "*We appreciate your request for information regarding the reports on the 'flying saucer,' which we understand have been given some world-wide prominence, but regret our inability to help you. Nothing has ever been released by our company or the Government of Canada on this subject.*"

Anything, therefore, which has appeared must be taken as pure conjecture. This does not mean that aircraft companies are not devoting attention to the subject of circular planes; for some of the earliest aircraft had circular wings. The drawing published in America shows a plane more resembling a horseshoe than a saucer. It does not revolve as the flying saucer is presumed to do, although the central power unit does. It is claimed that it will fly at a speed of 1,500 m.p.h., or about twice the speed of sound. Let it be said at once that such a plane is entirely practicable. The rotation of the central disc containing the power unit, presumably a turbo-jet, would provide a means of control and possibly greater stability both longtitudinal and lateral than is possible with normal aircraft. Air is drawn in through ducts in the front of the machine and after compression some is fed to the main engine in the revolving disc and the remainder to the combustion chambers arranged around the periphery of the saucer, whilst exhaust gas from the central power unit is expelled through ducts at the rear of the horseshoe.

In the early part of this year Air Vice-Marshal Smith stated that consideration was being given to flying saucers and later the president and general manager of Avro Canada in an interview said: "Like all other aircraft companies which want to stay in business, we are directing a substantial part of our effort towards new ideas and advanced designs. Like other firms, we have a number of such projects under way. One of them can be said to be quite revolutionary in concept and appearance." All very non-commital, although it does not rule out the possibility that the company is producing a saucer; it may be that some leakage has occurred which it is anxious to discountenance.

It cannot be denied, however, that up to the present no one has produced a jet engine which will propel an aeroplane in level flight faster than sound.

625-LINE TV TRANSMISSIONS

SIR ROBERT RENWICK, president of the Television Society, recently announced that it would shortly be building an experimental 625-line transmitter to provide a service to amateurs and the radio industry which will possibly help the export market. Receivers intended for the Continental standard of 625 lines can be better demonstrated and tested on a radio signal under working conditions. With the approval of the radio industry the society has undertaken to operate a suitable transmitter, and discussions have taken place with B.R.E.M.A. on a suitable site and the design of the equipment.

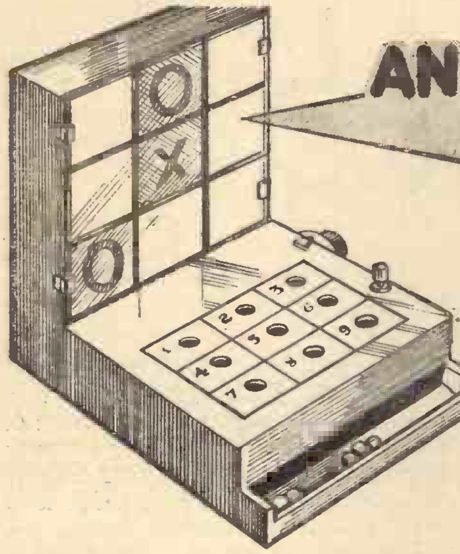
ART ATTACK!

THIS journal is not, of course, interested in Art as such, but it comes within our purview when we find a few pieces of twisted wire affixed to a concrete slab exhibited in London under the title of the "Unknown Political Prisoner." Wire and concrete are mechanical subjects and we are entitled, therefore, to comment on this latest example of futuristic art which gains for its lucky creator the princely prize of £4,500. Most of us are taught to draw and equally we are taught that our drawing should convey what it is without having to write under the drawing of, say, a flower, that it is a pansy. I have some sympathy for the visitor, so unappreciative of art, that he wrecked it. I was equally amused by the remarks of the magistrate who tried him for this lapse, and who asked if there was any evidence if the defendant was mentally unstable. With a twinkle in the editorial optic it did occur to me that the question was misdirected. Surely it is one which should have been asked of the prize donors?—F. J. C.

SUBSCRIPTION RATES
including postage for one year

Inland - - - -	14s. per annum.
Abroad - - - -	14s. per annum.
Canada - - - -	13s. per annum.

Editorial and Advertisement Office: "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2
'Phone: Temple Bar 4363
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.



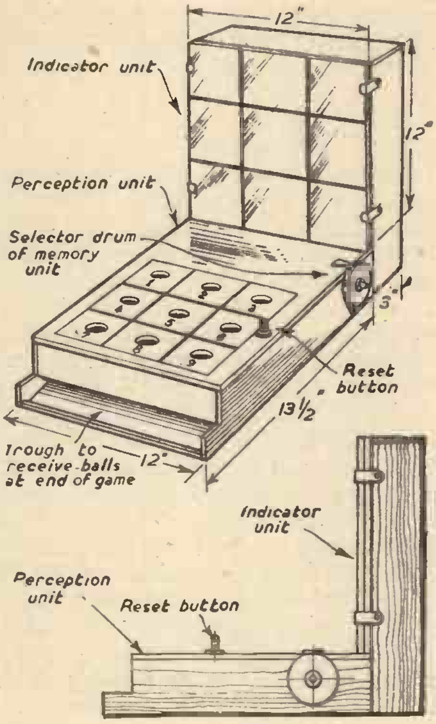
AN Electronic "BRAIN"

Constructional Details of a Novel and Fascinating Machine

By E. HARRIS MORGAN, B.Sc.

THE brain of a living organism has several important functions to perform. It receives messages and information from different parts of the organism, analyses them, and if necessary, sends out instructions to the parts concerned. If a hot poker is picked up by the wrong end, a message indicating this fact is sent to the brain which immediately responds by sending instructions causing the poker to be dropped. The brain cannot respond instantaneously, since the messages have to travel at a definite speed along the nerve channels. Another property possessed by the brain is that of storing information; we call this, memory. Above all, however, the brain can reason, and from known facts deduce a logical argument or produce an *original* idea. The last named property, that of reasoning, varies from one species of animal to another, and also from one individual of a species to another individual of the same species. Among lower animals, the power to reason, is nearly, if not quite, non-existent, whereas in the highest order of animals (man), it is of a very high order.

The way in which the brain works and the manner in which mind and and body are linked together has been the study of philosophers and psychologists for many decades.



Within recent years some scientists have attempted to create machines which duplicate the actions of the human brain. The piece of apparatus described in the following article is one such machine. Like the human brain, it can receive messages and send instructions; it possesses a memory and it can *apparently* reason. It is left to the reader to decide how justifiably it can be called a brain.

The problem which the apparatus is set is to play a game of "noughts and crosses," in which the brain of the apparatus is pitted against a human brain. In order to carry out its purpose, the apparatus must possess a means of perceiving the actions of its opponent; it must possess a memory and a selective mechanism to determine the correct answering play; and it must have a method of indicating its decision. Some of these processes are carried out mechanically and some electrically in the instrument to be described.

Analysis of the Game of "Noughts and Crosses"

In the game of "noughts and crosses," the object is to be the first to obtain a row of three noughts or three crosses, either horizontally, vertically or diagonally. One player uses noughts and the other crosses, and each takes it in turn to play.

The first player has a choice of nine squares in which to place his mark, leaving his opponent eight vacant squares. Thus the first square can be filled in any one of

Fig. 2. (Above left)—Two views of completed instrument showing the relative positions of the units.

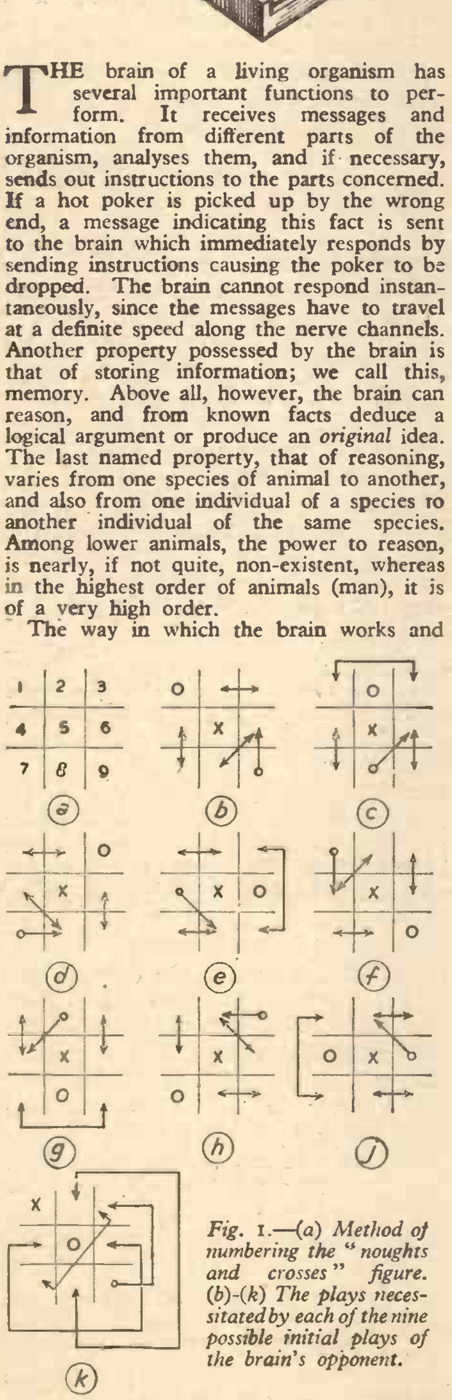


Fig. 1.—(a) Method of numbering the "noughts and crosses" figure. (b)-(k) The plays necessitated by each of the nine possible initial plays of the brain's opponent.

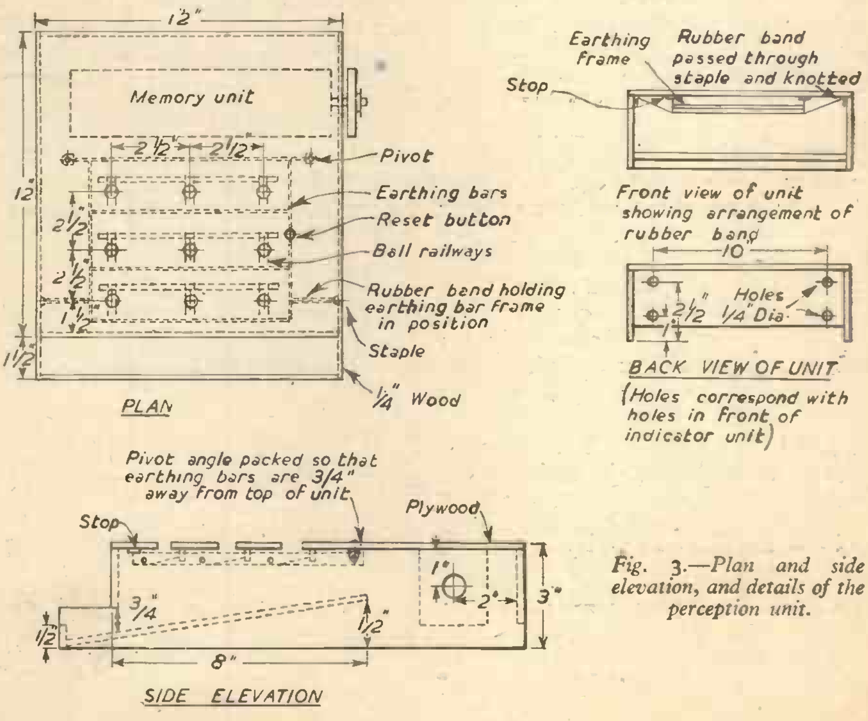
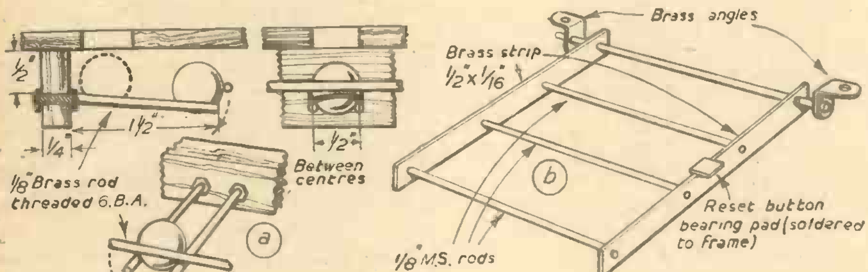


Fig. 3.—Plan and side elevation, and details of the perception unit.

nine different ways and the second square in any one of eight ways. There are, therefore, seventy-two ways of filling the first two squares. By applying this method to the whole game, and including arrangements where three "O's" or three "X's" appear in a row, it will be found that there are 9x8x7x6x5x4x3x2x1=362,880 ways of filling the squares. This is rather a large number of arrangements to deal with, and so some means of cutting them down must be employed. The machine's opponent must be allowed complete freedom of choice and, therefore, his moves cannot be cut down, but we can cut down the moves of the machine itself. Thus, whatever square is filled by the opponent, the machine must be limited to one choice. In this way the number of arrangements is cut from 9x8=72, to 9x1=9. The total number of arrangements then becomes 9x1x7x1x5x1x3x1=945, instead of 362,880; still a large number, but now within the capabilities of the machine.

The method of determining the electro-mechanical brain's answering play in each case will now be considered. For convenience, the squares of the "noughts and crosses" figure have been numbered from 1-9 as in Fig. 1(a).

The most important square of the figure is number 5, for a nought or a cross placed here stops the opponent from completing four out of the possible eight rows of three. Next in order of importance are the squares 1, 3, 7 and 9, for a sign placed in any of these squares blocks three rows. Last in importance come the squares 2, 4, 6 and 8, for these squares only block two rows each.



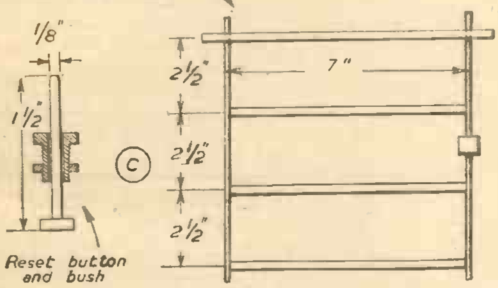


Fig. 4.—(a) The ball railways. (b) The earthing bar frame. (c) The reset button.

Of course, the squares alter in importance during the play, but this need not be considered at this point. If in his initial move the live player places a nought in *any* of the squares, 1, 2, 3, 4, 6, 7, 8, 9, the machine's best answering play is to fill square 5. If, however, square 5 is the initial play, the machine must fill one of the squares, 1, 3, 7 or 9. Since the machine has only one choice, it is predetermined that in this instance square 1 is filled. The ensuing play depends on the opponent's *initial* choice of square (the machine cannot initiate a game). The methods of determining the ensuing play will not be gone into here, but the results of such a determination are given in a series of diagrams in Fig. 1(b)-(k). The "O" in each diagram indicates the opponent's initial play and the "X" the machine's answering play. The double-headed arrows indicate that the plays are interchangeable, that is to say, if the opponent plays one square, the machine answers with the other, and vice versa. For example, in case 1(b), if the opponent plays square 2 the machine answers with square 3, while if the opponent plays square 3, the machine plays square 2. It will be noticed that each diagram contains one single-headed arrow. This arrow indicates that the play is not reversible. Thus, in Fig. 1(b), if the opponent plays square 9, the machine replies with square 6, while if square 6 is played by the opponent square 8 is played by the machine. In this case play in either square 9 or 8 will be answered by play in square 6. This causes difficulties in theory, but in practice they do not arise.

The selection of the necessary answering plays is accomplished by means of a specially constructed switch, which is, in effect, the memory of the machine. This switch will be described in detail later.

Construction

The machine consists of three major parts (a) the perception unit, which receives information from the machine's opponent; (b) the memory unit, which analyses the information and controls; (c) the indicating unit, which shows both the squares selected by the opponent and the machine's answering play. Fig. 2 gives two views of the machine and indicates the relative positions of these parts.

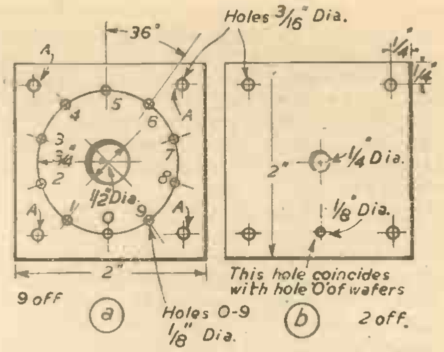


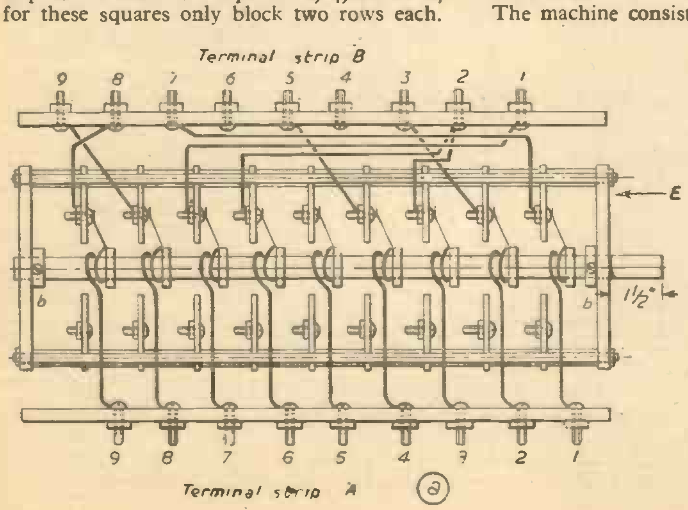
Fig. 5.—(a) Details of switch wafers. (b) The switch endpieces.

Perception Unit

The perception unit is, in effect, a switch unit with nine positions, each position corresponding to a square on the "noughts and crosses" figure. In the design here described the switching is carried out by using steel balls, but it is not claimed that this is the only, or even the best, method. Orthodox switches of the toggle type could be used. The steel ball method has one important advantage, and that is, that once a play has been made it cannot be altered, either accidentally or intentionally. No "trials" are possible by the machine's opponent. The machine cannot be made to "give away" its answering play, and then have to face a different play.

The perception unit is built in the form of a box as shown in Fig. 3. The box is oblong in shape and the top is pierced by nine holes. The floor of the box slopes towards the front of the box, so that when the balls are released at the end of the game they will run forward into the channel in readiness for the next game. The floor of the box is secured by screws passing through the sides of the box. It should not be finally fixed in position until after the instrument is wired up.

The measurements given in the diagram are not critical, but the following points should be noted. The box must be wide enough and deep enough to accommodate the memory unit. The width of the box is the same as the width of the indicating unit, and



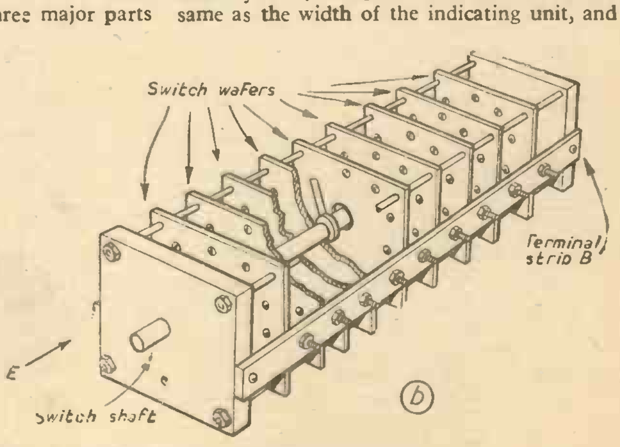


Fig. 6.—(a) Side view. (b) Cut-away perspective view of memory unit.

the holes in the back of the box should correspond with the holes in the front of the indicating unit; these holes being used to bolt the units together. Finally, the holes for the balls should be of ample size to allow the balls to pass freely, but not too large, otherwise the balls might miss the switch rods.

The machine's opponent selects his play by dropping a steel ball through the corresponding hole of the perception unit. The ball, after passing through the hole, drops a short distance on to two short inclined parallel rods (Fig. 4(a)). It runs down the rods until it is brought to rest by an earthing bar. There are three earthing bars running across the box. Fig. 4(b) gives views of the earthing bar arrangement. It will be noticed that the three bars are carried in a frame which is pivoted at one end. The frame is held in a horizontal position by means of a rubber band. When the game is ended the reset button is pressed, thus pushing the frame downwards, allowing the balls to fall to the floor of the box and thence to the channel. Looking at the instrument from the front, the rods of the ball railways are connected as follows; the left-hand rod in each case is connected to the side-contact of the "O" bulb of the corresponding square of the indicating unit. The right-hand rod of each switch position is connected to the corresponding moving contact of the memory unit (see Fig. 6). Thus the right-hand rod of switch position 2 will be connected to terminal 2A of the memory unit and hence to moving contact number 2. The measurements of the various internal arrangements of the perception unit will depend on those chosen for the box itself. The following points should be noted however. The size of the steel balls determines the distance apart of the switch rods. Half-inch steel balls are of a convenient size and the measurements shown in Fig. 4(a) should then be used. The distance between the centre of one railway and the next should be equal to the distance between centres of the holes in the top of the box. The angle of inclination of the railways should be large enough to ensure a positive contact between the balls and the earthing strip, but not so great that the balls "jump" the strip. Care should be taken that the wooden strips carrying the railways are sufficiently far from the holes for the balls to drop cleanly on to the railways. If dies are not available for threading the rods, threaded rods should be purchased and the unwanted portion of the thread filed away before bending.

The Memory Unit

The memory unit consists of a ten-position switch with nine switch wafers. To construct the switch, nine pieces of three-ply wood 2in. square and two pieces of ¼in. hardwood 2in. square are required. The squares of plywood are drilled as shown in Fig. 5(a), while Fig. 5(b) shows how the hardwood is drilled. This operation must be carried out accurately, and the reader is advised to make templates for the job and check against them repeatedly.

Through the holes in each plywood "wafer," numbered 1-9, are inserted ½in. 6 B.A. round-headed brass screws. Eighty-one screws are required. The wafers are then built up into the switch by bolting them together with long screwed rods (threaded 2 B.A.) through the holes marked A. Spacers ¾in. long are inserted on each screwed rod between each wafer, these spacers being cut from brass, copper or plastic tube. A plastic rod ¼in. dia. is then mounted in position as shown in Fig. 6, which gives side and perspective views of the completed swith, The rod is prevented from moving sideways by bushes bb which are secured to the rod by grub screws.

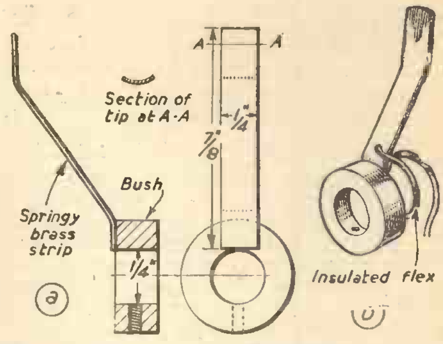


Fig. 7.—(a) The moving contacts of the memory unit. (b) Method of making connection with the contacts.

Nine other bushes are required for the moving contacts, and to these are soldered pieces of springy brass ⅞in. long and ¼in. wide (Fig. 7(a)). Through the remaining hole in the wafers and endpieces is pushed a number 11 plastic knitting needle. This acts as a stop and prevents the switch from being continuously rotated in one direction. To each moving contact a small spiral of insulated wire is soldered as shown in Fig. 7(b). The other end of the wire is brought out to a terminal strip A (Fig. 6), and from there to the correspondingly numbered right-hand rod of the perception unit. Each wafer is now wired in accordance with Fig. 8, the ends of the wires being brought out to terminal strip B (Fig. 6). In Fig. 8, the numbers in the circles represent the contact screws, while the numbers outside the circles correspond to the numbers on terminal strip B. The wafers themselves are also numbered, and these numbers correspond to the numbers of the moving contacts. It will be found to be easier to connect wires to the back of all the screws before assembling the switch, the wires being soldered or fixed with a second nut. Soldering provides a more effective connection.

Connections are taken from terminal strip B to the side-contacts of the correspondingly numbered "X" bulbs of the indicating unit.

(*To be concluded*)

LIST OF MATERIALS REQUIRED

18—M.E.S. lampholders.
18—2.5-volt lamps.
5—½in. steel balls.
7 doz. ½in. 6 B.A. round headed brass screws with nuts.
1ft. (approx.) ¼in. plastic rod.
1—No. 11 plastic knitting needle (1ft.).
3ft. ⅛in. brass rod.
3—⅜in. dia. M.S. rods 7in. long.
1—⅛in. dia. M.S. rod 8in. long.
2—Brass angle pieces.
1½ft. brass strip ½ in. x 1/16 in.
2 pieces glass 1ft. square.
12 bushes ¼in. bore.
4—1ft. lengths of 2 B.A. screwed rod.
Red and green cellophane.
Quantity of wood ¾in. thick.
Pieces of plywood.

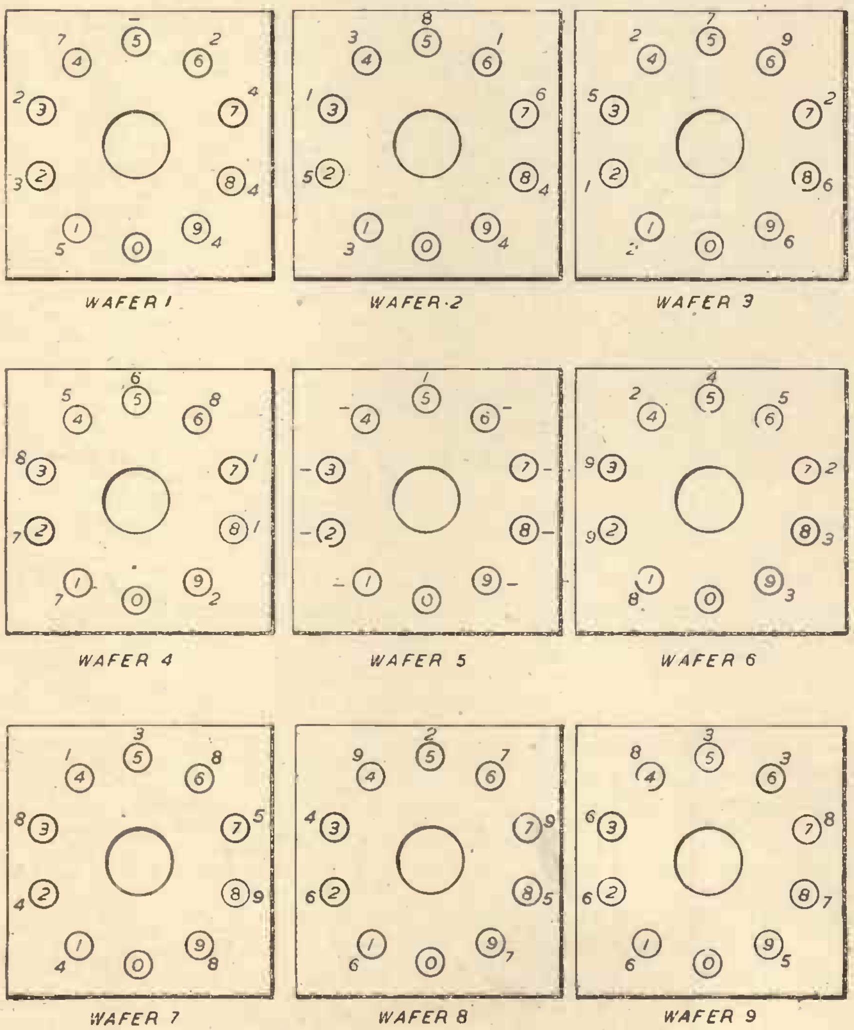
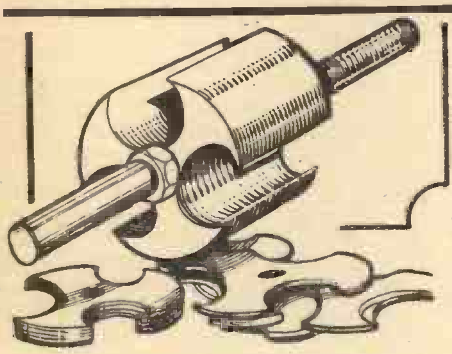


Fig. 8.—Diagram of memory unit connections.

MAKING ARMATURE LAMINATIONS



Simple Press Tools for Punching Out Armature Laminations from Thin Tinned Iron Sheet

By J. H. BLOOR

THE search for an inexpensive alternative to commercial products led the writer to construct his own press tools for making small three-pole armature laminations. These tools have so far produced sufficient for about half a dozen armatures and seem good for plenty more yet. The raw material used is soft iron from cut-up cocoa tins, etc.; this is about 12-15 mils. in thickness, so about 35-40 laminations are required for an armature stack ½in. thick plus a fibre one at each end to protect the winding insulation.

While construction of the tools may be a bit outside the scope of the modeller who is restricted to working on the kitchen table, there is nothing fundamentally difficult and the chief requisite is accuracy in marking out and drilling certain holes to size, and truly square.

Though possession of a lathe is not essential it is certainly an asset for jobs like this, and if the intending constructor is not so equipped it may be well worth while enlisting the aid of a fellow modeller possessing one. The materials required are small in number, and most of them can, no doubt, be requisitioned from the scrap box. Furthermore, mild steel strip is in rather short supply at the moment, and though alternatives are permissible for certain parts, some must be capable of being hardened.

Laminations are produced in two stages. The first tool, detailed in Fig. 1, yields ¾in. discs with a 3/32in. central hole; these are placed in the tool shown in Fig. 2, and three 3/16in. holes at 120 deg. spacing are pressed out so that three poles are left (see Fig. 4a and b).

Constructing the Tools

The diagrams are self-explanatory, but one or two details require amplification.

The base plate D is used for both tools and all holes in both tools should be accurately dimensioned from the centre punch pin F to ensure symmetry. It is suggested that D should be drilled first with all holes drill size 51, then each of the other plates may be clamped to it in turn and D used as a drill guide plate for locating the other holes; it will be necessary to mark out plates L and M before drilling as a centre pop mark is needed for dividers to scribe the 5/32in. pitch circle (see Fig. 3). Having marked this circle step out the radius around its circumference; it should go exactly six times. Alternate marks give centres for 3/16in. holes at 120 deg. spacing. After all pilot holes have been drilled carefully open them out to final sizes. In the case of the ½in. holes proceed in two or three steps, as this minimises any tendency to "wandering"; furthermore, plates A and B and L and M should be drilled in pairs to ensure alignment. The size of hole 'f' is not critical and if a drill larger than ½in. is not available it may be opened out with a small half-round file just to clear the punched discs.

	MATERIALS.
A, C	Mild steel ¼" x 1" x 2"
B, D	Mild steel ⅛" x 1" x 2"
E	Silver steel ½" x 1¼"
F	Silver steel 3/32" x ½"
G	Steel screws 2 B.A. x 1" C.H.
H	Washers 2 B.A. 2 B.A. x 0·015
J	Steel nuts 2 B.A. Hex

	DRILLINGS.
a	3/32"
b, d	1/2"
c, e, g	Drill No. 12.
f	5/8" or 9/16"
h	Drill 51 tap 8 B.A.
j	Drill 26 tap 2 B.A.

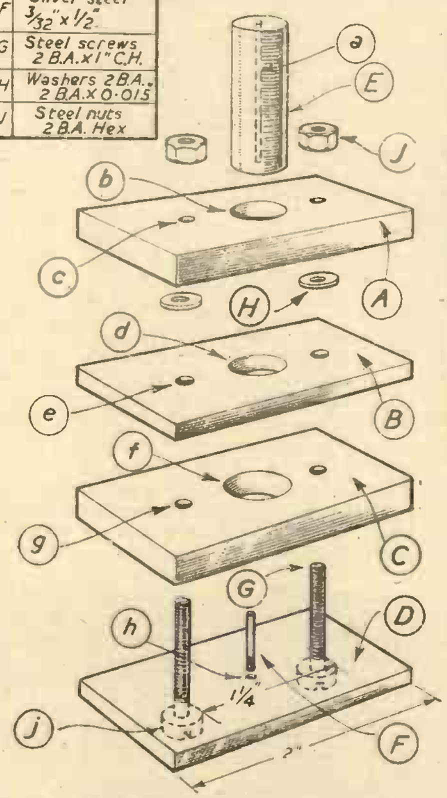


Fig. 1.—Details of the punching tool for forming disc blanks.

The Punch

The punch, E, should now be cut. It is a 1¼in. length of ½in. dia. silver steel; finish both ends square and, if a lathe is available, the punching end may be made slightly hollow. Drill a 3/32in. central hole right through. If you have to do this by hand make sure that the first ¼in. or so is absolutely central and square, then drill from the other end somewhat larger, say, about 3/16in., forming a stepped diameter hole.

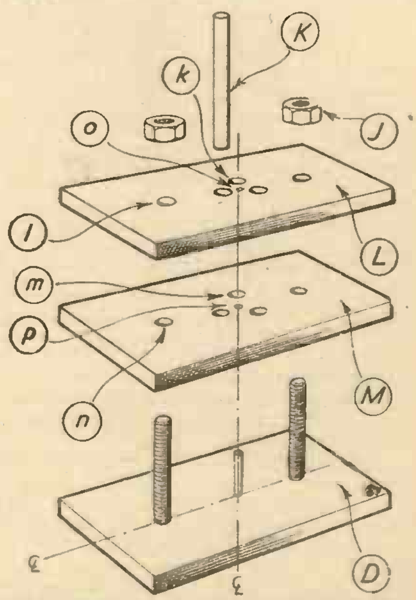
Pin F should be threaded 8 BA for ⅛in., and this is best done before cutting off Finish the other end off square.

Pin K is a plain length of 3/16in. silver steel about 1¼in. long, finished square on both end faces.

The three round pieces require hardening; heat to a bright red and quench in water, then brighten up with emery cloth and temper by heating in a tin lid over a flame to a light straw colour, and quenching again in water.

Hardening the Plates

The shearing faces of parts B and M now require hardening, and the easiest way of doing this is to pack the plates in a tin filled with case-hardening powder, e.g., Kasenit; ensure that the faces are in full contact with the powder. Now bury the tin carefully in the heart of a good fire so that it and the contents reach a good red heat and hold it for at least half an hour. Remove the plates and, holding them at both ends, heat up to red again and quench in water. Remove any scale and clean up by rubbing on a flat sheet of emery cloth.



	MATERIALS.
K	Silver steel 3/16" x 1¼"
L, M	Mild steel ⅛" x 1" x 2"
D, J	See diagram No. I

	DRILLINGS.
k, l, m, n	Drill No. 12. See dia. 3.
o, p	3/32"

Fig. 2.—Details of the tool for punching the winding slots in the disc blanks.

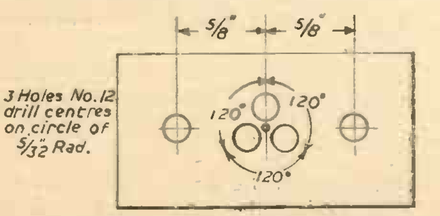


Fig. 3.—Marking out for plates L and M.

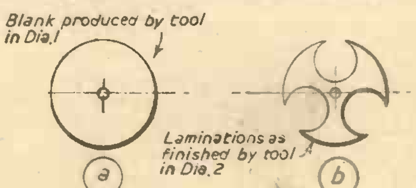


Fig. 4.—Detail of a blank, and a finished lamination.

Now the tools are ready to try out. Assemble the parts shown in Fig. 1. first. The washers, H, should for preference be a few mils. thicker than the tinplate to be used, but this is not critical.

"Punching" in the Vice

Before tightening the nuts insert the punch E and make sure it is a smooth sliding fit and does not snag either plate B or pin F. Tighten up with the punch right home, then remove it. Cut a strip of tinplate about ⅜in. wide and feed it between A and B across the holes; put E into its hole in the guide plate A, place the whole assembly in a vice and squeeze up. There should be a sudden cessation of resistance and a clean cut disc pushed on to F. Slacken off the vice, withdraw E, feed in the strip and tighten up again. After about 20 discs have been punched it is necessary to dismantle and remove the discs from the pin F.

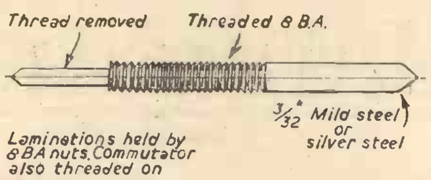


Fig. 5.—Silver steel threaded spindle for mounting the armature laminations.

Forming the Winding Slots

The second operation is somewhat slower. Assemble D on M, slip a disc on to the pin, add L and tighten the nuts. Returning to the vice, pin K is used to punch out three holes. If any slight burrs are produced a little work with a smooth file will put things right. When sufficient laminations have been produced for an armature make a couple more from thin fibre or card to go on the ends of the stack.

A final treatment is to heat the laminations to redness; this will not only anneal the laminations but will oxidise the tin coating and form a high resistance skin to minimise the flow of eddy currents.

Alternative Materials

Finally, a word about alternative materials; in the prototype, plate A was only ⅛in. thick and the backing plate C was omitted. It is felt that the extra thickness of A is worth while to ensure that punch E commences its work squarely. Without C the number of discs punched in one session is limited to about five or six. It is probable that satisfactory results would be obtained if A and C were of brass or paxolin.

Do not be tempted to hammer the punches through, as the probable result will be to drive them in off square and damage the edges.

A type of shaft used with these laminations is shown in Fig. 5.

Back to First Principles

5.—Friction in its Useful Function

By W. J. WESTON

Of course friction has its use. We could not walk, we could not drive a car along the road unless friction were present to give a grip. The emergence of friction as a benefit, instead of in the usual aspect of a nuisance, is clearly seen when it prevents overhauling in a machine, prevents the weight from taking charge upon a relaxation of the effort. Perhaps the most interesting instance of this is Weston's differential pulley; the ingenuity of its devisor has "turned a bane to antidote."

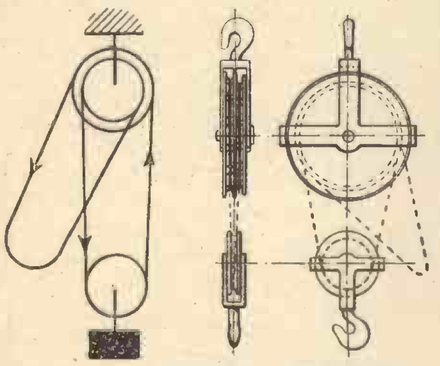


Fig. 1.—The differential pulley problem.

The Problem: In the diagram (Fig. 1) of a differential pulley the radii of the upper sheaves are 10 centimetres and 9.5 centimetres. What is the velocity ratio and what (efficiency being 40 per cent.) is the mechanical advantage?

The Comment: The essence of the differential pulley is that the chain round the larger of the upper sheaves is unwound while being wound round the smaller. The lessening of the loop holding the movable pulley is, therefore, for every complete revolution of the larger pulley, merely the difference between the winding and unwinding; and the pulley enclosed in the loop rises half this difference. The velocity ratio—the comparison between the distance over which the force acts, and the distance over which the resistance is overcome—is, therefore, very small; and the corresponding mechanical advantage very great.

The Answer: Distance through which force acts in one revolution of larger sheave $= 2\pi \times 10 = 20\pi$.

Distance through which weight rises in that revolution $= \frac{1}{2}\ (2\pi \times 10 - 2\pi \times 9.5) = \frac{1}{2}\pi$.

Velocity ratio is ∴ 1 : 40.

Force of friction reduces the 40 to

$$40 \times \frac{40}{100} = 16.$$

Mechanical advantage ∴ is 16.

The Problem: If the fixed pulleys of a Weston differential block have 10 and 11 teeth, and the effect of friction in the machine is to increase the effort by an amount which is a fixed proportion of the load, find that proportion when the efficiency is ⅓.

The Comment: In order that friction may operate to at least the desirable extent, the grooves through which the endless chain of a Weston differential goes have projections and recesses. This desirable extent is such as will reduce the efficiency to below 50 per cent.; otherwise any relaxation of the force will result in a slipping back of the weight. The efficiency, it must be noted, is the ratio of the effort *when friction is neglected* to the effort *when friction is considered*—as, of course, it must be in practice.

The Answer: The ratio of Effort to Load, friction being neglected, is 1 : 22.

Friction being considered the Effort in relation to the same Load is 3 : 22 (efficiency being ⅓).

Two units of force are, therefore, expended in overcoming friction as against one unit to raise the load. The proportion required ∴ is 2 : 22 or 1 : 11.

The Problem: A man weighing 130 lb. sits in a seat weighing 14 lb. (Fig. 2), which is suspended from a smooth pulley supported by the two parallel portions of a rope which is coiled in opposite directions round the two drums of a differential wheel and axle of radii 15in. and 12in., respectively. He raises himself by pulling one side of the rope. Which side is it? Show that to raise himself he must exert a pull exceeding 16 lb. weight.

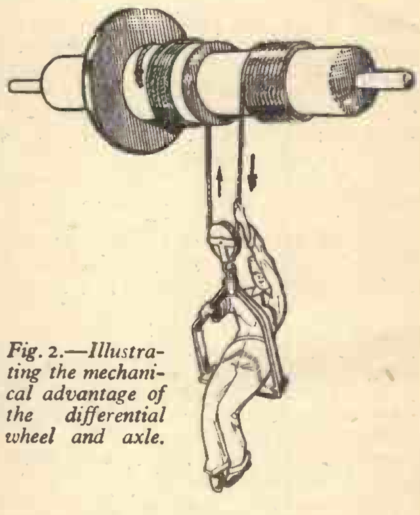


Fig. 2.—Illustrating the mechanical advantage of the differential wheel and axle.

The Comment: The differential wheel and axle applies the same idea as that utilised in the Weston pulley, as the wheel unwinds the rope the axle winds it; the distance over which resistance is overcome is thereby lessened and the mechanical advantage thereby increased.

The Answer: The mechanical advantage of the contrivance is $2\pi \times 15 \times 2 \div (2\pi \times 15 - 2\pi \times 12)$, that is $30 \div 3 = 10$.

The muscular pull of the man downwards, *exerted on the rope over the smaller drum*, makes the total pressure down into 130 lb. + 14 lb. + F lb. (F being the force exerted by the man).

So: 10 F lb. = (144 + F) lb.

So: 9F = 144 and F = 16 lb.

To overcome friction this 16 lb. must be augmented.

Restringing a Tennis Racket

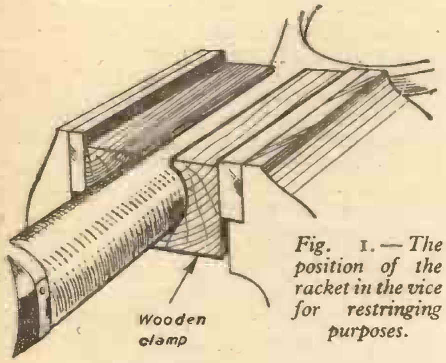


Fig. 1.—The position of the racket in the vice for restringing purposes.

How to Renew Your Tennis Racket Strings at Home

ALTHOUGH the restringing of a tennis racket, completely or in part, is a process which calls for the exercise of a certain amount of acquired skill, the task, once the necessary knack has been mastered, is not a difficult one. It is, indeed, an operation which is well within the practical capabilities of the average handyman, and only a minimum number of tools is required.

The amateur who takes up this interesting spare-time occupation needs merely a small work-bench fitted with an efficient vice, into which the racket under treatment can be held in the manner shown in Fig. 1. In order to obviate the risk of injury to the handle of the racket by undue pressure in the vice it is advisable to line the jaws of the latter with hollowed-out blocks of wood exactly conforming to the curvature of the racket handle. Such "liners" for the vice will also allow a better grip to be obtained on the racket.

For the purpose of racket restringing we require, in addition to the necessary gut, a pair of scissors, a pair of blunt-nosed pliers, and a "pricking" awl having a fine point, the latter being used for opening up the holes in the racket frame through which the gut is passed. A "setting-off" awl will also be required. This implement is merely a stout, stumpy variety of awl, having a short blade, and it can usually be made at home. Its purpose is for aiding the squaring-up of the strings of the racket during their final tensioning. Finally, one or more "stopping awls" will be required. This is merely a fine-pointed awl, whose function it is to prevent the slipping back of any tensioned string by being thrust into the hole through which the string passes.

Practise on Cheap Rackets

Before embarking upon the restringing of a really good quality tennis racket, the beginner would be well advised to practise upon a junior racket, or even upon a child's toy racket, and in place of gut to use ordinary strong string or very thin cord. A short practise along these lines, following out the instructions given in this article, will sufficiently acquaint him with the precise procedure of the restringing operation. With this knowledge and experience will readily come the necessary confidence for tackling a full-size sports racket.

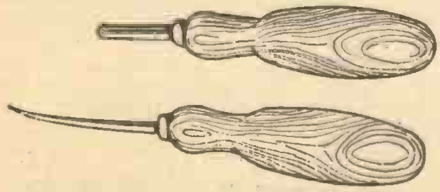


Fig. 2.—The types of awl required for restringing.

The gut for tennis rackets is obtainable in several grades and colours, the "extra-high tension" gut being the best. This quality of gut, which is expensive, is by no means necessary for average restringing work, for which purpose any average grade of gut will be quite satisfactory.

Tennis racket gut is usually supplied by sports outfitters or by gut manufacturers in 21ft. lengths for the "mains," as the vertical strings of the racket are called in the trade, and in 18ft. lengths for the "crossings," which is the trade name for the crosswise strings. "Mains" gut can usually be obtained in white, green, or black, whilst "crossings" guts are usually coloured red.

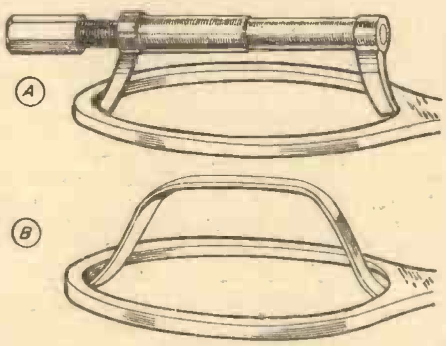


Fig. 3.—(A) The professional tennis racket "billiard," or racket-stretching implement. (B) A substitute for the above can be made from a strip of springy steel.

Good quality rackets usually have several crosswise lengths of gut put in at each end. These gut strings are professionally known as the "treblings," and their purpose is merely to fill up the space at the top of the racket which would otherwise have to be left vacant. "Treblings" gut is available in 18ft. lengths and in several colours.

Coming now to the actual task of restringing a racket, it is first of all firmly secured in the vice and all its old strings removed, the various holes in the racket frame being cleaned out by means of the pricking awl or some other sharp pointed implement.

The "Mains" String

In order to thread the "mains" strings, the 21ft. length of "mains" gut is threaded through the central hole in the neck or "throat" of the racket, as shown in Fig. 4, so that exactly one-half of the length of gut is made available on each side of the racket. One-half of the racket is then carefully threaded, following the method indicated in the diagram, Fig. 4. In this diagram the arrow heads indicate the direction of threading the "mains" strings on one-half of the racket, those on the opposite half are similarly threaded. Now comes the highly important task of tensioning the "mains" strings.

To effect this we must bring into service an implement known to racket makers and repairers as a "billiard." A professional racket "billiard" is illustrated at Fig. 3. It comprises merely a metal rod, which is capable of being screwed in or out of a short metal tube. To each end of the implement curved metal pieces are fitted. When the "billiard" is inserted into the racket, its projecting pieces press against the upper and lower ends of the racket, and by screwing up the implement it is possible to put a longitudinal tension on the racket frame and thus prevent it from being distorted during the tensioning of the strings.

Whilst a properly designed "billiard" is greatly advantageous for all serious work, a good substitute for this implement can be made from a strip of springy steel inserted into the racket frame in the manner indicated at Fig. 3(b).

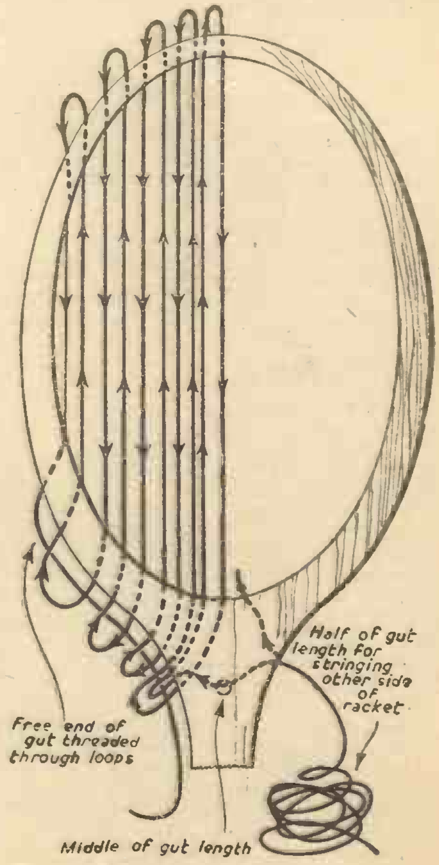


Fig. 4.—The method of inserting the "mains" strings.

Using the "Billiard"

The "billiard," or its substitute, is inserted into the racket frame, as illustrated, and the "mains" strings are each separately tensioned by pulling tightly upon them with the blunt-nosed pliers.

In tensioning these strings begin at the centre of the racket and work outwards in the order in which the strings were first threaded. In order to get the strings adequately and equally tensioned it will be found necessary to perform the tensioning operation about half a dozen times. When, however, the strings have been satisfactorily tensioned, pull the threaded ends of gut on opposite sides of the racket as tightly as possible and then cut them off short with the scissors.

If, during the tensioning of the gut, there is any tendency of the string to slip back, this can be prevented by "stopping" each string as the tensioning task proceeds. "Stopping" is a very simple operation. All it consists of is merely driving a fine pointed awl into the hole in the racket frame through which the tensioned string passes. The pressure of the awl blade against the string in its hole will prevent the string slipping back.

Having threaded and tensioned the "mains" strings of the racket, we have now to weave the "crossings." This is a rather easier task. The method of weaving the "crossings" is clearly shown in Fig. 5. Although in this diagram the loops of the "crossings" are shown on the outer side of the racket frame, these loops should be pulled tight as the work proceeds, and any slipping back of the loops being prevented by means of a stopping awl thrust into the hole through which the gut passes.

Crossings

The "crossings" are, of course, threaded over the one "mains" string and under the next one, and so forth. For squaring up the woven pattern of the strings, the "setting-off" awl will be required, this being used merely to press the various strings up or down or to the right or left.

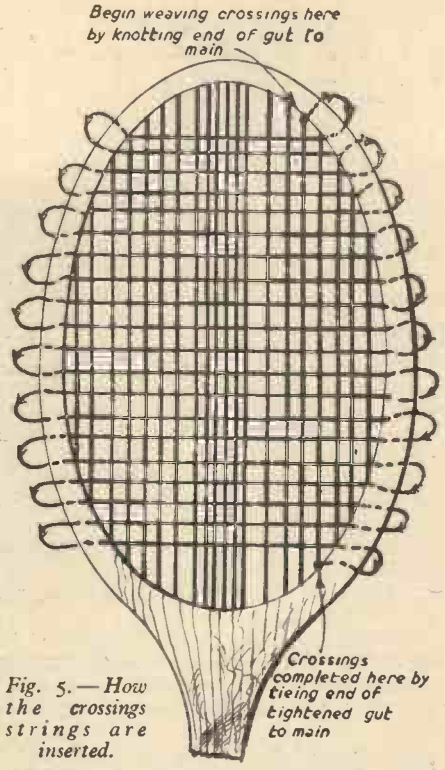


Fig. 5.—How the crossings strings are inserted.

Finally, the "treblings" are put in. These cross strings, which, as we have already seen, are those which occupy the extreme ends of the racket, need not be woven under tension. From the "trebling" gut, the necessary lengths required for the three or four rows of these strings at each end of the racket will have to be cut.

Note that the "trebling" gut is not merely woven in and out across the "mains" strings, it is taken right round each "mains" string, the two double "mains" strings near the centre of the racket being counted as one string for this purpose. Many racket repairers fill up the holes in the racket frame with a hard wax made by melting together resin and beeswax or any other similar natural wax, this mixture tending to keep the dirt out of the holes in the frame.

A racket which has been satisfactorily restrung should have all its strings lying in one plane, so that the entire network of strings presents a perfectly flat surface.

Note particularly that after the "billiard" or stretching implement has been inserted in the racket frame for the tensioning of the "mains" strings, it should not be withdrawn until at least half of the "crossings" have been woven and tensioned.

Replacing Broken Strings

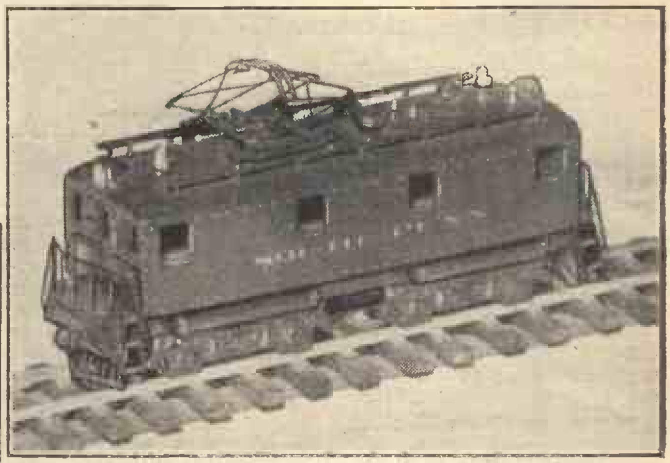
Rackets which have merely one or two strings broken need not, of course, be completely restrung for ordinary use. A new string may readily be inserted in the following manner, no knots being utilised in the process:—

Remove the broken string and bring its ends to the outside of the racket frame. Now restore the tension to the strings on each side of the broken string, maintaining their tension by means of a stopping awl thrust into the holes in the racket frame. Take now a length of gut slightly longer than the length of the new string. Pass its free end through the hole in the frame next to the vacant hole, wedging it by means of an awl. Then thread the gut through the adjoining vacant hole in the racket frame and, after tensioning the string, wedge it by pulling it through the adjoining hole.

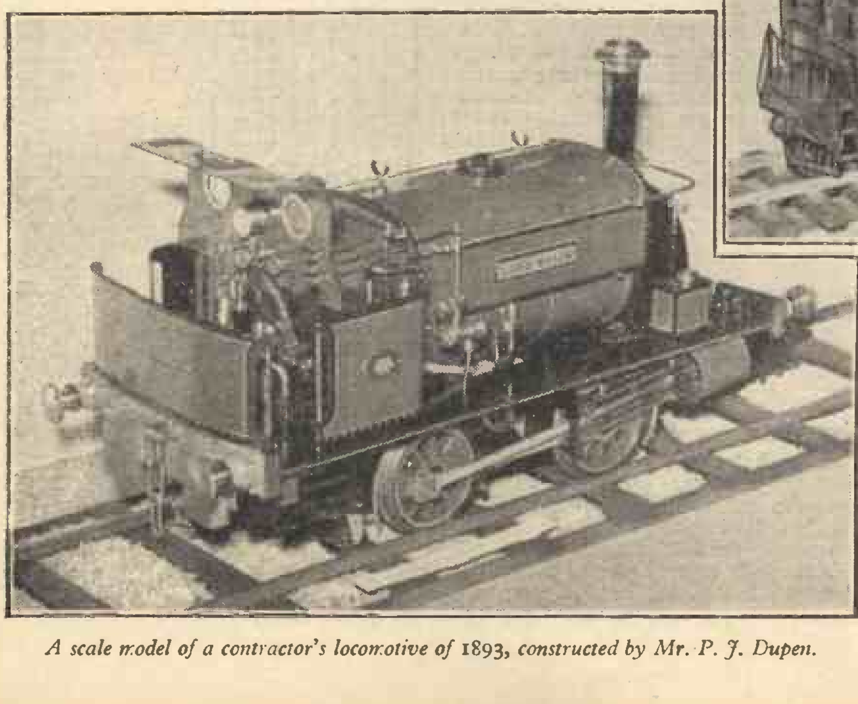
Model Railway Exhibition

THE Model Railway Club held its annual exhibition in the Central Hall, Westminster, from April 7th-11th inclusive. As in previous years, the show was well attended and proved a great attraction for enthusiasts of all ages.

The exhibition not only displayed several examples of fine craftsmanship in the art of modelling railway equipment, but it also afforded an opportunity of learning some of the history of the railways of Great Britain and of seeing in miniature the progress made in railway work, locomotives, rolling stock, signalling and permanent way. A feature on the historical side was a display in the Upper Hall of the crests adopted by many of the old railway companies for the embellishment of their rolling stock, and these made an interesting comparison with the present-day emblem of British Railways.



A model of a South Pennsylvanian old electric tunnel locomotive of the 1920's, made by Mr. H. K. Myers.

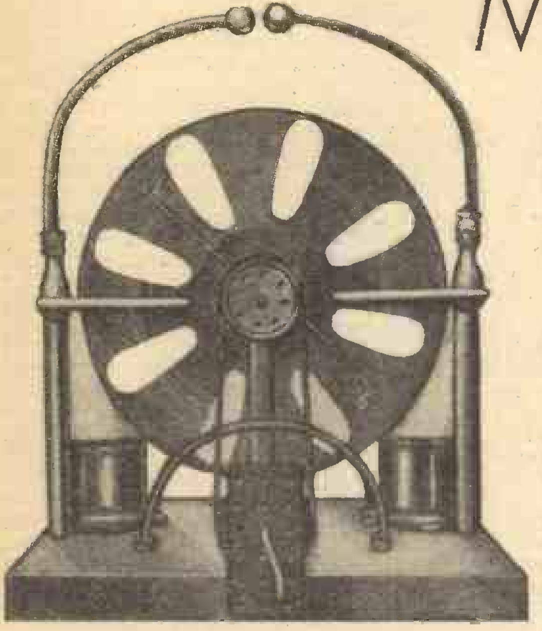


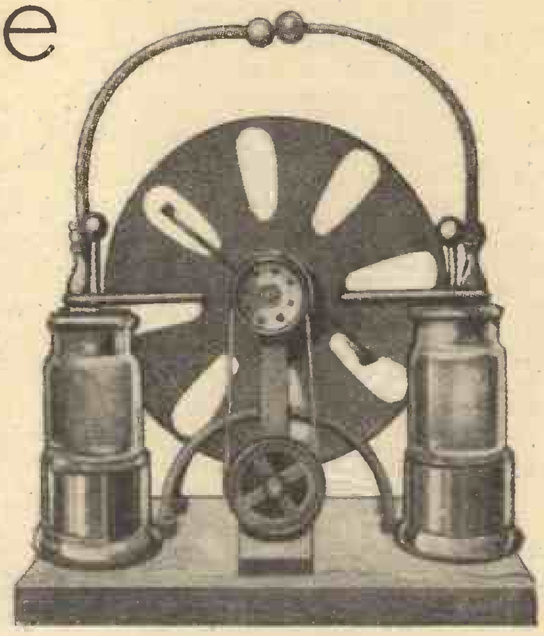
A scale model of a contractor's locomotive of 1893, constructed by Mr. P. J. Dupen.

Examples of scenic modelling were well in evidence and several working model layouts, including that staged by British Railways, were in operation in the Lower Hall.

Making A Wimshurst Machine

Made from Simple Materials, this Unit is Hand-driven and Generates 40,000 Volts





Figs. 1 and 2.—Front and back views of the Wimshurst machine.

A WIMSHURST machine, as shown in Figs. 1 and 2, is simply a mechanical device for rotating in opposite directions two sets of conductors—in this case slips of tin-foil glued to 8in. gramophone records—with appropriate apparatus for collecting the electric charges induced on them.

The essential parts of the machine must be perfectly insulated, for which reason they are usually mounted on glass pillars. In this model, vulcanite or some such composition is used, but it must be remembered that dry wood is no insulator to high potential static electricity.

The vulcanite posts are the tubes of 6in. wireless lead-in tubes. The brass rods and terminals, which are first removed, come in for use in other parts of the machine. The base is a block of 1in. oak and the posts are mounted on it. This is done by boring holes slightly larger in diameter than the posts half-way through the wood. Some flowers of sulphur are then melted in a tin over a gas jet, and the liquid poured into one of the holes. The post is stuck in, squared up, and held until the sulphur cools. Posts mounted in this way are surprisingly firm (Fig. 3).

To strengthen the middle posts, which carry the bearings of the plate spindles, a hole is drilled through each about half-way up, and a brass rod from a lead-in tube pushed through and bent into a semi-circle. The two ends, which are threaded, are then bolted down to the base in the manner shown.

The Bearings and Collecting Combs

The bearings can be attached to the tops of the posts by tight-fitting screws, which will cut their own threads in the vulcanite. The collecting combs can be made from lengths of brass rod bent into a U, having

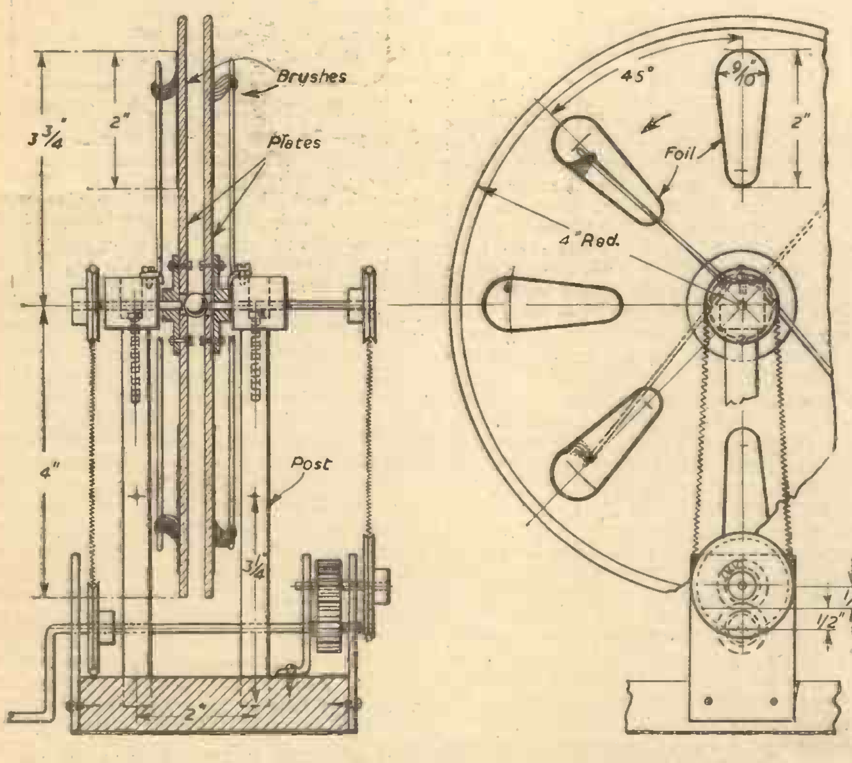


Fig. 4.—General arrangement of the discs and their mountings and method of connecting the brushes.

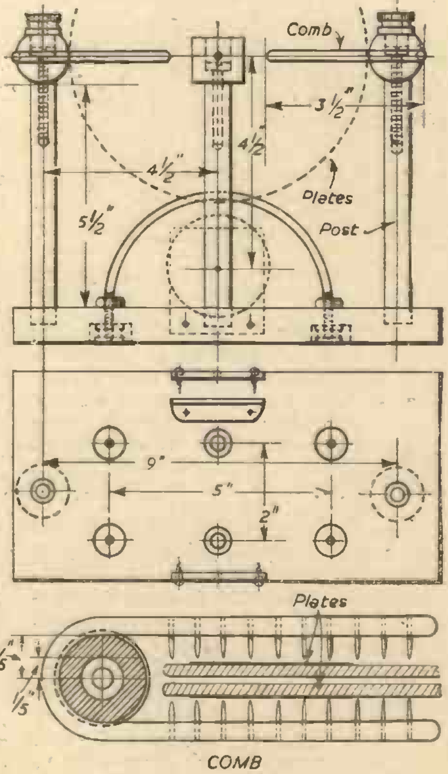


Fig. 3.—Mounting the posts and details of the comb.

a convenient number of small holes drilled through each arm and gramophone needles, broken off to a suitable length, soldered or cemented in. In the model shown, ordinary metal cement was found to be very effective. The ends of the rod should be carefully rounded, as it is essential in electrostatic machines to have all metal parts smooth and polished and to avoid all sharp corners. As, however, electric charges are carried on the surface, it does not matter whether the parts are hollow or solid.

The combs are then mounted so that the plates can revolve between them without quite touching them. The clearance may be as much as a fifth of an inch without any serious loss of electrical charge.

Eight strips of tin-foil—"silver paper" does very well—are stuck at equal distances on one side only of each gramophone record, and a wheel with a setscrew is bolted to the centre to facilitate attachment to the spindles. The records are then mounted to rotate back to back, the foils facing the points of the combs.

To keep the records apart, a ball bearing is slipped in between the two spindles, a device which also makes for smooth running, since the spindles rotate in opposite directions.

On the tops of the brass knobs to which the combs are attached, the terminals from a lead-in tube are soldered. Two of the brass rods can then be bent into semi-circles and screwed in to form the conductor arms. These terminate in two brass balls (between

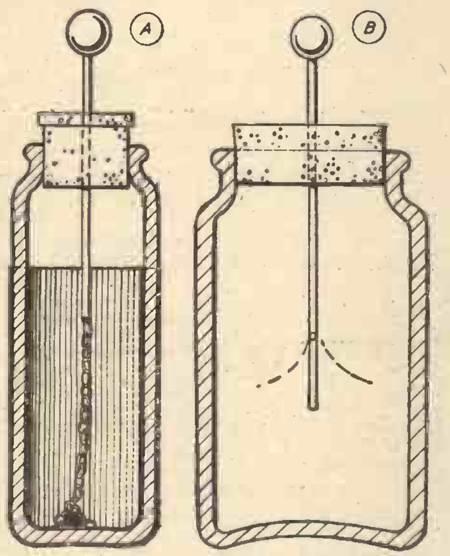


Fig. 5.—(A) shows a simple Leyden jar and (B) the electroscope.

which the sparks are produced) at the top of the machine. It is as well to use smooth rods to avoid the sharp edges occurring inevitably if they are threaded throughout their length. The brass knobs are those known as bell-knobs, and they are attached by filling them with metal cement, and then pushing the rods in. Alternatively, large, bright ball-bearings could be soldered on.

All parts of the machine so far described are thoroughly insulated from the base by the vulcanite posts, except the spindles bearing the plates. The rest of the apparatus—the simple system of pulleys and gears, and the "earthing brushes"—needs no insulation; in fact, it is better if they are earthed.

The Gears and Pulleys

The gears and pulleys must be chosen so that the two plates rotate at the same rate. The brushes are made from short tufts of wire taken from a piece of "flex" electric lighting wire. One brush is soldered to each end of a piece of brass wire about 7in. long, and the wire mounted on the spindle bearing, as shown in Fig. 4. This assures its being well earthed. The two arms of the wire are bent so as to make an angle of 45 deg. with the vertical, and the brushes adjusted so that they earth a foil on the opposite edges of the plate simultaneously. The brushes on the other plate are set at

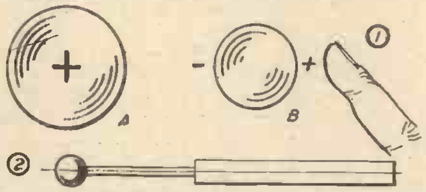


Fig. 6.—Metal ball and insulating handle for carrying charges.

right-angles to these, and earth their foils at the same time.

If the whole instrument is brightly polished and perfectly dry, on turning the handle slowly a sizzling sound will be heard. This is due to internal discharges in the machine, visible as a blue glow with sparks if performed in the dark. On turning a little faster, sparks up to ½in. in length will jump between the brass knobs at the top of the machine.

If you get no results at the first attempt, see that the brass knobs are not touching and then rub a vulcanite rod briskly on your sleeve to electrify it, then hold it to *one* of the combs while turning the handle and the machine will soon charge up and function normally. Sparks produced in this way, without the use of Leyden jars, can be taken on the finger or knuckle without harm or appreciable shock, though the voltage for a centimetre spark in dry air is 30,000.

Condensers

An enhanced effect can be produced by connecting a couple of condensers to the terminals. These are capable of accumulating the charges of electricity until they are full, and then discharging them suddenly in a violent blue spark. This should on no account be taken through any part of the body or a severe shock will be felt.

The type of condenser usually employed is the Leyden jar, shown in Fig 5, and it is quite easy to make one from a jam jar. Wash and dry the jar thoroughly and line it to about three-quarters of the way up inside with tin foil. The easiest way to do this is to cut up several small strips of silver paper and stick them in, one at a time, so that they overlap one another. Then the outside of the jar is coated to the same level in the same way. The cork, or vulcanite stopper, carries a short brass rod with a ball on its upper end. The lower end must make some sort of metallic contact with the inner coat of foil, the simplest way being by means of a short chain.

When two of these jars have been made connect the brass rods or balls with two terminals, or the comb bearers of the machine, and either earth their outer coats or connect them together by standing both jars on the same strip of metal. The machine will now produce the large sparks at about one second intervals, the size, but not the length of the sparks, and the interval depending on the size of the Leyden jars used.

The Principle of the Wimshurst Machine

In Fig. 6, A is an insulated conductor charged with positive electricity. If an uncharged conductor, B, is brought near it a strange thing happens. Its neutrality is destroyed and a negative charge is found to be induced on the side nearest A, while its opposite side acquires a positive charge! If it is now moved away again its two charges flow together and neutralise each other and everything is restored to its original condition. But suppose that while near A the positive side of B is earthed by touching it with a finger. The positive charge disappears and when it is removed from the vicinity of A, B is found to be negatively charged. The important thing is that, though B has been given an electrical charge, A has not lost any of its original positive charge. It looks like something for nothing, though the new electrical energy has really come from the work done in removing the two balls, which very slightly attracted one another.

It will be noticed in working the Wimshurst machine that it is quite hard to turn the handle when it is functioning well; this is due to the electrical attraction between the various parts of the machine. The extra energy that you have to employ to overcome this is the source of the electricity the machine produces.

In the diagram (Fig. 7) the two plates are represented by concentric circles for the sake of simplicity, the back plate with its brushes being shaded. The black lines are the foils. Imagine the foil A to have a positive charge. Then foil C, being momentarily earthed on the side away from A by the brush, acquires a negative charge and travels round to comb F^1 which collects it up. Before it gets there, however, it induces a positive charge in foil B^1, where that is earthed by

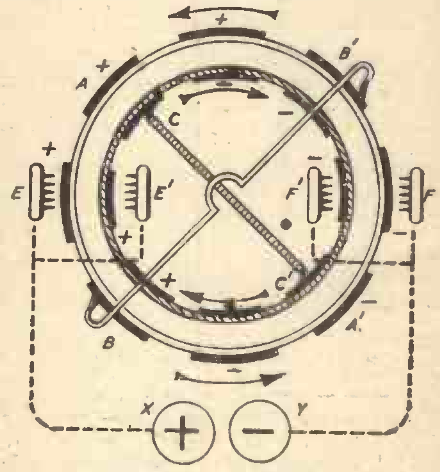


Fig. 7.—Diagram of the functioning of the Wimshurst machine.

a brush, and B^1 moves round to give up its charge to comb E. Thus there is a continual multiplication of charges, positive ones always moving towards the combs E, E^1 and the negative ones to F, F^1.

The Electroscope

A useful little instrument for testing charges is the electroscope shown in Fig. 8. The cork of a clean glass jar carries a brass rod and ball, as in the case of the Leyden jar. But the lower end of the rod supports two strips of metal foil, which hang close together. Gold leaf is the best substance to use, though very thin "silver" or aluminium paper will serve, provided the leaves are long enough to hang down straight by their own weight. If a charged conductor is brought near to B, the leaves repel each other and fly apart. Charges can easily be carried from one place to another on a metal ball held by an insulating handle, as shown in Fig. 6. The vulcanite handle is taken from a wireless lead-in tube and the brass rod cemented in with sulphur. A good round brass door-knob can be mounted in a glass ink-well (the old-fashioned, solid, square type) and used for the same purpose.

Putting Noise to Work

The Various Properties of Noise and Their Significance in Everyday Life

By Prof. A. M. LOW

MOST people look upon noise as a nasty racket and nothing else. It is more than that. Noise can break glasses, make you sick and wear you out, but if its waves are regular it becomes sound, and it can fasten metals together, make chocolate, mix oil with water and wash clothes to perfection at a cost of less than one farthing an hour. Sound is now an important new tool for industry.

Noise is mainly the result of alternate periods of compression and rarefaction in the atmosphere. It makes air warmer. It is quite easy to measure the rise in temperature of a room as the result of a distant rifle shot, and what is more, a man addressing an audience in London can be heard over the radio in Australia before his voice reaches the end of a long lecture hall in England.

Reflection

Reflection is another property. Thunder has its rattling sound because the waves of noise bounce off clouds, houses and trees. An echo is only reflected sound. Try putting your loudspeaker in a corner so that the walls act like the sides of a trumpet. These reflected waves are very complicated and easily distorted by a very loud radio set. Worse still, music can be partly absorbed and turned into heat, leaving the rest to be reflected inaccurately.

There are some buildings in London where high notes are almost entirely lost because the wrong material has been used to decorate the walls. Even in an ordinary room rearrangement of curtains or books on the wall can affect music. Too much volume from your loudspeaker invariably ruins the sound, quite apart from its unfortunate effect upon the neighbours.

All this is very fine, but noise can be an extremely serious thing to human beings. No one can get used to it. When we say "I used to live in the country, but I soon got used to the noise of London," we are talking nonsense. The truth is we can only resist the attack of noise by putting out energy which ought to be better spent. Noise enters the body all over, not merely by the ears, and it is most lucky for us that civilisation has reduced our sensitivity. Birds listen for worms many inches down in the earth, and if this is tested by putting worms in a box with a glass side they can be seen to stop wriggling as soon as a bird's foot lands on the grass. Terrible if with the brain of a human being you had the ears of a bird, for sitting on the greenest grass would prove a distressing experience, with nasty rattlings underneath you all the time!

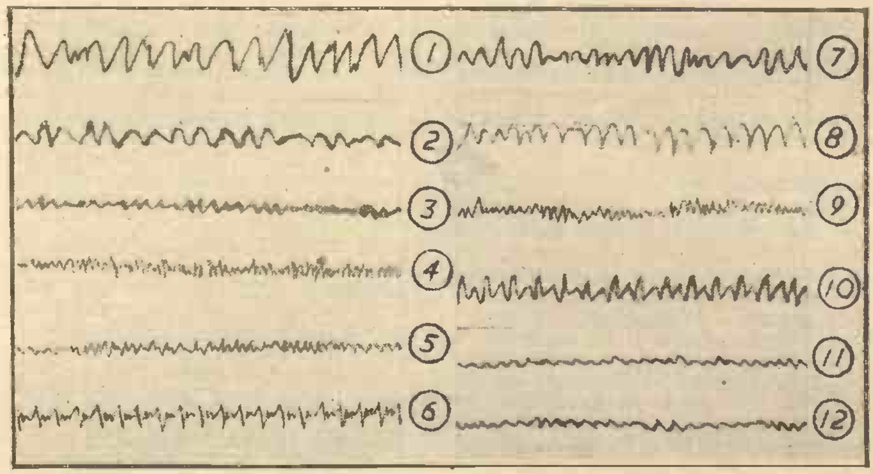
Photographing Noise

I have been photographing noise since 1910, not by film recording, but audiometrically. Everyone laughed in those days when London sounded like a series of bumps; in 1952 it is just one large crash, and it has made us more nervous in many ways. Wave shapes are interesting, for one can see the staccato yells of Hitler and compare them with the wave form of someone more gentle. That "pure" voice about which some of us rave looks rather like a snake that has swallowed a series of buns, and it usually sounds unbearably boring. It is the little "twiddles" in the wave which give a voice its attractive character. Many years ago the B.B.C. broadcast a joke about a riot in London. Hundreds telephoned to know if it was true. . . . It was their receiving sets which smoothed out the lilt which said "this is a joke," and gave the whole speech the solemn, rather monotonous tone of an announcement.

Professor Low is President of the Institute of Patentees. He invented the Audiometer in 1910.

It is difficult to think of a noise I have not photographed. Guns, Dame Nellie Melba, Hitler and worms. I had one case of a man who could not sleep because of twittering birds, and another where a parson was justifiably annoyed by jazz which bounced off a local reflecting wall and crept through his study window.

Travel is an important example. The passenger's ideal is that he should not know that he is travelling. What is important is that the noise should not be of a type to interfere with normal speech. It should not be of extremely high pitch nor must it be only barely audible if we are not to be kept on the alert all the time. It is easy to work in the neighbourhood of a waterfall, but the far lesser noise of a small mosquito can ruin our temper in a few hours.



Graphs of various sounds : 1. Road Drill. 2. Tram Car. 3. Steam Wagon crossing points. 4. Barking Dog. 5. Hitler. 6. Melba. 7. Sports Car. 8. Tram Car. 9. H.M. The Queen. 10. Passenger saying "oh !" loudly. 11. New York to London. 12. London to New York.

Quiet Air Trips

Now that we shall soon be taken to Africa for a day's swimming, some recent tests to find out why the Atlantic trip is so quiet and free from exhaustion are very interesting. People have been led to believe that all flying is unbearably noisy. This is by no means true. The B.O.A.C. Trans-Atlantic trip is more quiet than most tube trains to which we fondly believe we have become accustomed.

It is very nearly as quiet as a good carriage in an open-air corridor train, with the excellent result that everyone arrives without exhaustion and without the feeling that it would be a blessing to smash the crockery or kick the cat. The sounds experienced do not interfere with conversation, and passengers can talk in a normal voice over a small table. Better still, the frequencies are not those which hit your body with a jerk. It is easy to arrive and easier still to sleep all the way.

Look at the records and see how much louder is the passenger who said "Oh" close to my ear than the over-riding noise of the aircraft. Barking dogs, trams and rattling cars are all vastly more powerful than the note of good air travel. Even the low notes are not bad, however much they might annoy a worm. High squeaks are nearly non-existent, to the disappointment, perhaps, of any bats which might be listening. Bats steer by the reflection of high-pitched sound in the darkness, just as we use radar to guide ships.

The net result of flying tests is that no one need worry about noise in a properly protected aircraft. People on the ground have far more cause to complain. Remember that all our personal noises are unwanted by other people, that they waste energy, are the best present-day example of bad manners, and are very, very rude. There is no need at all to say "Oh" five times as loud as any other noise in the neighbourhood, or for impertinent loudspeakers in quiet streets to tell us how we should vote.

Making a Chronograph

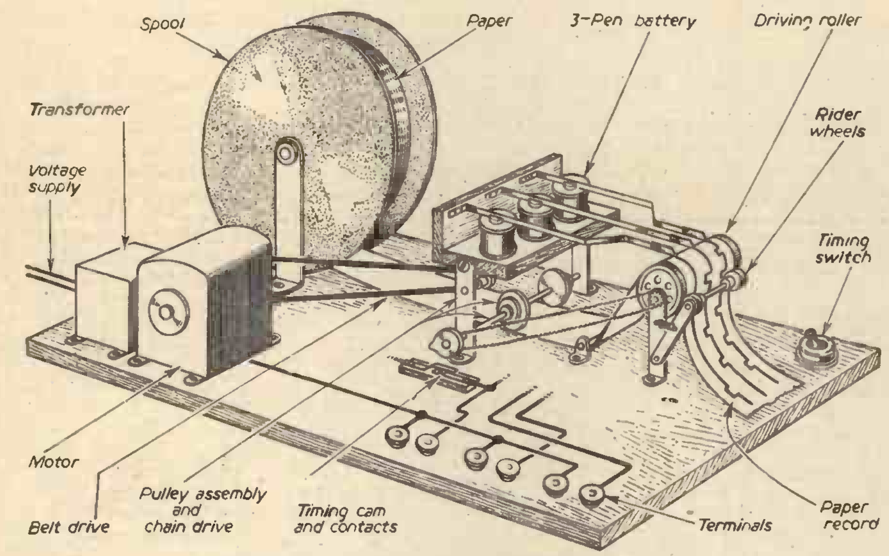


Fig. 1.—General view of the completed chronograph.

Constructional Details of an Interesting Instrument for the Home or Workshop

By L. R. C. HAWARD

THE chronograph is an instrument for measuring the frequency and duration of an activity and producing a permanent graphic record of the event in terms of a square wave-form. The instrument is widely used in industry and scientific research, particularly in the fields of medicine and psychology. In the home or workshop it can be used in a large variety of ways, both for profit and pleasure, and some suggestions will be detailed later.

General Description

The chronograph consists of a firm base on which is mounted the three major components: the drive, the feed, and the pen battery. The drive consists of an electric motor which operates, through a system of reduction gears, the paper feed. By the use of various gear sequences, the paper tape is drawn through rollers at a predetermined speed, being unwound from a large commercial spool. As the paper passes over the driving roller, three pens which rest on its upper surface inscribe a continuous straight line. These pens are afforded lateral movement, which is controlled by three separate electro-magnets. When the respective circuit is closed, the magnet will deflect the pen, keeping it deflected for as long as the magnet is energised. When the circuit is opened, the pen returns to its normal line, thus completing the form of a square wave. The wavelength represents the duration of the activity which was responsible for closing the circuit, and the number of such waves over any given length represents the frequency of the occurrence. Since the paper is moving at a constant speed, say, for example, three centimetres per second, the frequency per second can be obtained by counting the number of waves in a three-centimetre length of paper. A more direct method of frequency measurement will be described later. Fig. 1 gives a good idea of the parts and their general arrangement relative to one another.

The Base

When constructing a home-made chronograph the dimensions are of no importance, being determined by two things only, the size of paper you wish to use and the oddments you have at your disposal. For this reason the dimensions given here are suggestive only, and are intended more for a guide than to be adhered to rigidly. The writer used wood as the principal material, and most of the other parts were from a well-known construction outfit: he has seen a similar model made out of metal, however, the parts being obtained in a half-guinea parcel of junk from a Government surplus dealer, and the finished instrument was much more accurate and reliable, as well as being superior in appearance.

The two characteristics of the base are that it should be absolutely rigid, in order to preserve the correct alignment of the components, and that it should be heavy enough to damp down any vibrations which would otherwise be transmitted inadvertently to the pens. For size, 18in. by 6in. by 1in. will be found very convenient.

The Feed

This is in two parts, the driving roller and the spool support. The plan view in Fig. 2 shows the approximate position of these two items. The spool spindle should be 6.5in. above the surface of the base (see Fig. 2a) so that one-foot diameter roll of paper can be accommodated. Paper in various widths can be obtained, the one inch variety being the most economical. The support consists of two brackets screwed to the base about 1.5in. apart if the one inch paper is being used, and bored transversely at the top to receive the spindle. The spindle is secured by a collar and grub-screw outside each bracket, two loose collars and washers being placed between the paper roll and the brackets. If you intend to use the smaller diameter rolls there will be a tendency for the roll to rotate too freely; in this case it is advisable to make two 12in. dia. metal discs, one being placed on each side of the roll and made a tight fit by pressing the collars against them and securing to the spindle with the grub-screws. It will be found now that the friction of the unwinding paper bearing against the inside of these discs is sufficient to stop an excess of paper unwinding.

The driving roller is mounted at the other end of the baseboard, and consists of a solid cylinder about 1.5in. in diameter and about half-inch longer than the width paper being used. The cylinder is keyed on to a spindle. The writer used a cotton reel, which he fixed to the spindle, as shown in Fig. 4. The spindle passes through two brackets at a height sufficient to give the roller a half-inch clearance above the base. Two rubber rider wheels (tap washers are eminently suitable) are mounted on two radius arms, which bring the riders against the driving roller, where they are kept in place by the tension of the two springs shown in Fig. 3. The

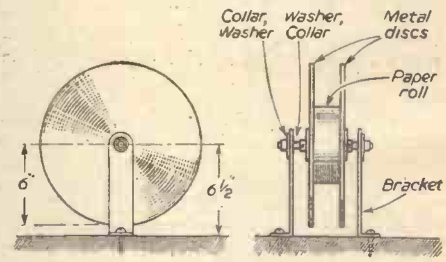


Fig. 2a.—Side and front views of the spool for the paper strip.

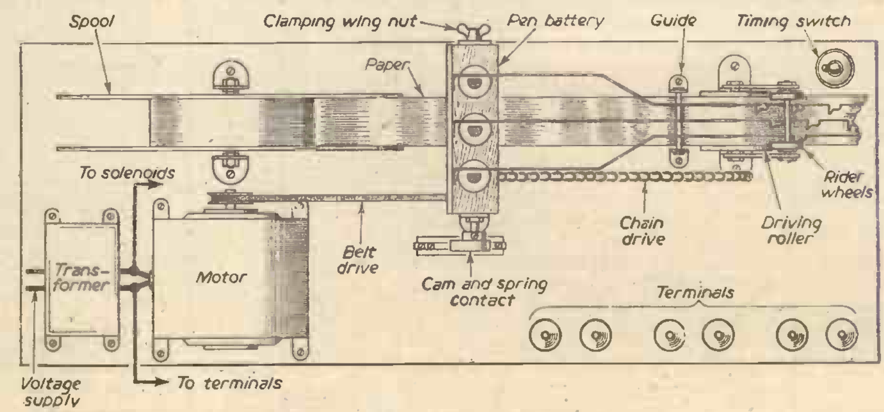


Fig. 2.—Plan of the chronograph.

riders should be prevented from moving along the spindle by the use of fixed collars, and the rubber edges should be roughened with a file so that a non-slip grip is kept on the paper, which will pass between the riders and the roller.

The Pen Battery

A three-pen battery is usual, but there is no limit to the number of pens used provided the paper is wide enough to take it. The widest roll of paper obtainable at present for this purpose is 12in., and so in practice 12 pens are the maximum employed in one instrument. The battery of pens is mounted on a platform between the paper roll and the driving roller. The platform should be about 1.5in. by 1in. per pen, that is, 1.5in. by 3in. for three pens and so on. The platform is supported by two upright brackets, between which it is allowed to swivel. These brackets also form part of the drive assembly, so that they should not be secured to the base until the requisite holes have been bored. Using the commercial metal strips which already have a series of holes bored, these can be immediately erected.

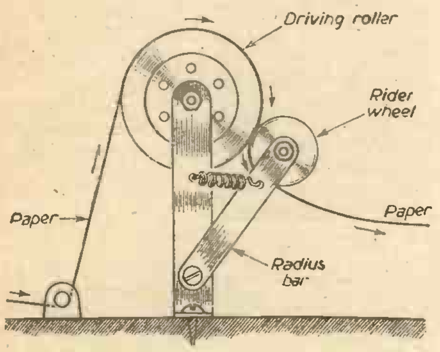


Fig. 3.—Side view of driving roller and rider wheel.

On the platform are placed three electro-magnets, those from electric bells or from ex-R.A.F. components (12 volt or 24 volt) being most suitable. They can be made from 1in. lengths cut from a 6in. nail, which gives the right thickness, and then winding bell-wire round until a total diameter of 0.75in. has been obtained. The wire should be taken down from the platform and led to three sets of terminals mounted at the front of the base. Fig. 5 shows the general arrangement of the pen battery and Fig. 6 the circuit. The pens themselves are cut out from a steel milk tin or similar source, and are secured by two screws into a back-plate (Fig. 7). Two screws are important here to prevent an axial movement of the pens. The pens pass within a sixteenth of an inch of the cores of the respective magnets, on which a flat should have been filed. Where the core is flush with the coil it is necessary to protrude the former for

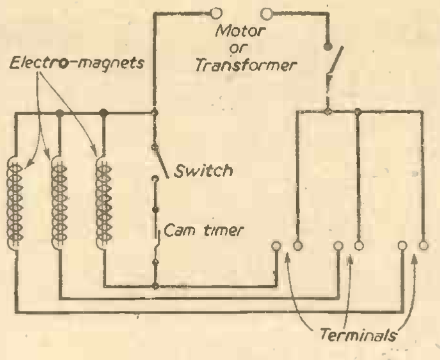


Fig. 6.—Circuit diagram.

this purpose. In cases where this is not practicable it is possible to modify the shape of the pen arms so that the coils can be accommodated in a horizontal position instead of vertically. The end of the pen is bent up in the form of a V, and this acts as a reservoir for the ink. The platform is swivelled, as shown in Fig. 5, to enable the pens to be brought into contact with the paper. When not in use the pens should not be left in contact. If the pen battery platform is made of wood, sufficient friction is obtained between the platform and the brackets to permit the platform to be retained in any desired angle. In the case of a metal platform, however, some form of locking device, as the wing-nut illustrated, is necessary. Careful insulation is also a necessity.

The Drive

Any type of motor will do; the writer uses a 24v. electric motor from a camera-gun. A drive should be taken to the pulley spindle mounted between the pen battery brackets, and a further drive taken to the driving roller. A sprocket and chain drive is the most efficient provided only one paper speed is required, but where a range of speeds is required a belt drive of heavy elastic is adequate, and this method enables different sizes of pulley wheels to be brought into use with a very rapid adjustment (see Fig. 8).

Timing the Record

There are three basic methods of timing the record. In the first place, the operator times the paper speed independently, so that for a constant speed record a given length of paper represents a given time. Secondly, a built-in timer may be incorporated, consisting of a cam driven by the motor, and arranged to close the contact of one pen circuit, say, every second. The result would be a series of blips with one second intervals on the record itself, beside which the frequency of the other two traces could be directly compared. Thirdly, an external timer could be used, such as a metronome, the arm of which closes a circuit on every beat.

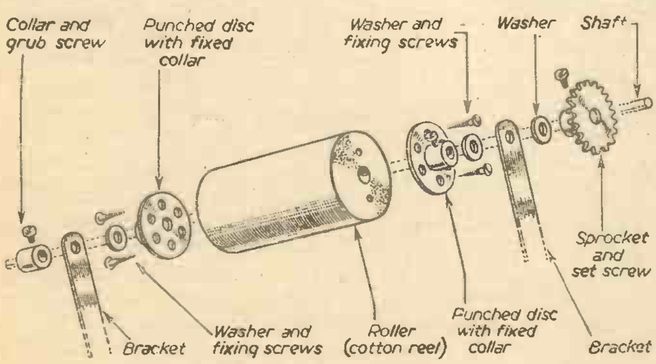


Fig. 4.—Exploded view of the driving roller.

Method of Use

Fill the pens with ink with a fountain-pen filler, using different colours if desired. A drop of glycerine in the ink will help to provide a smooth and continuous flow. Lower the pens into contact with the paper, and switch on the motor. As the paper commences to move the ink will flow from the pens, but should any pen fail to start mark-

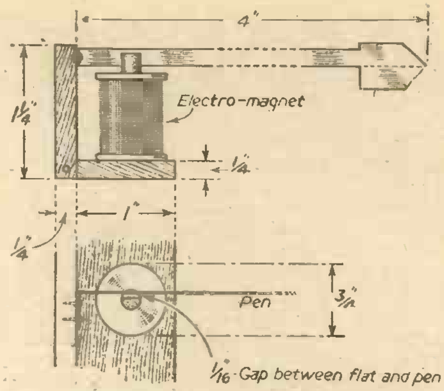


Fig. 7.—Elevation and plan of electro-magnet with pen in position.

ing the paper, slide a pin or similar sharp object through the reservoir and on to the paper; once the flow has been artificially started it will be found to continue until the ink is expended. If the ink flow presents any difficulty at the first trial, the underside of

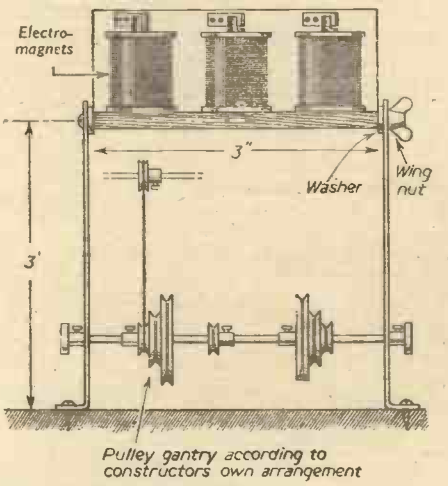


Fig. 5.—Showing the positions of electro-magnets and driving pulleys.

the pen and the inside of the V should be lightly filed, as shown in Fig. 9.

Gramophone Turntable Timing

This is perhaps the most useful purpose to which the chronograph can be put by the mechanic or handyman. A spring contact should be made from two small strips of brass fixed to an insulated base (Fig. 10). The strips should be no more than 1/16in. apart and capable of being closed at the slightest touch. To time a gramophone turntable speed, for example, the chronograph is set into operation, and a piece of plasticine attached to the outside rim of the turntable. The spring contact can now be held in such a position that it will engage the plasticine "cam" with each rotation, and retained with a further piece of plasticine, crocodile clips, or anything suitable for this purpose. Let the paper run for at least 30 seconds, remembering that the accuracy of your results is proportional to the length of the record. Tear off the strip of paper bearing the record, and rule a line transversely across the paper at the first convenient "wave." If the frequency of the rotation is greater than that of the time-marker, rule off at the first wave of the latter, and again at some factor of 60-15, 20 or 30 for instance. Now count the number of "blips" between these two parallel lines, estimating the last fractional one carefully, and multiply to bring the result in terms of revs. per minute. You will see now that the more waves contained between the two lines, the smaller will be the last fraction, and consequently the error of estimation will be smaller, too. This method can be used accurately on any type of rotating or reciprocating mechanism, provided the plasticine "cam" has no appreciable effect on the moving component (see Fig. 11).

For timing small mechanisms, such as a clock or watch movement, the reaction time method must be adopted. In this method, a mark is placed on the circumference of the moving part, and another mark placed on an adjacent stationary component. These marks should be made as fine as possible commensurate with legibility. The contact is now held in the hand and pressed every time the piece rotates and the marks are brought into alignment. You will see that this introduces the error of the human equation, as it is sometimes called. Because of the distance between the eye and the hand which the nervous impulse has to travel, and because of the time taken by the brain to sort things out, a period of time will have elapsed between the synchronisation of the two marks and the closure of the contact, a period of about 1/5 second. However, this time-lag remains surprisingly constant, and the gross effects will be cancelled out provided the record is long enough. If possible, at least 10 "blips" should be recorded to ensure the error has been averaged out.

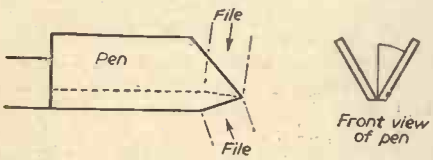
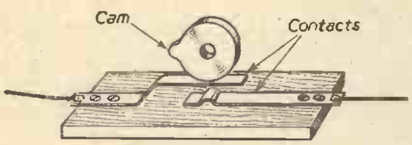


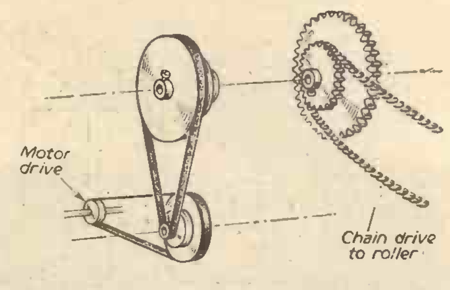
Fig. 9.—Enlarged views of pen tip.



Cam Timer
Fig. 10.—Details of spring contacts.

Measuring Reaction Time

This brings us to the question of the time-lag and how it can be measured. At modern speeds the reaction time of the individual is fast becoming as important as the machine he is controlling, and the time is not far distant when the performance of the machine will be limited by its operator, and not by its inventor's abilities. This is especially true in high-speed aircraft. At modern jet speeds a pilot seeing an object in front of him will move at least 200 feet before even starting to move a finger. Where a complex action is required, the reaction time is considerably longer. Even in a fast car you will travel nearly 10 yards before *starting* to brake!



By incorporating a number of pulleys and sprockets a range of paper speeds can be obtained
Fig. 8.—Details of belt and chain drives.

Measuring your own reaction times is quite a simple matter, but you will need a friend to help you. Sit at a table facing each other and both holding a switch contact before you connected to two separate sets of terminals. In the friend's circuit incorporate a bulb, and set the pulley ratios so that the paper is travelling at a fast speed. Hold your finger ready on the contact, and directly your friend closes his contact and the lamp lights up, press down on yours. Release both contacts and repeat this a number of times. The record will look like Fig. 12, and your reaction time is the distance between the two marker lines, that is, the difference in position of the two waves. This is your simple reaction time: to find out how you are likely to behave when the grey matter has to think a bit, tell your friend to close his contact, and *at the same time say a letter of the alphabet*. Giving A the number 1; B, 2; C, 3; and so on, you are to press your contact as soon as you hear the letter, but only if the number is an *even* one. Compare your performance with the former one, and also with your reaction time when you are given the numbers direct instead of the letters.

A Psychological Study

By having the chronograph moving slowly, and concealing the contact in the palm of the hand, it is possible to record the thousand and one repetitive acts which make up human behaviour: the blink rate of your friends, the number of times they say "I said to him, I said" and so on. You can also get them to measure their own oscillation rate. This is a rather intriguing little phenomenon which occurs when we look at an ambiguous reversible figure, three of which are shown in Fig. 13. Look at the white vase: if you study it for long enough you will see it can also be two black faces looking at each other, silhouetted against a lighted window, as it were. If you continue looking at this for a while, you will see it fluctuate from one form to the other quite involuntary. In the same way, the black cross on the white ground becomes a white cross on a black ground, and the transparent cube takes on two different positions. Cut out the illustrations and stick them on separate pieces of card and, taking them one at a time, press the spring contact every time a reversal takes place. You must adopt a really passive attitude to the diagram, however, and not try to concentrate on one particular aspect of it. Rates of reversal vary considerably from individual to individual, usually lying in the range 5-40 oscillations per minute. Fig. 14 shows the record obtained from a patient in a mental hospital where this particular phenomenon is of diagnostic value. The upper line is the patient's oscillation rate, the centre is the metronomic time-scale in one second intervals, and the lower one indicates the point at which the measuring should start. This enables the experimental subject to become acclimatised to the task, the operator pressing his contact as soon as the subject appears to be settled.

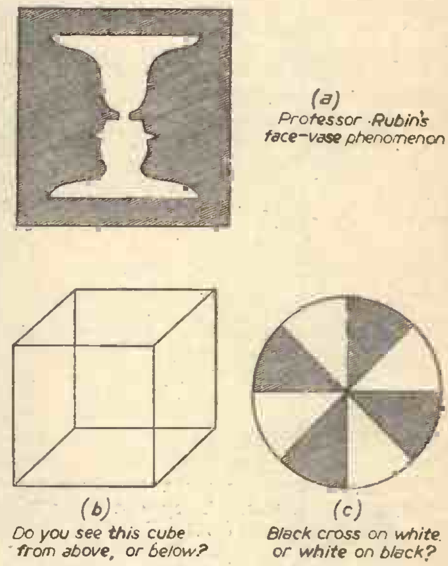
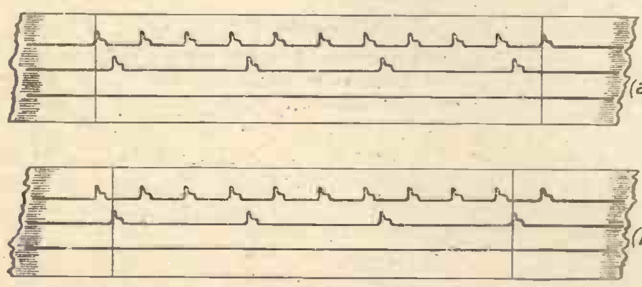


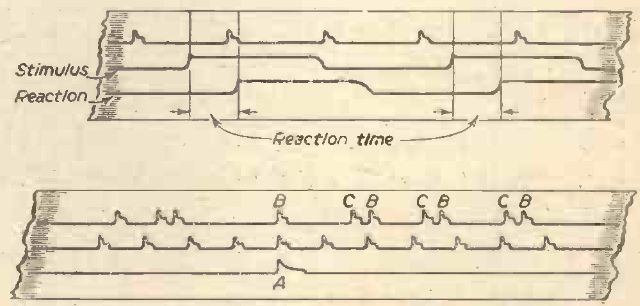
Fig. 13.—Reversible figures.

These few examples will be sufficient to show some of the possibilities a home-made chronograph can possess. They become almost limitless when one takes into account the modifications to the instrument that the ingenious handyman may wish to devise, and the chronograph can rightly take its place in the more useful section of the workshop paraphernalia.



The incorrect (a) and correct method (b) of ruling the record With 3-second intervals the record shows approx 60 r.p.m

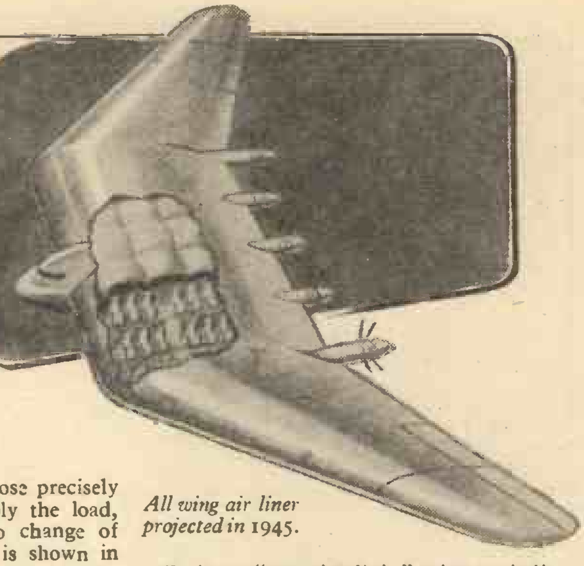
Fig. 11.—Examples of timing graphs produced by the chronograph.



Note that once stability has been established (A); one figure (B) remains predominant

Figs. 12 and 14.—Graphs recording reaction time and stability.

THE SHAPE OF WINGS TO COME



All wing air liner projected in 1945.

The Reasons for Sweptback Wings and the Problems Which They Introduce. Delta, V and Crescent Wings, and Possible Shapes for Supersonic Speeds

(*Continued from page 326 of the May issue*)

Washout Due to Flexure

THE loss of tip incidence which results from wing flexure has another very important effect on the handling qualities of swept wing aircraft. Let us take the case of a pull out from a high-speed dive. The pilot pulls the stick back so as to raise the nose of the aircraft and increase the incidence of the wing. He expects that, if he then holds the stick fixed, the aircraft will pull out at a normal acceleration: that is, in a flight path with a constant radius of curvature. But let us see what happens. After he has pulled the stick back, it takes a moment before the aircraft attitude can change and the lift build up on the wing. When this happens the wings bend slightly upwards and, as we have seen, shed lift at the tips. On a swept wing aircraft the tips are well behind the centre of gravity and this loss of lift, therefore, means a nose-up change of trim tending to make the aircraft tighten in to the manœuvre. In other words, an increase in lift causes a further increase in lift; there is, therefore, a loss of stability which could have serious consequences on a highly swept wing of high aspect ratio.

As we shall have occasion to refer to this effect again, I shall call it "washout due to flexure," the term "washout" being in common usage to describe a reduction in incidence of the tip of a wing as compared with the root. Some washout is often built into a straight wing to improve the stalling behaviour.

The Aero-isoclinic Wing

If we return to the model of the sweptback wing and apply the load farther forward, it is obvious that we will produce a nose-up twist which will counteract the washout due to flexure and, if we choose precisely the right point at which to apply the load, we can bend the wing with no change of incidence along the span. This is shown in Fig. 10c, which appeared in the May issue.

"The Shape of Wings to Come" was first presented as a paper at the British Association Conference in Belfast, September, 1952, and is reprinted here from the book by David Keith-Lucas, B.A., M.I.Mech.E., F.R.Ae.S., Chief Designer at Short Brothers, Rochester.

One way of doing this is to place the torsion box well back in the wing so that the air loads acting at about the quarter chord line have a considerable moment arm about the torsion box. Even so, the torsional stiffness of the wing may have to be less than usual so as to get the right relationship between twist and flexure. Problems of aileron reversal then have to be faced and it is probably necessary to use either rotating wing tip controls in place of conventional ailerons or else to use spoilers of some sort.

My preference is for rotating wing tip controls because, if used as elevators as well as ailerons, they offer a means of overcoming tip stalling by the simple expedient of increasing the washout as the wing incidence increases. They can also be expected to provide excellent control at high mach numbers.

This solution of the aero-elastic problems has been advocated by G. T. R. Hill, who calls it an "aero-isoclinic" wing to indicate that the incidence or inclination to the airflow remains constant along the span in spite of flexural distortion. Fig. 11 shows possible appearance of such an aircraft with rotating wing tip controls.

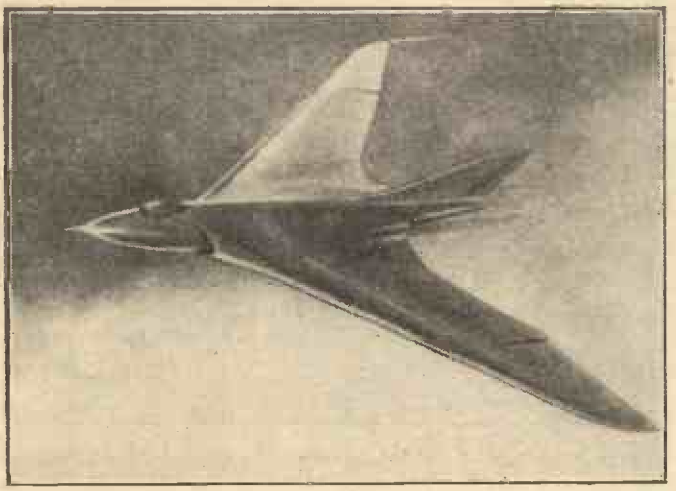


Fig. 11 (*Below*).—*Aircraft with rotating wing tip controls.*

The Crescent Wing

Another solution to the problem is to crank the wing tips forward from the rest of the wing so that the load on the tips is forward of the axis of the wing.

This is the "crescent wing" which was pioneered by Arado in Germany, and has since been developed by Handley Page in England and is shown in diagrammatic form in Fig. 12.

It is quite an attractive solution because it also lessens the tendency to tip stalling by reducing the sweepback over the critical tip portion.

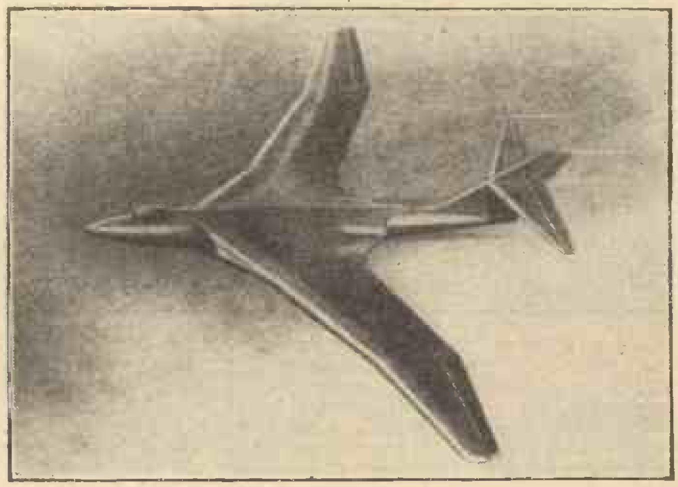


Fig. 12 (*Above*).—*The crescent wing.*

There is necessarily some weight penalty on the structure due to the crank but it need not be much, particularly as the crank is fairly near the tip.

Another slight disadvantage is that the tips have to be very thin in order to make up for the loss of sweep.

The aero-isoclinic wing and the crescent wing enable the designer to use higher aspect ratios than would otherwise be possible, and they show to the greatest advantage when the design conditions are such as to demand high aspect ratios.

Forward Sweep

The tendency to tip stalling of sweptback wings is a problem which the designer of

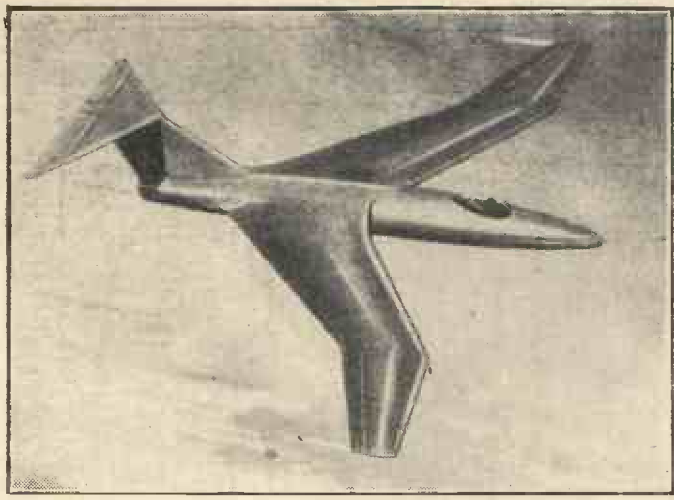


Fig. 13 (*Left*).—*Swept-forward crescent wing.*

every swept wing aircraft has to face and do something about. One possible solution is to sweep the wings forward instead of back and so get the stall to start at the wing root. It would then be accompanied by the same unstable nose-up pitching moment which we get with sweptback wings, but would be free from the loss of aileron control and sudden wing drop which occurs when the tips stall first.

It sounds quite an easy solution and has

Fig. 15 (*Above*).—*The Avro* 707, *which exemplifies the delta wing.*

certain other advantages, including the opportunity for a long tail arm without a long fuselage. The objection is again that of aero-elasticity. Flexure of a sweptforward wing produces an increase in incidence at the tips exactly the same way as flexure of a sweptback wing causes a decrease in incidence. It is easily visualised by thinking of our model of the sweptback wing and imagining it to be flying in the opposite direction. What was a decrease in incidence is now an increase.

At first sight it would appear that the increase in incidence forward of the centre of gravity would have the same effect on stability as a decrease in incidence aft. In fact, it is much more pernicious because the process tends to be self energising ; an increase in lift causes an increase in incidence which causes a further increase in lift, which causes a further increase in incidence, etc., etc., and at some speed the wing will fail by having its "neck wrung," which is the phenomenon known as "wing divergence."

Now, on a sweptback wing there is usually no danger of wing divergence because of the washout due to flexure. It is only when we try to correct the washout by using a crescent wing or some other artifice that the wing divergence can possibly occur and then only if the correction is overdone —which it obviously must not be.

With forward sweep we could also use a crescent wing as shown in Fig. 13 so as to overcome wash-in due to flexure as well as wing divergence. In this case we must be careful not to under - correct, the penalty for over-correction being only an increase in stability.

It is perhaps surprising that no designer has yet, at least to my knowledge, tried this variant of the crescent wing. Taken a bit further the idea leads to an M wing, which has certainly been tried by nature if not by man, as Fig. 14 showing a gannet in flight bears witness. But we must remember that the gannet is not designed for transonic speeds, so the reason for the sweep is not the same even though the aero-elastic problems may be similar. As a matter of fact, I imagine that the M wing on the gannet is as much to facilitate wing folding as to overcome aero-elastic effects. We shall therefore thank the gannet for an idea, but we shall not promise to take its advice.

Fig. 14 (*Right*).—*Gannet in flight.*

The Delta Wing

On the evidence of the aircraft which are now flying, designers throughout the world are concentrating on sweepback to the complete exclusion of sweepforward. After our brief excursion we will therefore return to sweepback and to the problem of aileron reversal and washout due to flexure.

The simplest solution of any is to make the wing really stiff by keeping the aspect ratio small. The delta wing exemplified by the Avro (Fig. 15) is the logical result and it offers very considerable structural advantage over other shapes. There is plenty of room to house a really satisfactory structure and to place the spars just where and how the designer wants them.

Subsidiary advantages are that the small

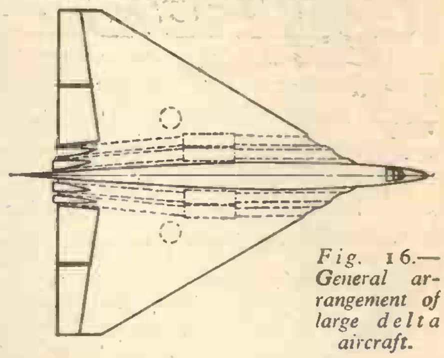


Fig. 16.—*General arrangement of large delta aircraft.*

aspect ratio has the property of reducing the effects of compressibility and of making the tendency to tip stalling less severe ; moreover, there is room in the wing to house the engines, fuel and undercarriage. Also, the cut-outs, which are necessary to allow the undercarriage to retract, are not nearly so serious as on a narrow wing. On the Boeing B47, with its very slender wing, it is interesting to see that the undercarriage is housed, tandem fashion, in the fuselage and the engines are slung externally on struts below the wing. How much neater to tuck everything tidily away inside the wing and keep the fuselage as small as possible! But, in spite of that and for all its virtues, the delta wing is not the answer to all our troubles. Strut-mounted engines may look untidy, but they are the favourites of the maintenance engineers. The crews of combat aircraft may also be partial to them on the grounds that the consequences of an engine fire are less serious.

Engines buried in a delta wing may present a beautifully clean installation, but the jet pipes and/or the intake ducts are undesirably long, especially when the aircraft is large, and there must be some weight penalty and loss of efficiency as a result (Fig. 16).

But what is more important is that when altitude requirements demand a wide span, the wing area of a delta becomes unnecessarily large and it has to be paid for in the most precious of aeronautical currency, namely drag and weight. The weight saving on the basic structure can easily be nullified by the weight of the skin sheeting to cover so large an area plus the weight of the large chordwise ribs and, most serious of all, the weight of fuel burnt in overcoming the skin friction drag of the additional wing area.

(*To be concluded*)

LOCOMOTIVE STAMPS

By H. V. A. HOWARD

(The Well-known Stamp Expert)

Railway Centenary stamp of Austria 1837-1937.

U.S.A. stamp issued in 1950 *to honour Railway Engineers.*

As I pointed out in my article on bicycle stamps in the April issue, the thematic collection of stamps lends itself to a wide diversity of interests ; it is always possible to make a small collection cognate to a particular subject. Those interested in locomotives, for example, will find that they have a greater pool from which to draw than is the case with bicycles. Bearing in mind the very close relationship between the railway and the mail, it is surprising that more use has not been made of the locomotive in postage stamp designs. Although this country pioneered the locomotive the collector will look in vain amongst British stamps for one depicting a locomotive; for in the six reigns which encompass the history of British postage stamps, without exception, the reigning monarch has provided the basis for the design.

Switzerland—Centenary of Swiss Federal Railways. "Limmat" first Swiss steam locomotive. (Top) Modern steam railway engine.

Quite apart from the interest in having a special collection of stamps relating to some particular subject, there is a never-ending fascination of studying the history of the designs portrayed. The earliest railways in this country were drawn by horses, the rails being of wood and the wheels of the carriages flanged. The earliest railways were used in connection with collieries and mines. Hedley's "Puffing Billy," the first successful steam locomotive, was patented in 1813, and it was worked at Wylam Colliery, Northumberland, until 1872. George Stephenson was the first to overcome the difficulty of keeping a sufficient head of steam in the boiler. He ran an 8-ton engine at 15 miles an hour on the Stockton and Darlington Mineral Line in 1825—14 years before Macmillan produced the first pedal-driven bicycle. The first passenger railway was the Liverpool and Manchester, opened in 1829.

South West Africa 1937 ; *Mail Transport Train, Steamer and 'Plane.*

To-day, every form of transport is employed to carry the mail, and it seems a pity that the opportunity was lost in 1929 of issuing a British stamp illustrating Stephenson's "Rocket." It is true that the locomotive is hardly an artistic subject, and in such locomotive stamps as have been issued (some dozens of them) it would seem to be a fault of the artist in choosing a wrong angle of perspective. However, the collector will not judge them from an æsthetic point of view, but purely as miniature illustrations of historic locomotives. Probably one of the worst designs is that issued in May, 1929 in connection with the International Railway Congress at Madrid. Some of the designs, however, are quite graceful, and I have illustrated here a few of special interest. A complete collection of stamps on which an engine, or a complete train, forms the outstanding feature, is well within the reach of the shallowest purse. There are many designs in which the locomotive is featured in microscopic form and not as the main motif. Those which I here describe, numbering fewer than 20 in all, are the main ones worth collecting. Of some of the designs there are sets of many values, but for the purpose of making a study an unused specimen of unused denomination will suffice.

The very first locomotive stamp was issued in 1860, when the British colony of New Brunswick (in 1867 incorporated in the Dominion of Canada) issued the 1 cent and 12 cents stamps showing a locomotive and a steamer. The former, with its towering tunnel and heterogeny of gadgets, is reminiscent of Stephenson's "Rocket." The next representation of an engine is the 3 cent of the 1869 issue of U.S.A. This is one of the sets which is memorable as being the first pictorial series of stamps ever issued. The locomotive shown on it is an improvement on the New Brunswick stamp. The railings have disappeared from around the boiler and a cow-catcher has been added.

Bulgarian Railways Jubilee 1888-1938. *(Top) Primitive railway engine. (Below) Modern express.*

(*Continued on page* 380)

(Below) Newfoundland 1928. *Express crossing Newfoundland.*

Centenary of Danish Railways 1847-1947. *(Above) First Danish locomotive. (Left) Modern steam engine.*

(Below) Ecuador 1908. 25*th Anniversary of the opening of the Guayaquil to Quito Railway.*

MAKING A I STEREO. C

The Principles and Application of Stereoscopic Photog We Give Constructional Details for an Instrumen

By E. W.

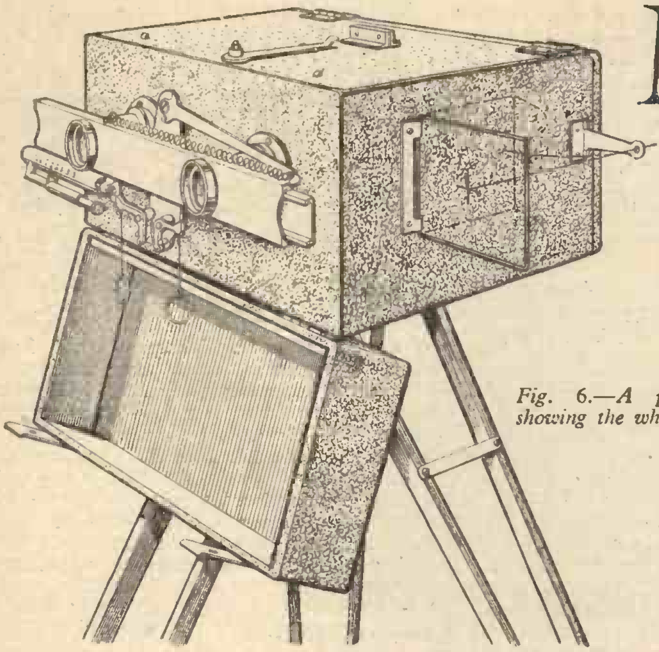


Fig. 6.—A perspective sketch showing the whole of the camera.

THE camera is designed to take standard plates and the magazine built to take up to eight at a time, each plate being held in a thin metal sheath which can be of either tinplate or brass of about No. 24 or 26 s.w.g.

The camera body is a rectangular box made of plywood, glued and pinned together with fine panel pins and with triangular strips of wood, on the inside, covering all joints; it is shown in longitudinal section and part sectional plan in Fig. 1 and in cross-section in Fig. 2. In this latter view are figured the only major internal measurements it is possible to give, and these are for vertical height and width. The length of the box must, to some extent, be governed by the focus of the two lenses which are fitted, but this focus cannot be much shorter than 5in.; about 4½in. will be the very minimum, and this only by placing the numbered lugs for engagement with the plate-changing trigger—details of which are shown in Fig. 3—on one side of the longitudinal centre-line of the camera, so as to clear the radially movable vane which separates the two pictures and prevents overlapping of the images projected by the lenses. It also renders dead sharp the inner edges of the pictures. This vane—see particularly the plan view in Fig. 1—must be pivoted on the centre line, although its bearings for pivots could be, say, ¼in. nearer to the front end of the box, i.e., the lens panel.

Focal Length

The question of the best focus to adopt for the lenses of stereoscopic cameras has been discussed in a handbook on "Photographic Lenses," published by R. & J. Beck, Ltd., of London, the well-known makers of optical apparatus, and the general conclusion is that 5in. is the best for all-round work, and the focus of my own pair was of that length. Actually, two standard ¼in.-plate lenses will be suitable for this camera, but they must be alike, both of 5in. focus and perfectly matched in every other way in the optical formation, angle of view and particularly in the diaphragm or stop aperture values. There is no rack and pinion; the focus is fixed for infinity, but I have taken portrait groups at distances of down to about 20ft. and a locomotive, at speed, was dead sharp at about 50ft. from the camera, full aperture being used in both cases.

Plate Carriers and Release

A few moments study of the upper drawing in Fig. 1 will show that, although sixteen plate carriers are drawn, only eight are intended to be contained in the camera. Those which are shown in the horizontal position are the same as those which are vertical, each of the former having been, supposedly, one at a time, dropped after exposure. After each plate is exposed the trigger on the top is moved over to the left or to the right in order to release it, and at the same time the partitioning vane is turned to one side or the other; it does not matter which. The turning of the vane may be made the means of lowering the plate slowly and without shock. Whether it is used for this purpose or not it is obvious that it must be moved out of the path of the falling plate.

When all plates are exposed, the back

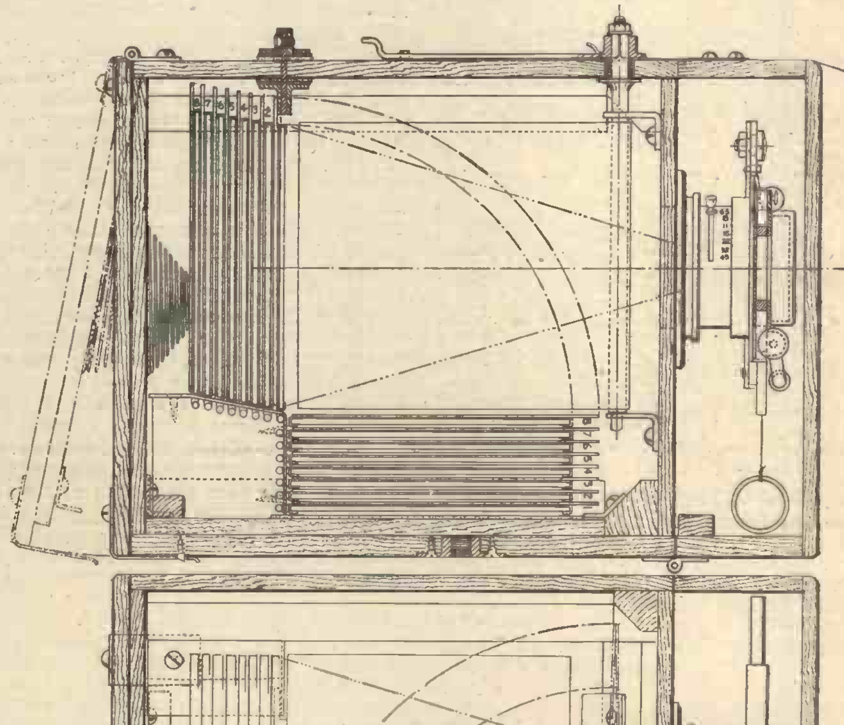


Fig. 1.—The camera in section and part sectional plan.

MAGAZINE
AMERA

...aphy were Dealt with Last Month and Now
... for Taking Stereoscopic Photographs

...WINING

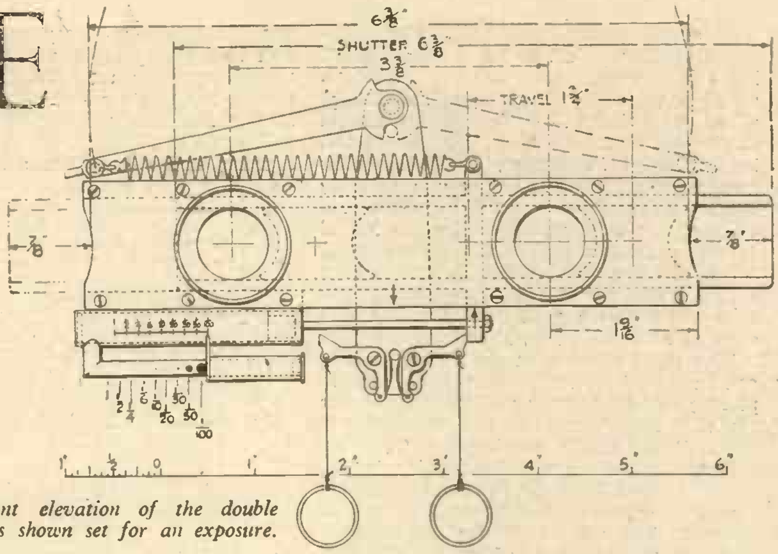


Fig. 4.—Front elevation of the double shutter. It is shown set for an exposure.

of the camera is opened in the dark room and the whole plate-holding gear, with the ramps on which they were first supported, can be slid out at the back, the plates pushed out of their thin metal sheaths or carriers and developed.

In reloading, the ramps and their base board are passed back into the camera, the release trigger is pushed over to the right and No. 1 carrier is put in first, then No. 2, and so on to No. 8. All the odd numbers will go to the right and even numbers to the left as in Fig. 3. In this perspective sketch it will be seen that the lugs on the carriers—which lugs are formed on the ends of straps soldered across the backs of the carriers—are shaped for the odd numbers, the opposite way to those having even numbers. This is a definite object in this, and the purpose served is to render it possible to know, by feel, which are the odd and even numbers when loading up, in total darkness, with panchromatic plates. In such cases, strict numerical order does not matter, but the odds, known by the shape of the lugs, must be put in alternately with the evens, and the first one in should be always an odd number.

The several parts of the trigger or plate release and their assembly are shown on the right in Fig. 3. The main item is a single plate, A, to the upper end of which two angles, B, B, are screwed, and to the lower end two other angles, B^1, B^1, are soldered: between these pairs of angles two thin brass plates, C, are placed, both shaped as shown. These, together with pieces of either suede leather or velvet (L), glued to the wood of the camera top, inside and out, serve to make the slot in which plate A moves, light-tight. The leathers or velvets are fixed, and plates C slide upon them.

The upper face of the slidable base of the ramp on the part where No. 1 plate carrier will fall, is covered with a piece of soft, thin felt or cloth to reduce the shock to the first plate dropped. This is indicated in Fig. 1, upper drawing.

In my own camera, the brass ramp on which unexposed plates are shown resting, was not made sloping, as in the drawing, but horizontal. With the present arrangement of making gravity assist in the forward movement of all the plates, a less powerful spiral spring will be needed; but this spring must be strong enough to keep the carrier lugs well up to the trigger.

Included as part of the woodwork and of the same vertical and horizontal size is a cover hinged at the bottom (Fig. 1). This is to protect the shutter and lenses from injury whilst the camera is being carried. When the camera is in use this cover will hang by the hinges.

Fig. 3 (Right).—Showing details of the plate release trigger on the right and the method of re-loading the ramps, with the odd numbered lugs to the right and the even ones to the left.

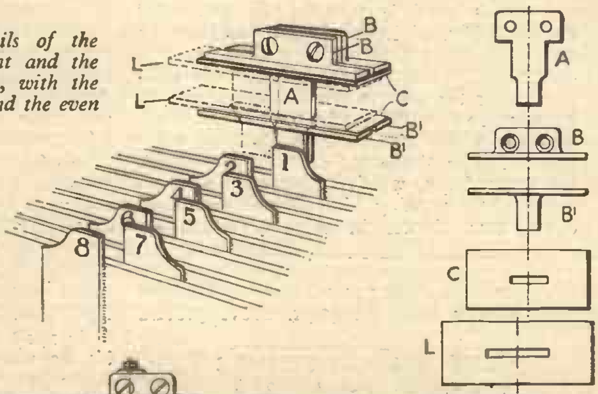
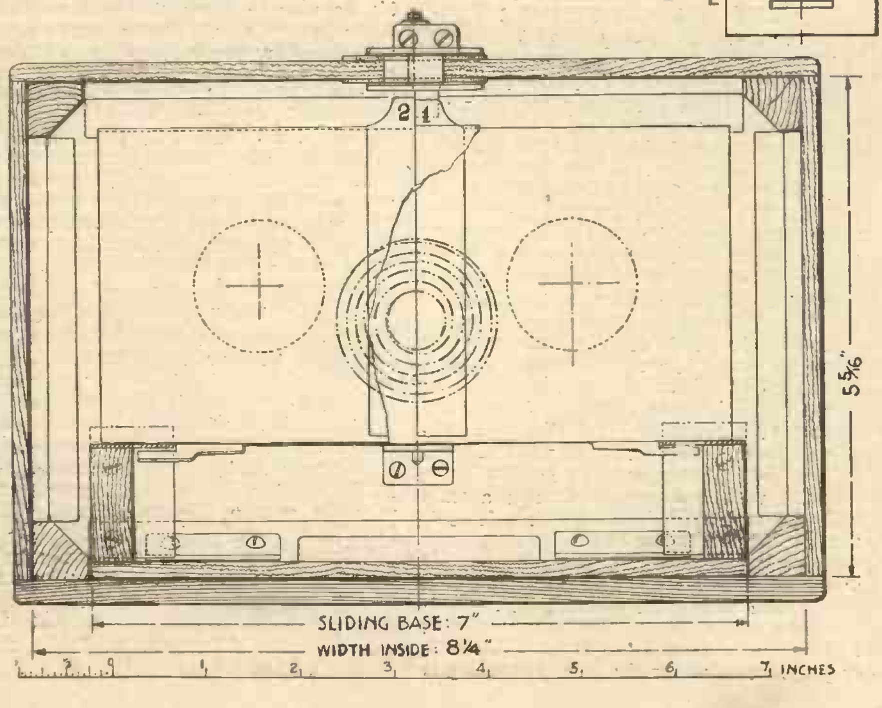


Fig. 2 (Below).—Cross-sectional view, in which are given the only major internal measurements it is possible to give; the length must be governed by the focus of the two lenses.



Covering the Case

The whole of the inside metal and wooden parts must be painted over with dead black lacquer so as to present no light or bright surfaces for reflection. This lacquer may be made by mixing vegetable black with a thin spirit solution of flake shellac or a ready prepared optical black may be used. Externally, the best finish to give to the camera will be to cover it with a leather-grained material, such as bookbinders' cloth. Obviously all the outside metal fittings must be put on after the covering is completed and these metal parts can be either black lacquered, polished and gold lacquered, or nickel- or chromium-plated. If the lens mounts and shutter are yellow lacquered brass then the other fittings should be made to match, and in such case, the cloth covering can be coloured dark green or brown, which makes a handsome job with gold lacquer. If the metal parts are chromium-plated, then the cloth will look best in black.

The Shutter

The power for driving the shutter is provided by a long, light spiral spring of fine steel wire and the duration of exposure, from approximately one second to one-hundredth second is controlled by a series of holes in a tubular extension of a cylinder, which cylinder is fitted with an airtight piston, the rod of which is attached to an arm carried by the shutter slide. The piston will be best fitted by lapping it into the tube forming the cylinder. Lapping is grinding in with a fine abrasive. If the inside of the cylinder is ground with a leaden lap turned to the same diameter as the piston, using tripoli paste or metal polish on the lap, then a final lapping with the piston itself in the tube will ensure a good fit and a film of a suitable machine oil will render it airtight.

The smallest holes in the extension tube can be drilled with a fine needle, ground to present cutting edges, or alternatively, there are very tiny twist drills and watchmakers' drills which can be purchased. Over the extension tube a sleeve is fitted which, lapped on to the outside of the tube, can, by being placed in appropriate positions, be made to close the larger holes for the longer exposures up to one second duration. On one end of this sleeve a plate is soldered which is so shaped that it partly embraces the cylinder and one of its edges acts as a pointer to any one of the marks figured on the scale.

The end of the long spring, opposite to that attached to the moveable shutter, is anchored on a long lever arm. With this lever over to the left, looking at the front of the camera as in Fig. 4, the shutter is set for an exposure. It is released by pulling down the right-hand ring, cord and catch, or pawl. When this is done and the exposure made, the lug to which the piston rod is secured will have passed over to the left and the lug become engaged with the left-hand pawl. To reset for the next exposure, the shutter itself is not touched, but the long spring anchorage lever is turned over to the right-hand side so that when the left-hand pawl is pulled out of engagement with the shutter lug the second exposure is made.

Time Exposures

For making exposures of longer duration than the pneumatic cylinder and piston allows the spring arm is moved to the upper quadrant; that is to say to a vertical position and the spring then becomes inoperative, except for the fact that the spring tension will produce such upward pull on the shutter that the friction will hold it in the full open position, where it is placed by opening and closing the shutter by hand.

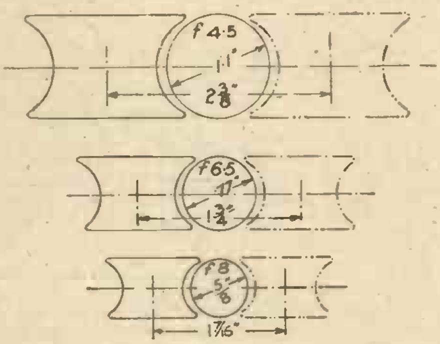


Fig. 5.—Full lens apertures and shutter travels.

To make such hand movements one or other of the pawls must still be pulled out of engagement and the same hand, which by a finger in the appropriate ring pulls the pawl down, can move the shutter until the arrow point marked on the lug coincides with the fixed arrow on the shutter frame. Obviously it is thus possible to make time exposures of any duration.

Fig. 5 is drawn to show the differences which larger or smaller full apertures in the lenses make to the size of shutter opening and the requisite amount of travel. From this sketch it will be seen that in the shutter shown in Fig. 4 I have selected lenses having full aperture of f 6.5, with a shutter travel of 1¾in. If less expensive lenses are purchased for the camera the full aperture may be no more than f 8 (still a very useful lens), and the whole shutter may then be made smaller. In the other direction, with full aperture: f 4.5, which means on 5in. focus a clear lens opening of 1.1in. dia., the type of shutter shown in Fig. 4 would be impracticable; for one thing the length of it would exceed the width of the camera body by an appreciable amount, chiefly because the travel has to be as much as 2⅜in., and some form of twin semi-rotary shutters coupled together by gears or links would have to be devised.

The View-finder

It will be noticed that in the drawings no view-finder is shown. Obviously a finder of some kind is necessary because there can be no focusing screen as there is on an ordinary field camera, and the best scheme would be to use the direct view, open wire frame type. This frame can be of the same size as one of the pictures, say, 3¼in. square and hinged to fold back against the camera when not in use. Similarly hinged, but to fold forward, there will be a plate with a spyhole in the top, which hole will be at such a height that it will be in line with the geometrical centre of the wire frame square and parallel with the optical axes of the lenses. It is suggested that this view-finder be fixed either on the left of the camera top, looking toward the front, or on the side of the camera, according to which is thought the more convenient for looking through the spyhole. If on the side, then the camera-user must choose whichever side is most suitable for the eye, right or left.

Fig. 6 is a perspective sketch of the completed camera including the finder, shown mounted on the left side. In connection with this the double dot-and-dash lines indicate the positions of the frame and spyhole plate when folded.

To my own camera I added a leather strap, fixed across the top of the instrument for use as a handle for lifting and carrying. In positioning this it would be well to consider the centre of gravity of the whole, both before and after exposure of the plates. Another thing is a pair of caps to cover the lenses, as a safeguard against accidental and unintentional opening of the shutter. One of these caps is shown in Fig. 1 and it is to take these that the tubular rings are provided on the outside of the shutter case.

Items of Interest

Cans by the Million

WITH a floor area of 62,000 sq. ft. and standing in an 11-acre site, the Portadown, Northern Ireland factory of the Metal Box Co., Ltd., produces more than 130 million cans a year. About 280 workers are employed, and into the cans produced in 1952 went 40,000 tons of fruit and vegetables as well as quantities of milk, meat and soup.

Atomic Submarine

THE American Atomic Energy Commission's Schenectady office recently released some information relating to the construction of an atomic-powered submarine. The prototype is land-based and experiments with it are to take place inside a 225ft. diameter metal sphere. The concrete saucer which is to form the foundations on which the sphere will rest has already been completed; it is 176ft. in diameter and 42ft. deep. Helping to support the sphere in the saucer will be a ring of steel columns set in concrete.

This giant steel ball has been designed in order to give additional protection to operating personnel above that given by the precautions taken in the reactor itself. The volume of the sphere will be 5.4m. cu. ft. and will be made of welded steel plates, which will be swung into position by means of a derrick mounted 424ft. above ground level.

LOCOMOTIVE STAMPS

(*Continued from page* 377)

The most valuable stamp, however, in the locomotive range, and certainly the most odd-looking, is the Peruvian 5 cent of 1871, which was issued for use on letters passing between the capital, Lima, and the towns of Callao and Chorrillos. It was issued in long horizontal strips instead of in sheets, and is imperforated. The design and inscriptions are embossed in white on a solid ground of red. The arms of the country occupy the lower part of the central space and above is a steam-engine and tender, both having six wheels.

Before the end of the century other examples came from Nicaragua (1890), Salvador (the 3 cent of the second issue of 1896) and Honduras (1897). These show engines of a primitive kind, the huge bell-topped funnel being a marked feature.

The United States came to the fore again in 1901 with a stamp illustrating a train with the caption "Fast Express." This is the first time an engine was illustrated, based more or less on present locomotive lines. It was one of a set of six values issued in conjunction with the Pan-American Exhibition held at Buffalo. The subject of each design was intended to represent the march of progress. Perhaps the most interesting is the 4 cent which depicts one of the earliest types of automobile.

In 1908 a special set of stamps was issued by Ecuador to mark the 25th anniversary of its first railway. The set consists mostly of triangular stamps bearing portraits of presidents and engineers, but the lowest value is rectangular and shows one of the contemporary engines. Four years later Nicaragua and the U.S. produced on the Zelaya issue of 1912 an engine of the ancient type and the 5 cent of the parcels post set, showing a modern locomotive. No further stamps were issued anywhere until 1918, when Mozambique issued a 15 centavos stamp with a view of a train emerging from a sylvan glade.

In 1920 Brazil issued two locomotive stamps: Guatemala in 1921 issued a stamp showing a train passing over a bridge, and in 1922 the Soviet Government issued a stamp showing a goods train emerging from a tunnel. In 1926 Turkey issued a postage due stamp showing a train crossing the Kizil-Irmak bridge; and Newfoundland in 1928 issued a beautifully engraved stamp with the caption "Express Crossing Newfoundland."

Other examples illustrated on page 377 indicate the great interest in collecting stamps illustrating a particular feature.

The latest stamp to be issued depicting engines is the Centenary of India, issued April 16, 1953 (1853-1953).

CATALYTIC CRACKING

The Story Behind the First Fluid Catalytic Cracking Plant in Britain

Just over a year ago Britain's first Fluid Catalytic Cracking Plant went on stream at the Esso Refinery at Fawley, near Southampton. Forty-seven tons of a finely powdered solid began to circulate every minute through the giant two hundred and sixty-five feet high unit, until it held altogether approximately one thousand tons. But this great mass of catalyst, equivalent to a hundred truck loads, did not behave like a solid; mixed with oil vapours, it flowed like a liquid throughout the cat-cracker to produce from gas oil feed stock more than half-a-million gallons of high-octane petrol every day.

IT is somehow symbolic that a revolutionary new process like catalytic cracking should be controlled by a young man. And Ted Jeffers, who bears the imposing title of Cracking and Light Ends Divisional Supervisor at the Esso Refinery at Fawley, is still only twenty-six.

After taking his degree in chemical engineering in 1947, he joined Esso Petroleum Company and went to work in the Technical Service Department of the old refinery at Fawley. For three years his progress and abilities were quietly watched and noted down, until one day he was called in by the Refinery Superintendent and told that he had been chosen to go to America for advanced technical training in new refining techniques. For by 1950, the great new refinery at Fawley was well on the way to completion, and many of the units being built had never existed in England before.

In the United States, Jeffers studied the design and theory of the Fawley cat-cracker and watched the operation of existing units at various refineries throughout the country. After four months' intensive study he returned to England, arriving back on Christmas Eve, 1950. At Fawley, the cat-cracker was still under construction, and Jeffers's first task was to prepare a training programme for the men who would ultimately operate it with him. These man had a basic knowledge of refining from their work in the old refinery, but they had to be introduced to new instruments and new techniques. For the unit is a sensitive mechanism which needs constant watching and a deep understanding.

All the molecules of petroleum contain the same elements—atoms of hydrogen and atoms of carbon. The molecules in crude oil, however, contain varying numbers of hydrogen and carbon atoms arranged in widely differing patterns. Some of the molecules contain a large number of atoms. Those with many carbon atoms make up the thicker and heavier components of petroleum, such as asphalt. Others with relatively few atoms make up the lighter and more volatile components, like petrol.

Distillation

The first step in refining is distillation, which roughly separates the molecules in crude oil according to their size and weight. The process can be thought of as taking a barrel of gravel containing stones of many different sizes and running it through a series of sieves to sift out the small ones, the next larger, and so on, up to the very largest of all. As applied to a barrel of crude oil, this process "sifts out" such things as gas, petrol, kerosene, heating oil, lubricating oils, heavy fuel oils and bitumen.

But while distillation can separate crude oil into its fractions, it cannot get more of a particular fraction out of the crude than nature put there. And consumers' demands for different products are not necessarily in accord with the proportions nature followed in mixing petroleum's ingredients. For example, if we had to depend on the amount of petrol naturally present in crude oil—20 per cent.—we could not make nearly enough of it to run the motor-cars now on the road.

Fortunately, at about the time that the growing use of motor-cars began to sky-rocket the need for petrol, a process was discovered for getting more petrol out of crude than is naturally there. This process is known as cracking.

Earlier we compared distillation to sifting out stones of different sizes from a barrel of gravel. Cracking is comparable to crushing some of the larger stones in order to get more small ones. Cracking amounts literally to breaking big molecules into little ones, and has made it possible to produce more than twice as much petrol from a barrel of crude oil as can be made by simple distillation.

The type of cracking which was first invented (and which is still used) employs only heat and pressure, and is called thermal cracking. A later development was catalytic cracking.

The Catalyst

A catalyst is a substance that causes other substances to change chemically without being changed itself. No one knows precisely why it works—only that it does. You can try it yourself by holding a lighted match to a lump of sugar. The sugar will begin to melt, but it will not catch fire. If you put the sugar in some cigarette ash, though, and then hold a match to it, it will burn. Now the ash itself would not burn, nor would the sugar by itself, but when combined the ash acts as a catalyst and changes the sugar's reaction to flame.

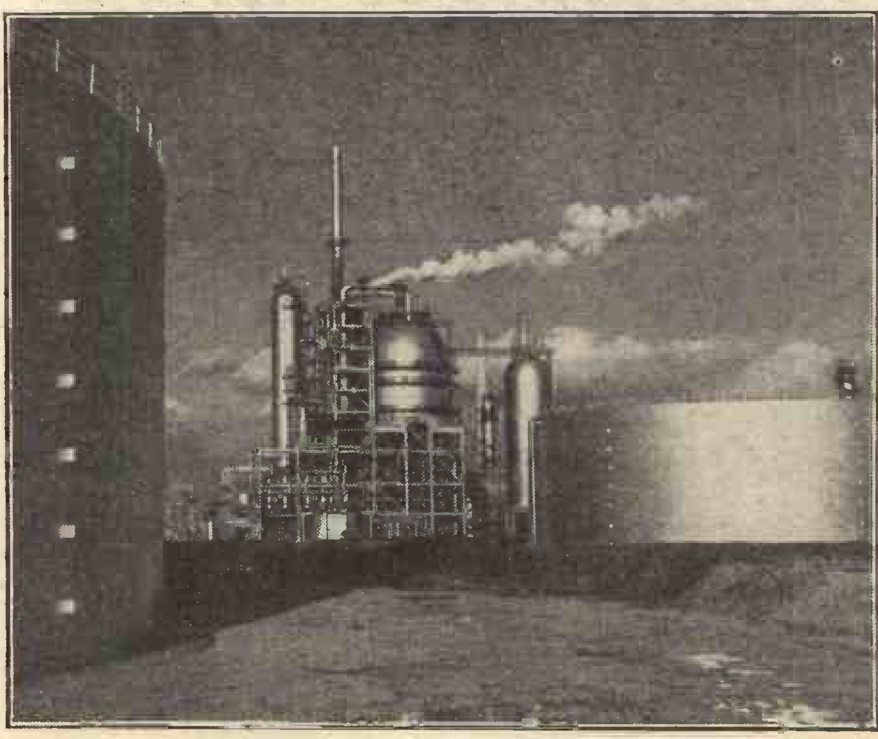
Fluid Catalytic Cracking

The fluid catalytic cracking process, which was developed in Esso Laboratories, revolutionised catalytic cracking, for it enables the process to run continuously for months on end. Thermal crackers require overhauls about once a month, whereas fluid crackers have been on stream for periods up to a year or more; and these longer periods between overhauls mean lower maintenance costs and a cheaper product.

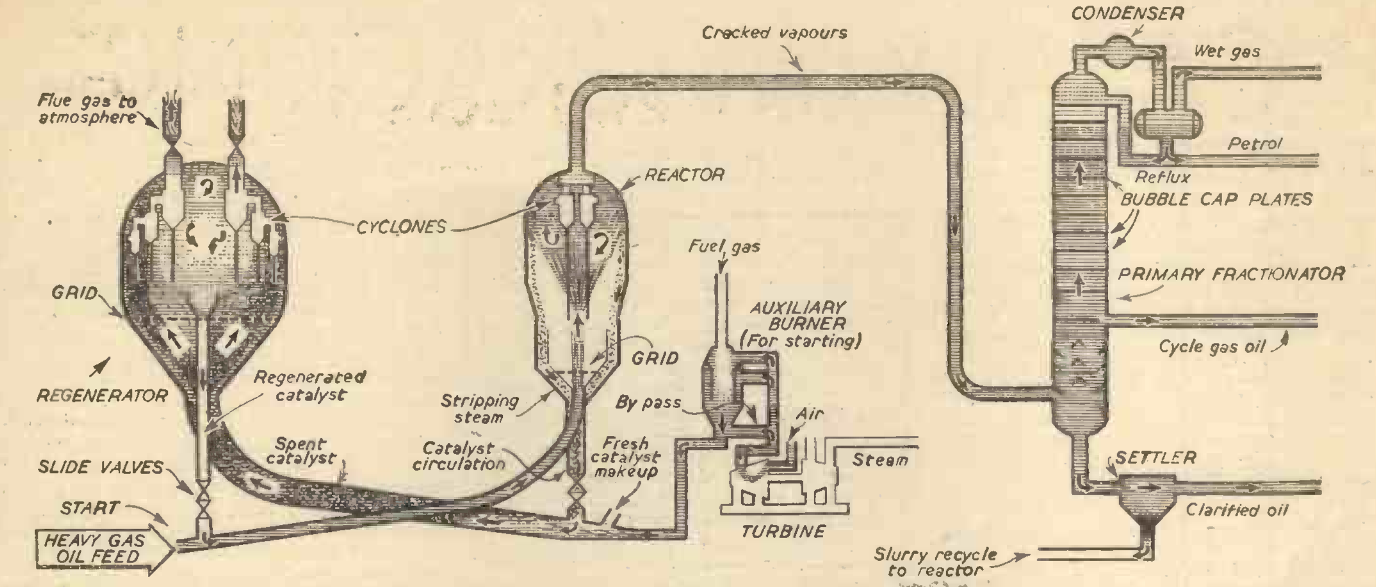
Fluid catalyst cracking, therefore, is now the leading cracking process. But at the time the Standard Oil Development Company began its experiments with catalytic cracking thirteen years ago, fixed-bed or stationary catalytic cracking was the accepted method.

Initial tests carried out in Esso Laboratories were literally on a half-pint scale. A number of small units were set up consisting of catalyst containers through which oil vapours could be passed and from which the cracked petrol could be withdrawn. Hundreds of catalysts and dozens of oil stocks were tested with results so favourable that it appeared desirable to step up operations and to begin thinking how to overcome the difficulties inherent in the fixed-bed type of operation.

The size of the organisation concerned with the development of this process soon grew from a few technical men to a very large team of more than a hundred chemists, chemical engineers and mechanical engineers, who worked together with several



A general view of the Esso Refinery at Fawley.



Fluid catalytic cracking unit. The fluid catalytic cracking process begins when oil vapour enters the system, picks up regenerated catalyst and flows to the reactor, where cracking takes place. The cracked vapours then go to a fractionating tower for distillation and used catalyst returns to the regenerator.

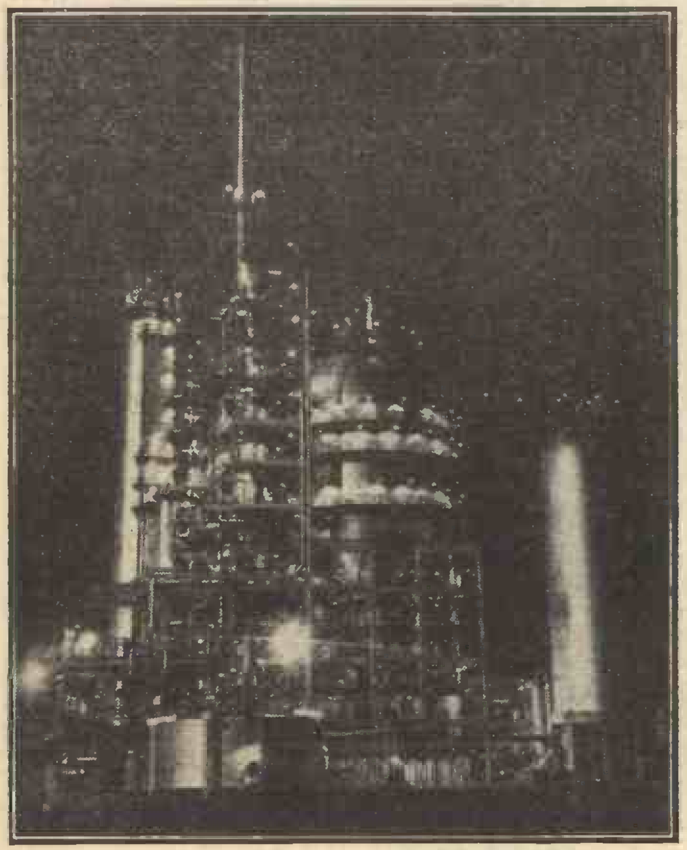
hundred operators, analysts and mechanics. Work was then proceeding on the designs of a large fixed-bed plant, and in order to miss no chances, it was decided that part of the organisation should work on alternative techniques which offered the promise of being better than the fixed-bed type of plant. Experiments with these entirely different methods were also begun on a very small scale, but it soon became apparent that the use of powdered catalyst would enable the plant to be more easily built and operated.

The laboratory tests with powdered catalyst were soon being scrutinised by all the chemists and engineers involved, and a three thousand five hundred gallon-a-day pilot plant using powdered catalyst was built. In its operation, catalyst from a hopper was forced by a screw conveyor into a vapourised oil stream, and the mixture of catalyst and oil vapour was sent through a heated coil where the cracking took place.

Again after several months of intensive effort, the engineering details of the process were worked out on this pilot plant and plans for a four hundred and fifty thousand gallon-a-day commercial plant began to go on to the drafting boards.

Just as the construction of the four hundred and fifty thousand gallon-a-day unit was about to begin, there came one of these moments which gladden the hearts of research workers. By tying together all the work on powdered catalyst, it became clear that if the proper amount of gas (either oil vapours or air or steam) were mixed with the catalyst, it became fluidised and could be handled like water or oil.

Further, it became evident that this "fluid" composed of catalyst and vapour could be made heavier or lighter as desired, simply by changing the amount of vapour added to the catalyst and by controlling the speed at which the new fluid moved. This technique of changing the density of the fluid could be used through a system of stand-pipes to generate any desired pressure at any particular point in the system, and by proper manipulation could circulate the catalyst through the units without moving parts.



The catalytic cracking plant operates day and night and the photograph shows what it looks like after dark.

Here was a really revolutionary idea. It was recognised at once that by the time these new principles were put into operation, still further simplification and ease of operation were bound to result. Again the three thousand five hundred gallon-a-day pilot plant was completely rebuilt to put these new principles into effect. The engineering factors were established in a relatively short operation of the pilot plant, and development moved directly to the building of the four hundred and fifty thousand gallon-a-day unit.

Despite the risk involved, the first large unit proved completely successful and development was hurried on to its goal, the designing and constructing of large commercial units. The extent of engineering work needed to design a big commercial plant may be judged from the fact that one of the first of them took one hundred and twenty-five thousand man-hours of engineering work alone. Contributions to the development work have also been made by many other oil companies; and the patents which cover the fluid process have since been made available to the entire industry.

The fluid process grew in a remarkably short time from the laboratory to the first commercial plant, which went into operation in May, 1942, at Esso's Baton Rouge Refinery. The first commercial unit was over a hundred times larger than the previous pilot plants. In spite of the growth in size, however, the development of the process has been marked by a continuous simplification. In the number of its plants, the fluid process leads the other catalytic cracking processes by substantial margins.

Fawley Construction

Construction of the vast cat-cracker at Fawley began in April, 1950, when thirty thousand cubic feet of concrete were poured all in one day to form its foundation, and it was completed and on stream two months ahead of schedule towards the end of 1951.

Although the cracker's exterior shows no movement, a veritable storm takes place inside its huge vessels. Vast quantities of vapourised oil, air and powdered catalyst circulate at high temperatures through miles of pipes and reactors.

After being in use for a while (the average particle of catalyst makes its way round the complete circuit every ten minutes) the fine

grains of catalyst become coated with carbon removed from the oil. The catalyst is then inactive. By being whirled into a regenerator where the carbon is burned off, however, the catalyst is reactivated and thus can be used over and over again. The regenerator liberates heat equivalent to fifteen hours of coal every hour, and this is used to raise the temperature of the oil to the cracking temperature. Any surplus heat is used for steam raising. Although its intake is approximately a million gallons a day, the instrumentation of the unit is so skilfully designed as to be largely self-controlling and only twelve men are needed to supervise the running of the plant. But once the cat-cracker is in operation, it runs continuously night and day for many months on end, and so there are four shifts of these twelve men, three on eight hours of duty each day and one shift off-duty.

The Stillman's Work

As an example of their jobs, let us take the stillman. On arriving at work, he takes over his duties from the previous shiftman, who explains any variations in operation that have recently taken place or anything abnormal that is occurring. Then, with his assistant, he checks the operation of the pumps, sees that the control valves are correctly adjusted and that the correct amount of aeration is being used on the catalyst, and checks the performance of the air blowers and gas compressors. This inspection is carried out once an hour throughout the whole shift.

In between times, a close watch is kept on the dials in the control room, which report on the operations taking place in the various parts of the unit. If one of the instruments registers anything unusual, an immediate check is made. First the stillman checks the particular section of the plant where the upset has taken place; he checks all flows, temperatures and pressures relevant to this section of the plant and modifies any of these if he feels it is advisable. If, for example, an instrument is obviously giving trouble or a pump is not running as it should be, then he will call in the necessary mechanical personnel to remedy the defect. If, however, the upset is something that he cannot analyse himself, then wherever necessary he will call in the unit supervisor who can bring in any further assistance that is required.

Ted Jeffers, the supervisor, and Leonard Keel, his assistant, work only on the day shift, but they are on twenty-four-hour call on alternate days.

The Supervisor's Job

When Ted Jeffers arrives in the morning he first checks the plant, then issues operational instructions and prepares a list of required maintenance for the engineer. Next he collects the details of the previous day's operations, including log sheets, laboratory reports and instrument charts, and prepares a summary of them, which is presented at the daily process meeting with the process superintendent, Dr. Pearce. At this meeting, the complete refinery operations for the previous twenty-four hours are analysed and discussed and any alterations for the present twenty-four hours are announced. Such variations may be designed to meet a change in the demand for the finished products.

His other duties are the general supervision of the running of the cat-cracker, the training of new staff, and planning the future operation of the unit. (The annual shut-down is not decided by him, for it is planned well in advance to fit in with the refinery's other operations.) Then, just before going home in the evening, he puts down in the general instructions book all details of the unit's operations during the day.

The feed stock for the cat-cracker is a heavy gas oil, which normally forms part of the fuel oil used for bunkering ships and of which there is a surplus after normal distillation. By subjecting this gas oil to catalytic cracking, however, 65 per cent. of it is transformed into far more valuable and far more necessary high-octane petrol, while the remainder emerges as gas oil, which is not re-processed, but is used as a blend stock in the manufacture of industrial and marine fuel oils.

Reprinted from "The Esso Magazine," by courtesy of The Esso Petroleum Company, Ltd.

An Automatic Draught Excluder

A Device Which Automatically Lifts a Rubber Strip Over the Carpet When the Door is Opened

By J. L. BROWN

As will be seen from the sketches, the opening of the door releases a spring which lifts the draught excluder away from the floor. When the door is closed a screw positioned in the door jamb acts on a cam to which a lever it attached. This lever is connected by a rod to the hinged draught excluder and imparts to it a downward movement, bringing it into contact with the floor as the door finally closes.

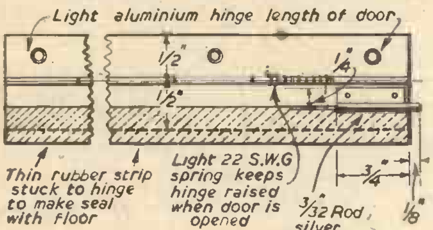


Fig. 1.—Details of the draught excluder.

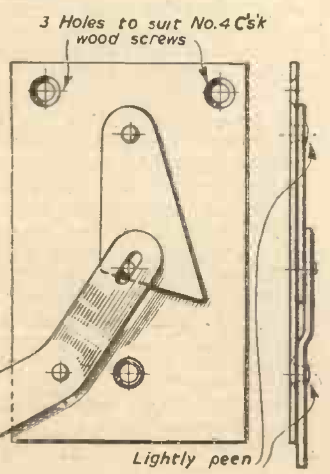


Fig. 2.—The cam plate and lever.

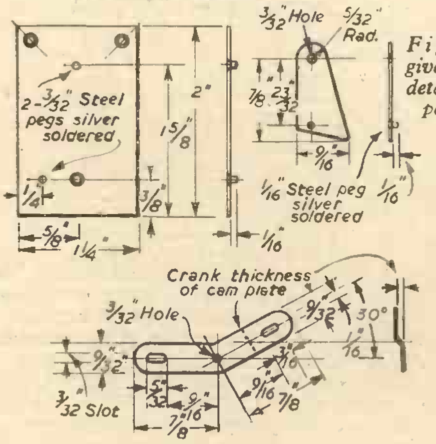


Fig. 3.—(Left) gives dimensioned details of component parts.

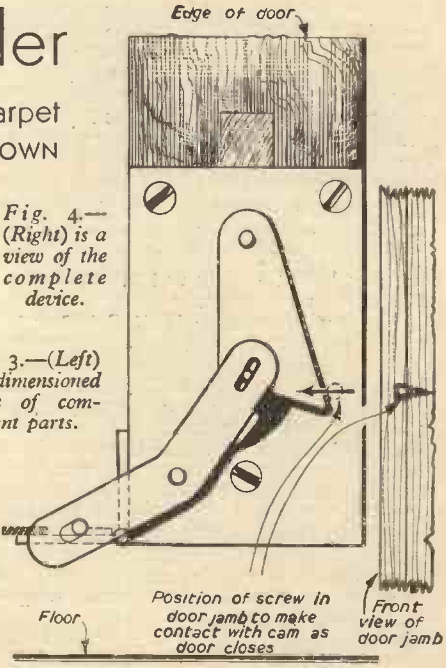


Fig. 4.—(Right) is a view of the complete device.

Draught Excluder

The actual draught excluder is formed of a light aluminium hinge running the full width of the door, a rubber strip, forming the seal, being attached to the lower leaf of the hinge. A light 22 S.W.G. spring is positioned round the hinge pin, the two ends being braced against the top and lower halves of the hinge respectively; this keeps the draught excluder in a raised position when the door is opened. A 3/32in. rod is silver soldered to a plate which is in turn riveted to the lower half of the hinge so that the end of the rod projects past the edge of the door sufficiently to engage in the elongated hole on the end of the lever. Details are shown in Figs. 1 and 4.

The Cam Plate

This is cut to the thickness of the door, drilled and countersunk as shown in Fig. 2, so that it may be screwed to the edge of the door. The cam is formed as shown in Fig. 3 and hinges on a steel peg, silver soldered to the cam plate. The cam and cam plate are formed from 20 S.W.G. mild steel.

The Lever

The lever is also cut from 20 S.W.G. mild steel and the dimensions are given in Fig. 3; it hinges on a steel peg silver soldered to the cam plate. Both this peg and the one on which the cam hinges are lightly peened when their respective parts have been fitted.

The device may, of course, have to be made opposite hand depending on which way the door opens.

LETTERS TO THE EDITOR

The Editor does not necessarily agree with the views of his correspondents.

Petrol Pump for Lighters

SIR,—I have a suggestion which would, I think, improve the design of the lighter fuel pump described by Mr. L. Wingrove in the March issue.

Lighter fuel is very volatile and highly inflammable, therefore it would be dangerous to have Mr. Wingrove's pump anywhere in the house. The reason is this: when a lighter has just been filled there is liquid on top of the plunger up to the level of the spout, therefore, until the pump is used again the fuel will be evaporating through the spout. Also when the pump is used again the fuel will not be up to the level of the spout, and so it will not deliver the required amount of fuel.

If the rod were shortened so that in the rest position the plunger just closed the end of the delivery tube, the whole thing would be sealed, so no evaporation could take place. The pump would still operate in exactly the same way, because the tube below the plunger would always be full of liquid, so that when the plunger is depressed an inch, an "inch" of fuel would be transferred to the top of the plunger and expelled when the plunger was released.—CHRISTOPHER FOX (Wellington).

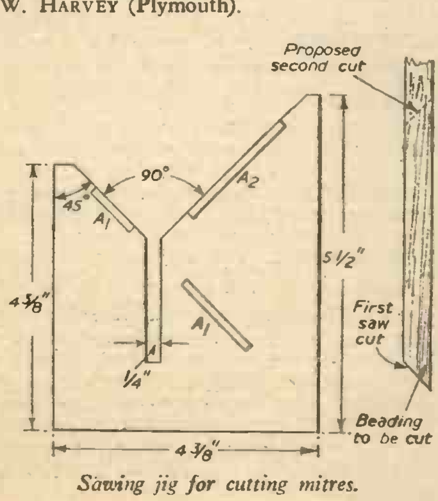
Jig for Cutting Mitres

SIR,—After a few attempts at cutting accurate mitres, suitable for small picture frames, I evolved the following jig to enable them to be cut rapidly and accurately on a 4in. circular saw table.

The tool I use is the Wolf Cub Saw Set, which is fitted with an adjustable fence.

To use the jig adjust the fence so that the blade of the saw fits into the ¼in. slot. Lay the piece of beading to be mitred along the edge A2 and slide the jig across the table, keeping hard up against the fence until a cut is completed. Measure the total length required, and turn the beading end for end, and lay along A1, A1. Adjust the length until the saw will cut on the required mark.

A1 and A2 are brackets brazed on to the base plate to keep the work steady. The material used was ⅛in. brass plate.—W. HARVEY (Plymouth).



Sawing jig for cutting mitres.

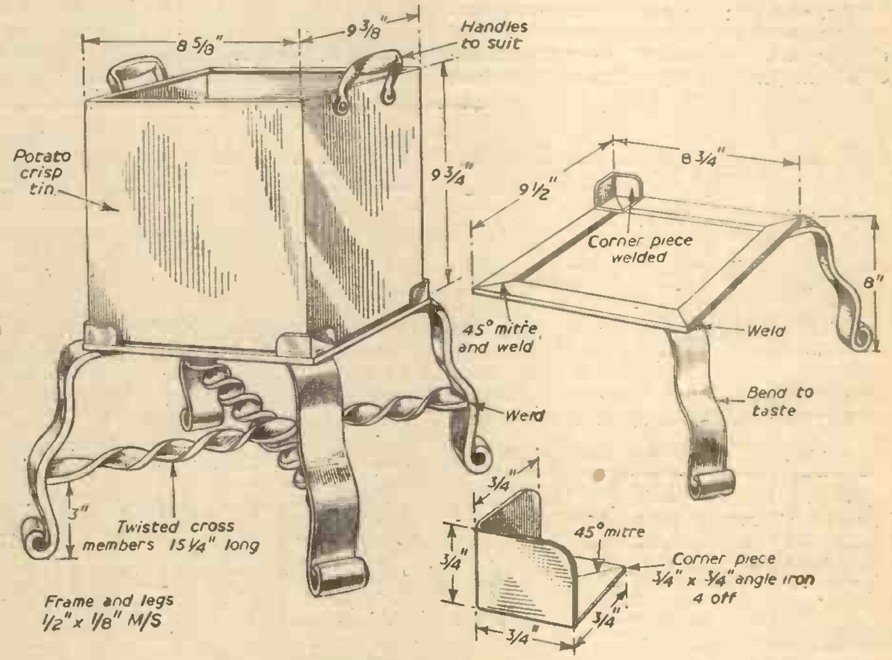
A Hearth Coal-box

SIR,—I enclose a sketch of a simple but efficient hearth coal-box.

The container itself consists merely of a discarded potato crisp tin; a biscuit tin would also suffice, the lid being discarded. The idea is that the box, which is located on the stand by four angle pieces, can be lifted out, carried to the coal pile and filled, thus dispensing with a bucket. Likewise, it can be taken direct to the fire when the latter requires remaking.

I have not shown too much detail on the sketch as the making of the stand can be left to the builder's own choice of shape, etc. The tin sizes are apparently of standard dimensions and the sketch shows how I fitted mine on the stand. Alternative leg shapes could be bent quite easily, the whole job being extremely simple.

With regard to finish, I painted the box a bronze colour, and the stand and handles black.—D. McGREDY (Harborne).



A hearth coal-box, and details of construction.

Time-lag in the Cinema

SIR,—The time-lag between the picture seen and the sound heard at the back of a cinema is quite a normal thing, and it is difficult to see how it can be avoided. What surprises me is that the manager and visiting engineer at the cinema did not point out the reason to your correspondent, for all terrestrial purposes light travels instantaneously but sound travels at the comparatively slow pace of round about 1,100ft. per second, so that at the back of a cinema 140ft. long the sound is heard about one-eighth of a second after the appropriate picture has been seen. Such a lag can quite easily be observed but is rarely noticed by the average cinemagoer for two main reasons, the principal one is that this time-lag is normal in everyday life, a speaker on a public platform may be 140ft. away and this same time-lag *must* occur, but is never noticed unless the listener concentrates on it. The other reason is that producers avoid or keep as short as they possibly can shots which would make this time-lag apparent.

The sound for a given "frame" on a film is eight frames in front, this allows for a minimum of loop in the projector. If a careless projectionist threads the film with too great a loop the film takes too long to get from the projector "gate" to the sound "head," thus increasing the time-lag; I have known this lag to be increased in the projector by as much as 50 per cent. without anyone complaining, so that it would appear to pass quite unnoticed by the majority of persons.

Extension speakers at the back of a cinema would be just horrible. If a cinema fitted with hearing aids (miscalled deaf aids) is available to your correspondent he should visit it and experiment with one of the aids, the plugs for these instruments being usually on the back seats which shows up the effect to the greatest extent. The sound is produced in the ear-piece of the aid at the same time as it is produced in the loud speakers behind the screen, but, of course, it takes time to travel down the hall to the observer in the rear seat; the sound from the aid is heard by (say) the right ear and that from the screen by the left ear, and the result has to heard to be believed.

Experiments are now being conducted in St. Paul's Cathedral on sound reinforcement by loudspeakers fitted in different parts of the auditorium, but a time-lag has been artificially introduced into the loudspeaker circuits so that each speaker produces the sound at the same time as the air-borne sound reaches the same position.

The artificial time-lag is very interesting; it consists of a rotating disc on which the sound is magnetically recorded, the reproducing head is at a suitable distance around the disc from the recording head so that the time taken for a given recorded sound to

(*Continued on page* 389)

LETTERS TO THE EDITOR

(*Continued from page* 386)

travel from the recorder to the reproducer is the time-lag; the record is wiped out before the disc rotates back to the recording head.—" DERBIAN " (Barking).

Conservation of Energy

SIR,—The work done by a magnetic field in moving an iron object from one place to another is the same as the work done *on* the magnetic field by moving the object back to where it came from.

Thus, in Mr. Bailey's hypothetical experiment the field is " recharged " by the work done in pulling the weight off the magnet and replacing it on the platform. If the weights are not removed, the magnet will pick up as many weights as the original strength of its field allows. In either case energy is conserved.—R. A. FAIRTHORNE (Farnborough).

Cistern Fault

SIR,—May I offer my experience to augment your answer to the above query, which seems to have nothing to do with the inlet valve. To answer the question we must first realise how the cistern works. When we pull the chain we raise the bell up the stand pipe inside the cistern. On releasing the chain the bell drops down, and displaces some water down the stand pipe which is actually a continuation of the flush pipe into the cistern. This water, falling down the flush pipe, reduces the atmospheric pressure inside the pipe, and so the water still in the cistern is pushed out down the pipe by the normal, and greater atmospheric pressure on the surface of the water. When the cistern is empty air enters under the bell and equalises the atmospheric pressure and the syphonic action is stopped. If air is unable to get into the bell the incoming water from the valve continues to trickle down the flush pipe owing to automatic syphonic action.

I have found the reasons for this are:—

Sludge in the bottom of the cistern, which the bell beds down on;

Wear on the nibs at the bottom of the cistern which the bell rests on;

Wear on the lever which lifts the bell, and so allows the bell to descend too far into the cistern.

The cures are: Clean out the sludge. Drill a small hole in the bottom of the bell. Place a piece of lead or other material about a ½in. thick across the bottom of the cistern so that the bell is slightly raised to allow air to enter. In examining the causes and cures we must bear in mind that if air cannot enter the flush pipe after the flush, the incoming water from the valve will continue to trickle down the flush pipe. When your correspondent pulls the chain a second time immediately the cistern is flushed he lets air into the flush pipe before the cistern is filled again. There is one other source of trouble, which seems unlikely in this case. Where a lead flush pipe is used, and has not been properly fixed, it may sag downwards and form a trap which holds water where it is connected to the W.C. pan.

Your correspondent does not mention that the cistern overflows, as would certainly occur if the valve was defective in seating or the ball float contained water.—E. H. GAYWOOD (Radstock).

Re Information Sought

SIR,—Mr. E. J. Crocker will not be able to cool the air to any appreciable degree unless he does work with the expanding air. It would be best to expand it through a nozzle to drive a suitable size turbine wheel. The energy given up must be absorbed in some way and a paddle type fan might be a useful way of doing this. A unit, utilising a turbine wheel which then passed its power back to a turbo-compressor for compressing the air, was in production at one time for cooling and drying air for air conditioning. An electric motor or small steam turbine provided the extra power required.

It would appear that the querist has based his thoughts on refrigeration principles, but the physical properties of air and refrigeration gases are very different. If a small amount of air is to be cooled, a heat exchanger cooled by a small refrigeration unit is the most satisfactory solution. Advertisers in PRACTICAL MECHANICS would help with such a problem, particularly Messrs. Braid Brothers, 50, Birchwood Avenue, Hackbridge, Surrey, as they handle industrial and scientific refrigeration, as well as refrigeration for the home constructor.—" FACITUR " (Merton Park).

SIR,—With reference to Mr. C. Micallef's query on page 306 of the April issue: (a) Pearl powder can be made from fish scales—preferably those of the bleak—by digesting these with dilute ammonia, shaking occasionally. Two or three days usually removes the pearly nacre and leaves the exhausted scales. The latter may be removed by straining through a fine sieve. On allowing the filtrate to settle, the liquid can be siphoned or decanted off and the nacreous sludge dried in gentle heat. Household ammonia diluted with an equal bulk of water is suitable.

The dry powder can be mixed with varnish to make into a paint.

(b) A better pearl paint can be made by mixing clear lacquer, 8 pints; pearl powder (as made above), 8 oz.

The clear lacquer is made as follows: Mix butyl acetate, 30 parts; toluene, 10 parts; ethyl acetate, 10 parts; and dissolving therein nitrocellulose (dry), 10 parts; all by weight.

Coloured pearl paints can be produced by using the following: coloured lacquer, 1 pint; clear lacquer, 7 pints; pearl powder, 8 oz.—L. A. FANTOZZI (Winsford).

BOOKS Received

Watch and Clock Making and Repairing, by W. J. Gazeley, F.B.H.I. 440 pages, demy-octavo. 314 illustrations. 42s. net. Published by Heywood & Co., Ltd., Tower House, Southampton Street, Strand, W.C.2.

IT can be said at once that this is one of the most important books on horology published during the present century. The standing of the author is sufficient guarantee of the contents, for he is not only a practical craftsman but a well-known lecturer in horology at Northampton Polytechnic. In this book he has compressed a diversity of experience gathered during a lifetime, and a praiseworthy feature is the large number of practical illustrations, many of them in perspective and thus easily understood; for the book is designed to appeal not only to the skilled watch and clock maker, for whom it will provide a most valuable day-to-day work of reference, but also to the student. The book is published at a time when this country is gradually getting back into the world markets in clocks and watches which it lost at the beginning of the century to Switzerland and America. Indeed, to-day the largest watch factory in the world is located in this country. The contents embrace practically every aspect of horological theory and practice and, where necessary, historical information is given, often of value when dealing with very old handmade watches.

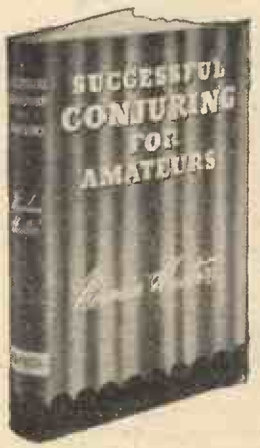
The comprehensive list of chapters will indicate the scope of the work. They are: Tools and Equipment; Materials; Watch Movements; Clock Movements; Filing and Making Drills, Taps and Screws and Methods of Polishing; Turning; Gearing; Watch Escapements; Clock Escapements; Keyless Works, Self-winding Mechanisms and Motion Works; Balances and Balance-springs; Pendulums; Striking Mechanisms, Repeaters, Clock-watches, Musical and Alarm Watches; Chronographs and Stop Watches, Calendar Watches and Clocks; Chronometers, Tourbillons and Karrusels; and Cleaning Clocks and Watches and Practical Hints. A useful feature is an Appendix which lists the causes of failure and bad timekeeping in watches and clocks. The author describes many special tools he has devised. A most praiseworthy feature is a very comprehensive cross-referenced index. The publishers, too, deserve praise for an excellent piece of book craft.—F. J. C.

Modern Pumps. Edited by E. Molloy. 240 pages, 158 illustrations. 21s. net. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, W.C.2.

THIS is a survey of modern pumping equipment, a subject of great and growing importance to-day. Pumps exist in great varieties and of widely different capacities. Pumping applies not only to liquids but to solids, and this book deals with the subject in two parts: the first dealing with principles and layouts, construction and operation of the three main types of pumps, installation, maintenance and repair; whilst the second half deals with special applications for particular duties and their choice. The contents include: Principles of Pumping; Reciprocating Pumps; Centrifugal Pumps; Rotary Pumps; Installation, Maintenance and Repair: Boiler Feeding and Feed Pumps; Pumps for the Mining Industry; Oil Pumps; Well and Borehole Pumps; Pumps for Special Applications. The book is fully indexed.—F. J. C.

Successful Conjuring for Amateurs, by Norman Hunter and edited by F. J. Camm. 384 pages, 2nd impression. 18s. net. Published by C. Arthur Pearson Ltd., Tower House, Southampton Street, Strand, W.C.2.

THE first edition of this book went out of print within a few weeks. It is the book which the conjurors unsuccessfully tried to ban. The publishers, however, undaunted by threats have embarked upon a second edition, and no doubt large numbers will be sold to conjurors themselves! It covers such subjects as conjuror's equipments, tricks with flowers, magic wands, cards, coins, billiards balls, chemical magic, cookery, levitation, lamps and candles, knots, watches, pictures, trays and plates, dice and cubes, conjuring with colours, tricks with hats, paper, rings, cigarettes. There are nearly 400 illustrations.



The book the conjurors tried to ban.

Trade Notes

Photographic, Optical and Scientific Instruments

WE have received a new catalogue of the products of Messrs. Charles Frank, 67-73, Saltmarket, Glasgow, C.1, and a wide range of items is listed.

Many types of binoculars are included, ranging from the lightweight for holiday use to ex-German navy deck-mounting binoculars, weighing, with mounting pillar, 134lb. There is a section covering many kinds of rangefinder, sextant and navigational compass, and a long and comprehensive list of lenses and prisms is included. Several pages are devoted to second-hand astronomical and terrestrial telescopes and also available is a wide range of both new and second-hand microscopes. Details are given of a comprehensive stock of ex-Government and second-hand theodolites, levels and other surveying instruments and accessories and examples are shown of the varying types and sizes of kits of drawing instruments which are for sale. Many items are offered "on approval" if desired, and all goods carry a guarantee of satisfaction or refund of payment. Charles Frank also runs a binocular repair service.

Low Melting-point Solder

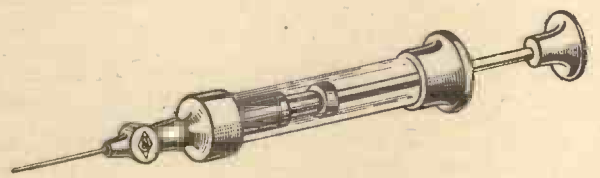
A NEW Multicore tape solder, which melts with a match, will shortly be available, and this will mean that small components can be jointed, models constructed and repairs made on toys and other household articles with a real tin lead solder, without the use of a soldering iron.

The solder contains cores of Ersin extra active non-corrosive flux and thus no extra flux is required. It is of the same high quality as the well-known Ersin Multicore solder which is sold in cartons and on reels.

The price of a card of this new product is 1/- and full directions for its use are given on each card. The maker's address is Multicore Solders, Ltd., Multicore Works, Marylands Avenue, Hemel Hempstead, Herts.

S. and B. "Dermic" Oiler

DESIGNED for the controlled and accurate lubrication of any small or intricate working parts, the "Dermic" oiler can also be used as a grease or flux gun. It can be loaded with any oil up to XL consistency. Similar in size and action to a hypodermic syringe, it is particularly useful for clock and watch lubrication. The oil is fed down a needle tube and if the cleaning wire is inserted into it, the flow of oil will be restricted, the wire acting as a stylus, feeding the minutest drop of oil required for watch pivots, etc.



S. and B. "Dermic" oiler

When using as a grease or flux gun the needle is dispensed with as the bore is too small to force it through; soldering fluid, however, may be fed through the needle. The "Dermic" is also very efficient for injecting fluid into wormholes in woodwork. Spare needle tubes are available; standard 9d. each, and extra long 1/- each, and a packet of six spare leather washers costs 6d. The "Dermic" oiler costs 4/11, and is manufactured by S. and B. Productions, South Norwood, London, S.E.25.

Steam Traction Engine Preservation Association Publications

TWO small booklets entitled "Burrel Two Seven O Four" and "Doble" E24 "Essex to Norfolk by Steam Car" have been written, edited and published by A. T. Phœnix, who is founder of the Steam Traction Engine Preservation Association, Thetford, England. The first of these is a collection of humorous short stories dealing with the now almost extinct steam engine fraternity. The second is an account of a journey by the American-built "Doble" steam car, with an authentic description of the car, some humorous incidents and photographs taken en route. The price of these books is 1s. 9d. each, or 2s. post free from the address given.

Electronic and Radio Equipment

MESSRS. CLYDESDALE SUPPLY CO., LTD., have sent us their two latest catalogues, one containing a list of ex-service items and the other being a supplementary list of radio and television components. These two books will shortly be produced as one. Both catalogues are arranged alphabetically and contain a vast diversity of equipment with widely different applications in the fields of electronics, radio and television. The items listed range from small things such as control knobs and resistors at a few pence each to complete ex-R.A.F. transmitter and receiver units costing several pounds and include such things as television aerials, morse practice kits, electric motors, plugs and sockets, switches, capacitors, gramophone pick-ups, wireless books, loudspeakers and many other components too numerous to mention. The price of the ex-service catalogue, and its radio and television supplement is 1s. 6d., and it may be obtained from Clydesdale Supply Co., Ltd., 2, Bridge Street, Glasgow, C.5.

Club Reports

Ramsgate and District Model Club

AN "At Home" will be held at the above club's premises from September 21st to 26th inclusive, from 6 p.m. to 10 p.m. daily and from 3 p.m. to 10 p.m. on the Saturday.

Guests are invited from local patrons, modellers, etc., on special days, leaving Tuesday and Friday evenings open to anyone who would care to come and see over the club, and to view the demonstration of its activities including a display of members' models.

On the Saturday it is hoped that any club or society interested will pay us a mass visit, and secretaries of some that are interested are asked to contact the club first so that arrangements can be made to make their visit pleasurable.

During the past year the Ramsgate Model Club has made good progress. Membership has increased and several promising juniors are "coming along."

During the summer months the workshop is open on Friday evenings *only* from 7 p.m. to 9 p.m. Visitors are always cordially welcomed at the club in Princes Street, off Queen Street, Ramsgate.—Hon. Sec., E. CHURCH, 14, St. Mildred's Avenue, Ramsgate.

Port Talbot, Neath and District Society of Model Engineers

THERE was a good attendance at the fifth annual general meeting of the above society which was held in the Club Room, Melyn Works, Neath, on Friday, April 10th, 1953. The balance-sheet for the year ended revealed a very satisfactory credit balance on the year's working. Thanks were accorded to the Auditors, Mr. E. J. Williams and Mr. J. V. Roberts, and the following Officers for 1953-4 were elected. Chairman, Mr. J. Thomas; Vice-Chairman, Mr. A. Hiscock; Treasurer, Mr. D. H. Jennings; Secretary, Mr. D. Elwyn Evans; Committee, Mr. S. Morse, H. Tudgay, E. J. Williams.

The third annual dinner was held at the Castle Hotel, Neath, on Thursday, March 19th, 1953. A good number of members and their womenfolk were present, and we were honoured by the presence of our President, Major J. L. M. Bevan, and Mr. A. R. Harris, Hon. Solicitor, and a very enjoyable evening was spent.—Hon. Sec., D. Elwyn Evans, Bronelwyn, 6, Beechwood Avenue, Neath, Glam. Tel. 726.

Birmingham Society of Model Engineers, Ltd.

AT the A.G.M. of the above society, held on March 18th, Mr. J. E. Guy was elected hon. secretary in place of Mr. R. Phillips who resigned. The following dates have been fixed as part of our summer programme :—

June 6th—Public Day.

June 13th-14th—West Midland Federation Rally.

June 28th—Social Day.

July 4th—Public Day.

July 19th—Visit from St. Mellans and "0" Gauge Day.

August 1st—Public Day.

August 15th-16th—Loco trials.

September 5th-6th—National Rally.

The National Rally has been fixed for early September, therefore will all clubs please make a note of these days, as this annual event is a rally of live steamers on quite a large scale.—Hon. Sec., J. E. Guy, 21, Penwood Road, Bordesley Green East, Birmingham, 9.

READERS' SALES AND WANTS

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

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

SKILLED INSPECTORS wanted by large Brighton firm; must be experienced in general machine shop work and capable of making decisions. Apply Box No. 105, c/o PRACTICAL MECHANICS.

FOR SALE

HOUSE SERVICE METERS, credit and prepayment; available from stock. Universal Electrical, 221, City Road, London, E.C.1.

COMPRESSOR EQUIPMENT, Miscellaneous Items; catalogue, 1½d. Pryce, 157, Malden Road, Cheam.

COMPRESSORS for sale, 3 CFM, 180lbs. sq. in., on metal base, with driving wheel and receiver, price £3; ¼ h.p. Heavy Duty Motors, price £3; carriage forward. Wheelhouse, 1, The Grove, Isleworth. (Phone: Hounslow 7558.)

TRANSFORMERS, for trains, welding, low voltage lighting, battery chargers, etc.; all transformers fitted with "earth protection" screen, "play safe." Write or phone your requirements to F. W. Whitworth, A.M.Brit.I.R.E., Model Dept., Express Winding Co., 333, London Road, Mitcham. (MIT. 2128.)

SYNCHRONOUS CLOCK MOTORS, 230v. A.C. S/Ph 50c., 12/6 each, plus 1/- postage. Universal Electrical, 217, City Road, London, E.C.1.

NUTS, BOLTS, SCREWS, Rivets, Washers and hundreds of other items for model engineers and handymen. Send now for free list. Whiston, New Mills, Stockport.

REJUVENATE your Water Softener; New Zeolite, 2/3 lb.; 10lbs. post paid. C. G. Nelson, 118, Anchorway Rd., Coventry.

AIR RECEIVERS, 24in. x 12in. x 150lbs., £7; 15in. x 12in., £2; Moisture Filters, 7/6; Safety Valves, 8/6. C. G. Nelson, 118, Anchorway Rd., Coventry.

AMAZING DEVICE, cuts perfect discs, wheels, etc., to 12in. diameter, with any circular saw, 10/6; p.pd.; sample 6in. mahogany disc, photo, details, 1/6. Below:—

HOW TO RE-WIND and Service Electric Motors, Generators. Complete Practical Book only 3/-; p.pd. Below:—

HOW TO MAKE IT BOOKS: Whittling in Wood; Inlay Pictures, Marquetry; American Action Toys; 21 Lovely Lamps; 3/- each; p.pd. Below:—

BUILD YOUR OWN PHOTO Equipment, 12 designs in two books. Enlargers, printers, dryers, timers, etc., 6/-; p.pd. Below:—

40 POWER TOOLS You Can Make from scrap, pipe fittings, etc. This amazing book of plans for circular saws, lathes, band-saws, jigsaws, planes, tapping attachment, jigs, etc., has sold 250,000 copies, and is a "must" for every home workshop, 12/6 only; p.pd. Below:—

AMERICAN BOAT BUILDERS Annual: 28 boat plans, 8-22ft., and other helpful articles, 7/6; p.pd. Below:—

CAR BODY REPAIRING. Complete A B C course; illustrated; 7/6; p.pd.; lists free. A.P.S. (P), Sedgeford, Norfolk.

SMALL DENTIST'S SYRINGES, beautifully made all metal instruments by leading makers. All parts heavily plated, and machined from solid. Smooth positive action. Lapped piston and cylinder. Piston rod calibrated 0-30. Ideal for precision lubrication without mess, and many other purposes. Complete with 6 strong hardened steel needles, in plated metal case with hinged lid and fastener. Ex-Ministry, new, unused. Worth ££££s. Our price 9/6, post 6d. K. W. Logan, Westalley, Hitchin, Herts.

"CONSTRUCT Your Own Refrigerator." This book, written by a refrigeration engineer, is profusely illustrated with drawings and photographs and tells you, not only how to construct a Cabinet or Built-in Refrigerator, but illustrates many that have been built by amateurs and are operating satisfactorily; 3/6, post free. Obtainable direct from author and publisher. Robert C. Scutt, Refrigeration Engineer, 52, Hadley Way, London, N.21.

"PICADOR" ROTOSAW. Portable circular saw attachment for your electric drill fitted with 4in. circular saw blade, adjustable fence to cut up to 1in. in depth, ideal for wood, plastic, or soft metals; 33/-, each, post paid. Lambs-wool polishing Bonnets, 5in., 4/3 each; Rubber Backing Discs, 5in., complete with key, 4/6 each; Abrasive Discs, 5in., 6 assorted grades, 2/-. Send 2½d. for lists of Saw spindles. Vee Pulleys and Belts. Plummer Blocks, etc. Sawyers, Ltd., St. Sepulchre Gate, Doncaster.

NEW!!! Real chromium-plated Mouldings; also Plastic Veneered Board in colours, marble and wood finishes; send 1/- P.O. for actual samples and catalogue. L. J. Plastics, Galleywood, Essex.

CELLULOSE, Synthetic, Stoving Paints. Spraying Handbook, 3/6; lists free. Leonard Brooks, Ltd., 75, Oak Road, Harold Wood, Romford.

RING TYPE OFFICE BINDERS, 14in. x 10in., 2/6; Red Rubber Sheeting, 4½in. wide, 50-yard rolls, 5/-; Air Pressure Tubing, ¼in. bore, 10 yards, 12/6; Red Rubber Tubing, ⅛in. bore, 100ft., 15/-; Perforated Metal Sheets, 35in. x 24in., 1/16in. and 3/16in. holes, 4/-; Wire Net Sheets, 28in. x 10in., 3 mesh per 1in., galvanised, 2/-, 25 for 30/-; carriage extra. Batley & Co., Gorsey Works, Stockport.

POWER FILING Circular Sheffield Steel Files; suitable use own lathe, motor, quickly file all materials; everlasting wear, 2in. diameter, drilled ¼in., 5/16in., ⅜in.; cash with order; 5/6, post free. Dept. P.M., Metrodent, 78, John William Street, Huddersfield.

ELECTRIC MOTORS, B.T.H. 230/240, ¼ h.p., 1,425 r.p.m.; new and unused; £5/5/- each. Miniature 12 or 24v. Motors, A.C./D.C.; ideal for models, etc.; size 2½in. long x 2in. x 1¾in. New Twin 40w. Ballast Units, no starter required; all voltages, 200/250 supplied; 25/-; requires holders and lamps only to complete; Single 40w. Units, S/H 17/6; Holders, 2/6 each; Starters, 2/6 each; 24v. Vent Axia Fans, new, 45/- each; Crompton Parkinson Chlorinator Pumps, 220v., 230v., A.C., ¼ h.p.; little used; £10. Harringay Photographic and Electrical Supplies, Ltd., 423, Green Lanes, N.4. (Tel.: MOU. 2054.)

HEYWOOD COMPRESSORS, 1¼in. x 1¼in. bore and stroke, as new, 35/-; Oil and Water Traps with 0-150lb. pressure gauge, drain and male outlets, new and unused, 22/6; ex-Aircraft ditto without pressure gauge, 12/6; Heavy Gear Pumps, 25/-; Radial Piston Hydraulic Pumps, high pressure type, 25/-; small Precision Hydraulic Pumps, up to 1,850lbs. pressure, 25/-; Diaphragm Pumps for can operation, 10/-; Pesco Fuel Pumps, with carbon seals, a super job, new and unused, 25/-; Rotary Blowers or vacuum pumps, 25/-; 1,600 va. Transformers, 40/110 sec., 30/-; 12v. 2 amp. ditto, 15/-; 14/20v. at 20 amp., 40/-. All 230v. input. Motorised Reduction Units, ideal for sack hoists or door operators, 230v., motor final rev. 5 r.p.m. with baseplate and shaft on standards, electrical switches, etc., 90/-; lift 10 cwt. 244, Marton Road, Middlesbrough.

ELECTRIC WELDING PLANT, used and unused, for sale; s.a.e. for lists. Hermsworth, Townley & Co., 1, Brook Road, Manchester, 14.

COLLARO AUTO RECORD PLAYER unit, 10-12in.; perfect; £5. 86, Luton Road, Harpenden, Herts.

WIND GENERATORS, Plants, Propellers, Dynamos, etc. (s.a.e., brochure). Jamielite, Midtaphouse, Liskeard, Cornwall.

TRY MELNOR CLOCK OIL. You can oil your own clock with our instructions, given free with every bottle; price 1/6. Below.

BARGAINS.—Quantity of reconditioned Clocks for sale; Timepieces, Alarms, wood and metal, 30 hour, 8 day; special price for quantity; also other types in stock; Strikes, Mantle, etc.; state requirements. For sample Clock send 15/-; money refunded within 7 days if not satisfied. Below.

SPECIAL. Silver Plate Polish, will not harm the most delicate silver, gives lasting lustre; per bottle 1/9. Each of the above obtainable from: Melnor Horological Dept., 32/2, Waterloo Road, Nottingham.

B.T.H. Motorised Dust Extractor unit, £15, one-third cost; 8/1 Worm Reduction Gears with vee pulley, £1 each, posted. Bellangers, 306, Holloway Road, London, N.7.

CHARGERS, 1 amp. for 6 or 12v. batterys; strong moisture-proof construction; satisfaction or money back. 39/6, Cooper, 10, Fowler Street, Nechells, Birmingham, 7.

EXPOSURE METER PHOTO-CELLS, 40 x 22 mm., 7/3; all sizes in stock; Exposure Meter Kits; s.a.e. details. G. R. Products, 22, Runnymead Avenue, Bristol, 4.

HEATER TRANSFORMERS, input 230v., 50 cy., output 6.5v., 0.5A, 3/10 each; post 8d. Clearing over 300 various transformers. Let us know your requirements; s.a.e.; all ex-Gov. The Radio Services, Lower Bullingham, Hereford.

TOOL and Materials Catalogue, free to all sending s.a.e.; materials now free of restrictions. Kennions, 2, Railway Place, Hertford.

FOR SALE, brand new 3½in. SC Cromwell Lathe, 5in. bed, 19in. centres. Write for details. Box No. 104, c/o PRACTICAL MECHANICS.

A.C. TRANSFORMERS for model railways, 2¼a., 16/-; Rectifiers, 16/-; Selenium Rectifiers, FW, 24v., 6a., £2; 12v., 6a., 24/-; s.a.e. for bargains list. Lawrence, 134a, Cranley Gardens, N.10.

PAINT LINING made easy with the Rolls Paint Liner, a precision tool, not a brush; will paint straight or curved lines in any desired position. Tool supplied with 3 heads for 1/16-3/32 or ⅛ lines, 27/6 each, post paid. Hogley Bros., Sowgate Lane, Ferrybridge, Knottingley, Yorks.

1,000 CHEAP RADIO VALVES, components, etc. List. Selsyn Repeater Motors, 6/-; P.K. Self-tapping Screws, 100 assorted, 3/3; Compressors, Tanks, etc. Rogers, 2, Matlock Avenue, Southport.

"PERSPEX," clear, coloured, sizes cut, also Corrugated; Plastics, Aluminium, Asbestos, Mouldings. Henry Moat & Son, Ltd., Atom Works, Newcastle, 1.

AIRCRAFT SURPLUS, Flexible Drive, 48in. long, brass unions each end, outer casing ⅝in. dia., 10/6 each. Also Nuts, Bolts, etc. S.A.E. for list. Hulse & Goddard, Buxworth, Stockport.

LENS WORKERS: Supplies of Abrasives. Lists available. Mason & Gantlett Limited, 3, Orford Place, Norwich.

SAW BENCHES, 7in. £4/15/-, 8in. £5/10/-; Combination Lathes, £10; Planers, £9/10/-; Motors, Spindles. Send 4d. stamp for complete illustrated booklet. H.P. available. James Inns (Engineers), Marshall Street, Nottingham.

PERSPEX for all purposes, clear or coloured, dials, discs, engraving. Denny, 15, Netherwood Road, W.14. (SHE. 1426, 5152.)

MODEL DEALERS

SHIPS IN BOTTLES.—The constructional kit that tells you how to make them; build for pleasure or for profits; kits 6/- ea. from Hobbies Ltd., and model shops, Cooper-Craft Ltd., The Bridewell, Norwich.

HORNBY DUBLO CONVERSIONS, Duchess, Gressley 2-rail scale, 52/6, 3-rail scale, 42/6; Tankers 2-rail, 42/6, 3-rail, 32/6. Sheffield Electrical Model Engineers, Shalesmoor, Sheffield.

LONDON. — Robson's Hackney's Model Shop, 149-151, Morning Lane, E.9. (Tel.: AMHerst 2989.)

ATTENBOROUGH Model Railway. Model railway specialists; finest in the Midlands: Agents for and stockists of many well-known firms. Why not ask for a copy of our A.M.R. Chronicle? The latest information regarding our stock, 1/-, post free. 82, Arkwright Street, Nottingham, and 64, Narborough Road, Leicester.

BUD MORGAN, The Model Specialist, 22, Castle Arcade, Cardiff. (Telephone: Cardiff 29065.) Model Aircraft, Trix, Tri-ang, Graham Farish, Model Railways and Galleons; first-class mail order service. Send for my 1953 price list, price 3d.

HOBBIES LTD. have over 50 years' experience of catering for the needs of modellers, handymen and home craftsmen. Branches at 78a, New Oxford Street, London, and in Birmingham, Glasgow, Manchester, Leeds, Sheffield, Hull, Southampton and Bristol. Head Office, Dereham, Norfolk.

MODEL-MAKERS and Mechanics! Here is the simple-to-operate Blow-lamp for all soldering jobs; the Britinol Self-acting Spirit Blow-lamp; price 7/-, or 6d. extra post and packing, direct from Bi-Metals (Britinol) Ltd., Balfour Mews, Bridge Rd., London, N.9. Illustrated list s.a.e.

SMOKE UNITS.—Transform your O gauge into smoker; suit all "Hornby," "Lowke" tube and those with removable fronts; slight modification required; suit model electric launches, steamers, ensures photographic realism; safe; clean; exciting; each unit guaranteed 15 minutes; 3/- dozen. Jackson, 51, Northcourt Road, Worthing, Sussex.

HOBBIES

HOBBYISTS, handicraft workers send 6d. stamps for our illustrated catalogue, "Perspex" Jewelcraft, Flowercraft, etc. Newing & Co., 96, Grove Vale, London, S.E.22.

TOY CASTING MOULDS, soldiers, sailors, airmen, animals, etc., catalogue, 3d. Moulds for Plastic-work, plaques, ornaments and Coronation souvenirs. Moulds from 3/6 ea.; catalogue, 9d.; s.a.e. for list. F. W. Nuthall, 69, St. Marks Road, Hanwell, London, W.7.

DOLLS HOUSE FITTINGS and Papers; Wooden and Metal Toy Wheels (trade supplied); illustrated brochure; s.a.e. Jasons, 135, Nags Head Road, Enfield, Middlesex.

INTERESTED IN MONEY MAKING? Our handicraft catalogue will give you a profitable hobby. Perhaps you saw our stand at the Daily Mail Exhibition; we've some wonderful hobbies: Jewellery making, Marquetry, Moulding, Plastics, Shellcraft, etc. etc. Our super 10in. x 8in. Catalogue (price 1/-) will make your leisure profitable. Rawson's Craft Shop (P.M.), 3, Westcombe Hill, London, S.E. 10.

WANTED

"PRACTICAL MECHANICS," June, 1940 required. Phillip Bartlett, 37, Finchley Avenue, Chelmsford, Essex.

WOODWORKING

TYLER Spiral Hacksaw Blades cut in any direction at conventional hacksaw speed without turning the work. 10in. Hacksaw Blades 4d. each from leading tool dealers. Write to Spiral Saws, Ltd., Trading Estate, Slough, for details.

MAHOGANY PLYWOOD, any parcel £1 delivered c.w.o.; following new: 5 at 11¼ x 66 x ⅛in.; 6 at 23 x 20 x ⅛in.; 12 at 14 x 26 x ⅛in.; 14 at 12 x 27 x ⅛in.; 14 at 14 x 23 x ⅛in.; 20 at 14 x 17 x ⅛in.; 16 at 60 x 5 x ⅛in.; 20 at 42 x 5¼ x ⅛in.; 6 at 14 x 23 x ⅜in.; 8 at 66 x 5¼ x ⅜in.; 12 at 66 x 4 x ⅜in.; 6 at 78 x 9 x 3/16in. Small Mixed Sizes, £1 ½ cwt. Following one side slightly gluestained: 5 at 41 x 20 x 3/16in.; 7 at 23 x 23 x 3/16in. M. Leader (1920), Gosford Street, Middlesbrough.

(Continued on next page)

(Continued from previous page).

MYBLO Ball-bearing Circular Saw-bench, 18in. x 13in. rise and fall table, ripp, and mitre fences, riving knife and guard, 9in. and 6in. saws, grooving cutters, sanding plate and discs, ½ h.p., 230v., A.C., single-phase ball-bearing motor, pulley and endless V-belt; all brand new; £25/10/-. P. Blood & Co., Wolseley Bridge, near Stafford.

PLYWOOD, 3/16in. Finnish Birch, very clean, sanded stock; 4 sheets, 30in. x 30in., 18/-; carriage paid. Stamps for lists of mouldings, plywood and complete woodworkers' supplies. Sawyers, Ltd., St. Sepulchre Gate, Doncaster.

REFILL YOUR OWN BALL PEN
KOLOID REFILL KIT
POST FREE 3/6 PER OUTFIT
COMPLETE WITH ILLUSTRATED INSTRUCTIONS AND TOOL
Contains Ink for 12-15 Refills | Blue, Violet, Red, Green.
G. H. HOLMES,
67, Brunswick Park Road, London, N.11.

DRAWING COMPASSES.—Ex-R.A.F., ideal schools, 3/6 each, post 4d.; 30/- per doz., post 1/2.

ROTARY POWER UNITS in smart black metal cases. Input 24 volts, output 250 volts at 50 m/a. and 6.5 volts at 2½ amp. These will also run in reverse from 250-volt D.C. mains, and be suitable for chargers or models, etc. Complete with all smoothing and suppression components; a bargain. 15/- each, plus 2/- p. & p.

ROTARY POWER UNITS as above, but 12-volt input. These are ideal for a 6- or 12-volt supply for a car radio, in fact many are in use as such. Also useful as 6- or 12-volt supply for Electric Shavers, etc. Price 20/-, plus 2/- p. & p.

CAMERA MOTORS.—Ref. No. 14A/988 R.A.F., 24 volts, make ideal low-volt motor for sewing machine, models, research, etc., 20/- each, post 1/6.

AMPLIFIERS.—1134A. Less valves, contains Key switch, transformers in neat wood box, 7/6 each, post 2/-. Many of these units are in use as intercomm. and pick-up amplifiers.

CONDENSERS.—Large Size. 15 mfd. 1,000 volts, 7/6 each, post 1/6; 60/- doz., carriage 5/6.

HIGH VOLTAGE CONDENSERS.—.01 at 7,000 volts and .02 at 12,000 volts, 1/6 each, post 1½d.

BRITMAC PANEL MOUNTING SWITCHES.—15 amp. single pole for back panel mounting, suitable fires, power control, new, 2/6 each, post 6d.; 21/- doz. to clear, post 2/-.

FLEXIBLE DRIVES.—Used, good condition, about ten feet long, many uses, 7/6 each, post 2/-.

UNIVERSAL COUPLERS for mechanical transmission, will drive at an angle, sizes 1¼in. to 2in., takes 3/16in. to ¼in. rod, 1/9 each, post 3d.; 18/- doz., post 9d.

SMALL ELECTRIC MOTOR KITS.—Set of parts to make model motor for low-volt operation, complete with instructions, 4/- each, post 4d.

ELECTRICAL TEMPERATURE GAUGES.—ENGINE OIL or Radiator, Gauges only, 3/6 each, post 6d.

FUSE UNIT.—Neat black bakelite box with four glass fuses and two spare in lid, the best job for low tension wiring, caravans, house-boats, motor-cars, etc., new, 3/6 each, post 6d.; 36/- doz., post 2/-.

JEFFERY H. DAKIN
13, CHURCH RD., EDGBASTON, BIRMINGHAM, 15.

HANDYMEN.—New Timber, sound, seasoned, selected, thicknessed, neatly bundled. Send for list. ½in. x 1in., 11/3; ½in. x 2in., 20/3; ¾in. x 2in., 25/-; ¾in. x 3in., 39/9; 1in. x 1in., 19/9; 1in. x 3in., 52/9; 1in. x 4in., 72/-; Glazing Bar, 55/-; Weatherboards, 32/6; all per 100ft. run; good lengths; immediate delivery; minimum order 20/-; c.w.o.; carriage paid. Generous Sample Bundle 15/-. Blacknell (Dept. 75), Farnborough, Hants. (Phone: 106.)

WATCHMAKERS

INTERCHANGEABLE Watch Parts, Balance Staffs, Winding Stems, Centre Wheels, complete Balance Assemblies, Hands, Buttons, Mainsprings, Tools; send for lists. H. S. Walsh, 28, Anerley Station Road, London, S.E.20.

GET YOUR TOOLS, Materials and Spare Parts from Western Watch Supplies Ltd., 17, Yorke St., Wrexham. Send 6d. for lists.

WATCH Repairers and Experimenters; 5 English Lever Movements from gold and silver cases, take 15/- the 5; 5 Swiss Lever Movements, 15/- the 5; 5 Geneva Movements, 10/- the 5; 5 beautiful 3/4 plate English Lever Movements from expensive watches, 30/- the 5; 5 Centre Second Chronograph Movements, from £50 watches, 50/- the 5; postage please. MERKELS, Jewellers, Grey Street, Newcastle-upon-Tyne.

INTERCHANGEABLE Watch Parts: Staffs, 1/-; Stems, 9d.; Buttons, 5d.; other material quoted for; make and cal. no. or movement required. Every description repairs undertaken. J. H. Young & Son, Wholesalers, 133, London Road, Chippenham, Wilts.

WATCHMAKERS' SCREWDRIVERS, high tensile blades, swivel top; set of 5 graduated sizes, in fitted box, 5/- post paid. Sawyers, Ltd., St. Sepulchre Gate, Doncaster.

DRAWING SERVICES

BARGAINS in Drawing Instrument Sets and Slide-rulers. Send for our catalogue now. Box No. 102, c/o PRACTICAL MECHANICS.

ELECTRICAL

BRAND NEW Brooks ½ h.p. Motors, ball-bearing, 230v, A.C., single-phase, 50 cycles, 2,800 r.p.m.; ideal for driving woodworking machines, grinders, etc.; latest type in maker's sealed box; £8/15/-; carriage paid. P. Blood & Co., Wolseley Bridge, near Stafford.

FLUORESCENT LIGHTING.—Control Kits for 18in., 2ft., 3ft., 4ft. tubes, 24/-, post free; Instant-starting Models, 34/-. Dynalite Electrical (M), 38, Stevedale Road, Welling, Kent.

PHOTOGRAPHY

ENLARGER and Camera Bellows supplied; also fitted. Beers, St. Cuthbert's Road, Derby.

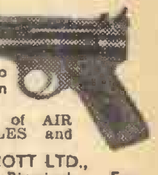
MISCELLANEOUS

BUILD YOUR OWN REFRIGERATOR, all components available at reasonable prices. Frigidaire flowing cold units, £5; small units, Kelvinator, etc., £4; ¼ h.p. heavy duty Motors, £3; Chrome Cabinet fittings, new, £1; money back guarantee; s.a.e. for list and schematic diagram. Wheelhouse, 1, The Grove, Isleworth, Middx. (Phone: Hounslow 7558.)

1,100 FORMULAS for model-makers, engineers, handymen, etc., 3/9. P. M. Ashdown, 3, Raynham Terrace, Edmonton, N.18.

BOOKLETS "How to use ex-Gov. Lenses and Prisms," Nos. 1 and 2 price 2/6 ea.; ex-Gov. Optical lists free for s.a.e. H. English, Rayleigh Road, Hutton, Brentwood, Essex.

WEBLEY AIR PISTOLS
Marvellously accurate for target practice.
No licence required to purchase for use on enclosed premises.
Write for Catalogue of AIR PISTOLS, AIR RIFLES and Accessories.



WEBLEY & SCOTT LTD.,
106, Weaman Street, Birmingham Eng.

BRAND NEW BOXFORD LATHES FOR ONLY £24.17.6 DEPOSIT
NEW MODEL C.S.B. 18in. between centres. MOTORISED COMPLETE. (Cash Price £95.17.6) ORDER NOW! to secure delivery without delay, as we anticipate a waiting list soon for these popular lathes. Telephone GULliver 6006 during the week for any Saturday appointment. Monday-Friday hours: 10—5.30. When enquiring for machine tools, please state **YOUR** requirements—machine, maker, model, motorisation, etc. Similar Terms. Immediate Delivery for Myfords, Acorn, Senior Granvilles, etc. Also Bandsaws, Drilling Machines, Sawbenches OF ALL MAKES.
Regd. Offices: RENTWELD, 94, Camden Road, London, N.W.1. Demonstrations: 4, Jeffreys Place, London, N.W.1.

CHEMISTRY APPARATUS
Send 2½d. stamp for
COMPLETE PRICE LIST

Booklets:
"Experiments" 10½d.
"Formulas" 10½d.
"Home Chemistry" 2/3
Post Paid.
BECK (Scientific Dept. A) **60 HIGH STREET, Stoke Newington, London, N.16**

PLASTICS
sold; Perspex sheets and offcuts in stock, large quantities of clear and coloured, Acetate sheets and rods, Catalin rods, etc.
Please send your inquiries to:
MULTITEX LIMITED
10-11, Archer Street, London, W.1
Tel.: GERrard 9520 and 5728

IMPETUS Precision PLANERS
Circular safety type cutter-head High quality tempered steel knives. Tables mounted on machined inclined ways. Ground table-surfaces. Fences adjustable to 45 deg.
4 in. MODEL, **£9.10.0**
Motorised, £18.10.0. 6 in. MODEL £28.10.0. Motorised £41.0.0. *Send for Catalogues of other 'Impetus' Products.*
JOHN P. M. S. STEEL, Dept. 80, BINGLEY, YORKS.
Phone: BINGLEY 3551 (4 lines).

Amateur Radio Enthusiasts
THE INCOMPARABLE
GLOBE-KING
SINGLE VALVE S.W. RECEIVER
● WORLD-WIDE RANGE 11-100 METRES ● CRYSTAL-CLEAR NOISE-FREE RECEPTION ● ELECTRICAL BAND-SPREAD TUNING ● EXTREMELY LOW RUNNING COSTS
Catalogue Free. Stamp for postage.
JOHNSONS (RADIO)
46, FRIAR STREET, WORCESTER

Make Money
SILK SCREENING AT HOME
This amazing equipment **PRINTS** anything, **COLOURS** anything, **DECORATES** anything, and **DUPLICATES**. 6 colours in bold design or small type. 16in. x 12in. **BARGAIN OF THE YEAR OFFER** of printer complete with all supplies, inks, etc. and **FREE 10/- COURSE** (7 days approval) post pd. **47/6**
A.P.S., SEDGEFORD, NORFOLK

REP
Matched pair Dual Range High Gain TRF Coils, with 3 valve Mains and Battery Circuits. Price 8/- pair (post 4d.).
(Trade supplied)

REP LIMITED
33, Much Park St., Coventry.

INVENTORS
and those interested in inventions write for particulars of **GADGET INVENTORS CLUB, 44, Otto Terrace, Sunderland**

L. ROBINSON & CO. (GILLINGHAM) LTD.
London Chambers, GILLINGHAM, KENT. Phone 5282

EX-AIR MINISTRY WRAY PRISMATIC BINOCULARS.—6 x 30 eyepiece focusing. Guaranteed condition. Complete in web case. Price, **£7/19/6.** Leather case, if desired, **10/-** extra.

EX-GOVT. BARR & STROUD RANGEFINDERS.—80 cm. base. Original cost approx. £100. Perfect condition. **£12.**

EX-R.A.F. MARCHING COMPASSES.—As new, **£1/1/-.**

OPTICAL KIT for simple Astronomical Telescope, **9/6.**

EPISCOPE LENS with constructional diagram, **12/6.**

ACHROMATIC OBJECT GLASSES.—Diam. 50 mm., focal length 5 in. Perfect. **10/6** each.

New illustrated Catalogue on request. Satisfaction guaranteed on all purchases or full refund.

CHARLES FRANK,
67-73, SALTMARKET, GLASGOW, C.1
Phone: BELL 2106-7

Drill it Faster WITH A

MASON MASTER

You can drill all building materials in half the time with a Mason Master, the drill that ensures effortless and rapid penetration and gives a longer life without wear or abrasion.

See your dealer about Grinding Wheels for re-sharpening Mason Master drills. 3in. diameter wheel, mounted on ¼in. diameter steel arbor. Can be fitted into any portable electric drill.

MASO-PLUGS and "Mason Master" Drill Bits form an ideal combination. Easily cut with penknife. Moisture and chemical proof. Send for free samples.

Write for illustrated booklet 'L' *Agents in most countries*

JOHN M. PERKINS & SMITH LTD.
LONDON ROAD WORKS, BRAUNSTON, NEAR RUGBY, ENGLAND
Telephone: Braunston 238 *Telegrams: Drills, Braunston, Rugby*

QUERIES and ENQUIRIES

A stamped, addressed envelope, three penny stamps, 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.

Carbon Arc Welding

I HAVE a mains transformer, 230v. to 8, 12 or 14v. 60 amps., and have been experimenting with carbon arc welding and brazing of thin sheet steel, one cable connected to the work and the other to the carbon-holder, the size of the carbon being about ⅝in. dia., filed to a point. My trouble is I cannot get the metal to run together using copper-coated welding rod 1/16in. dia. Please tell me if any flux is required for welding. I have tried borax for brazing with little success. Also, what is the best voltage to use ?—Geo. Baxter (Derbyshire).

FOR contact welding with a carbon electrode we advise using an uncoated pointed electrode of about 9.5 mm diameter and painting of the workpieces with flux. Place the electrode in contact with the workpiece and allow the work to warm up before moving the electrode along the line of the joint. Press the bronze filler rod firmly into the point where the electrode touches the work until the filler rod starts to melt. Allow the molten bronze to form a pool at the base of the electrode and then move the electrode along the joint.

We suggest that you use a flux made of G.K. powder, prepared for use by mixing it with water to form a paste. This powder is obtained from Messrs. G. K. Lancaster (London), Ltd., of 50, George Street, Croydon. For butt welding of sheet metal of 0.005in. to 0.022in. thick we would suggest about 3.5 volts, and for butt welds in sheet metal from 0.022in. to 0.06in. thick you could use 3 to 6 volts. For overlap welding of sheet metal of 0.005in. to 0.022in. thick we suggest about 3.5 volts, with 4 to 6 volts for overlap welding of sheet metal 0.022in. to 0.06in. thick. As your transformer voltage is rather high it may be an advantage to use a rather long projection of the electrode from the electrode holder to absorb some of the voltage.

Cementing Microscopic Fluid Mounts to Glass Slides

IS cellulose acetate a suitable material for making cells for microscopic fluid mounts ? How can rings of this material be fixed to glass slides ? What would be the best method of cementing to cover glass under these conditions ? —S. B. Carter (Maida Vale, W.9).

IT is usual to use rings of glass for making fluid mounts for microscopical specimens, and the cement employed is either Canada balsam, Japan gold size or, if permissible on the score of colour, Brunswick black. Everything depends upon the fluid with which the cells are to be filled. If it must be one of the essential oils, then use either Japan gold size or a water solvent glue.

Turpentine will mix with and thin out Japan gold size, but when it has become perfectly dry and hard it cannot be redissolved with turpentine. If the specimen is to be immersed in methylated or similar spirits, or water, then Canada balsam may be used as a cement.

Cellulose acetate sheet is not permanent or rigid ; it both darkens in colour and shrinks with the passage of time. The only way in which rings of this material could be stuck to the slide would be to immerse the whole slip of glass in a cellulose solution —celluloid dissolved in amyl acetate—let it dry off and then stick the ring down with a celluloid cement. The cover glass would have to be similarly treated. Alternatively, for use for a limited time only, the acetate sheet could be used for both bottom sheet and cover, using no glass at all. Cementing difficulties would then disappear. If there is to be no cover glass, and the fluid, say, oil of cedar wood, is to serve for oil immersion, then I suggest cementing with glue.

Readers are asked to note that we have discontinued our electrical query service. Replies that appear in these pages from time to time are old ones and are published as being of general interest. Will readers requiring information on other subjects please be as brief as possible with their enquiries.

In any case, you would be well advised to abandon the acetate material entirely and purchase rings of glass from dealers in microscopic materials.

Ice-box Insulator

WISHING to make an ice-box, suitable for use in a trailer caravan, I should be pleased of your advice as to the best insulator to use.—D. S. Marshall (Brighton, 7).

WE suggest that you use any of the following materials for thermal insulation : Slab Cork, Fibre Glass, Stilbat, Slag Wool, Cellotex.

The thermal conductivity of each of these substances is about .3 B.T.U.s per sq. ft. per inch thickness per deg. F. temperature difference.

Naturally, 2in. thickness will provide greater efficiency than 1in., but in view of the space difficulty which must necessarily be present in a caravan, you will probably be satisfied with results from the use of 1in.

Greenhouse Heating

AT present I have fitted into my 8ft. x 6ft. greenhouse 14ft. of 2in. galvanized conduit pipe with a return of ⅜in. copper pipe. This is heated with a small (6in. x 4in. x 4in.) boiler which has clamped to its side a smoothing iron element (500 watts). Sufficient heat is given out from the boiler but it continually burns out the element. Can you tell me how I can rectify this ? Or can you inform me what other method I could use to obtain the heat electrically ? —F. Wallwork (Cumberland).

THE resistance element is evidently burning out on account of the comparatively low thermal conductivity of the boiler shell and/or because the element is not making close and tight contact with a smooth and clean surface on the boiler. As a result all the heat generated in the element is not being transmitted to the boiler but is causing the element to operate at an excessive temperature. Better results would be obtained by using an immersion heater in the boiler.

However, we consider that more efficient results would be obtained by using tubular heaters. These could conveniently be in 2ft. lengths each of 70 watts loading, the various sections being connected in parallel. For use on a 230-volt supply each 70-watt element could consist of 40ft. of 38 s.w.g. nickel-chrome resistance wire wound on a strip of asbestos.

Repairing Prismatic Compass

I HAVE an old oil-filled prismatic compass (Barkers Patent, Pat. No. 296FF, 1910). I recently stripped it down to renew the luminous portions and to remove air bubbles, and refilled it with meths. This had disastrous effects on the celluloid card, which ceased to exist. Could you tell me if I could get another card, also if I can get a suitable liquid to refill it ? If I cannot repair mine, could you inform me where I could buy prismatic compasses ?—P. G. Adam (Rutland).

YOUR difficulty will be to obtain a compass card of the exact dimensions for your existing instrument, and you may have to make an extensive search. The following firms, however, are actual makers of mariners' and prismatic compasses, or else are suppliers and retailers. From one of these sources you will probably (with a little luck) be able to obtain suitable replacements : Messrs. Henry Hughes and Son, Ltd., 59, Fenchurch Street, London, E.C.3 ; Messrs. F. M. Vowell, 13, John Street, London, E.C.3 ; Messrs. A. W. Gamage and Co., Ltd., Holborn, London, E.C.1 ; Maritime Stores, Ltd., 8 and 10, Lancelots Hey, Liverpool ; Messrs. James Morton, Ltd., Villier Street South, Sunderland ; Messrs. J. J. Wilson and Son, 19, Hudson Road, Sunderland ; Messrs. James Bedington and Son, Ltd., 16, Loveday Street, Birmingham ; Messrs. C. Baker, 244, High Holborn, London, W.C.1 ; Messrs.

Broadhurst, Clarkson and Co., Ltd., 62, Farringdon Road, London, E.C.1; Messrs. Philip Harris and Co., Ltd., Birmingham.

The fluids used for filling compasses of this type vary considerably in composition. Strictly speaking, any reasonably inert fluid will be suitable, and often enough the liquid used is a plain rectified spirit, but such was obviously unsuitable for your compass. The compass card was certainly not a celluloid one, for celluloid is not soluble in spirit. We can only suggest, in the present circumstances, without having seen the instrument in question, that you use carbon tetrachloride for refilling the compass, this liquid being fairly heavy and being completely non-inflammable.

Prismatic compasses can be obtained from most of the firms above listed.

Ultra-violet Experiments

RECENTLY I purchased some 12-volt ultra-violet bulbs and have been told that many interesting experiments can be carried out with them. For example, some materials glow in the dark when an ultra-violet light is brought near them. Please would you send me details of some easily obtainable materials that could be used for the above-mentioned experiments?—M. H. Hall (E.17).

YOU will see some interesting phenomena if you will irradiate the following substances on ground glass surfaces with your ultra-violet bulb. You are aware, of course, that you must shield your own and observers' eyes from direct illumination from the rays by screening the light with a sheet of aluminium foil.

Moisten some anthracene with water and brush this paste on surface of ground glass, to which surface most of it will adhere.

I would suggest cutting your glass into a dozen or so squares and mounting these squares, after treatment, on to a wooden screen. Treat each of the surfaces (after preliminary treatment with either anthracene as above stated *or* alumina). Both should be ground into a finely divided state. Having prepared your separate glass discs put on to each separately a selection from the following compounds:

Substance	Colour
Resin (abetic acid)	Green
Acetanilide	Bluish violet
Aspirin, add Alumina ...	Brilliant blue
Alizarine	Yellow
Ambergris	Blue
Ammon. acetate	Blue
Anthraquinone	Orange
Fluorescene	Blue
Mangan. stearate	Rose
Mangan. resinate	Violet
Naphthalene sulphonated dyes	Various
Rhodamine	Red orange

Rough Cast Wall Finish

THE walls of my house have a rough cast finish. Unfortunately, the rough casting has broken away in some places and I would like your advice on the best and quickest way to repair it.—H. J. Meyer (W.7.)

THERE are two methods from which you can choose in order to obtain a rough cast finish:

(1) Pebble dash.

(2) Rough cast.

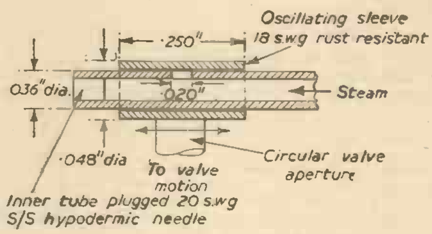
Your material should be ⅜in. graded shingle to begin with.

Method (1) is to mix your cement and sand to right consistency and to make this mixture "fat" by the addition of a little lime. You then take a scoop and scatter the shingle from a wet bowl or pail in which the shingle is kept wet by partial immersion in water. The lime renders the surface swollen or "fat," and you will find the stones that strike the prepared surface will stick. You want to acquire a sweeping action so as not to bunch the shingle.

Method (2) is to prepare your wall with the cement/sand mixture and to mix your shingle with lime. Cast this lime-washed shingle at the prepared wall surface and again the bulk will stick.

Model Sleeve Valve

I HAVE been trying to construct the following sleeve valve for a working scale model.

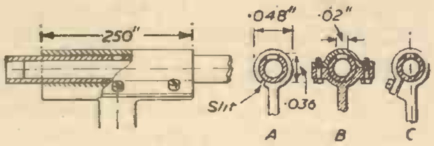


Proposed sleeve valve.

The inside bore of the hypodermic needles from which the valve is to be made is very rough, though the outside dimensions are true within .001in.

My main difficulty has been fitting the oscillating sleeve to the plugged needle, it must be steam-tight when closed yet free enough to be moved by the valve gear. Can you suggest a way of doing the job?—Kenneth Young (Liverpool, 15.)

IT would appear that the only way in which such a sleeve valve can be made and fitted will be to split it and lap it on to the hypodermic needle and the enclosed sketches show three ways in which the sleeve can be so split. Cross-section A is the most simple and perhaps the best. The sleeve is first drilled to a diameter of .035in. then split on one side, close up to the valve gear attachment, using a fine jeweller's or watch-maker's slitting saw. The sleeve can then be pushed on to the needle and ground in, or lapped, to fit with the finest liquid metal polish.



Three ways of splitting the sleeve.

Section B shows the sleeve made in two halves, but this scheme is not so good as C where the sleeve is split, after drilling exactly as A, but is fitted with three watch-maker's screws, which, by careful adjustment, can be utilised both to put extra pressure on the lapping medium and to take up wear should re-lapping be necessary.

In lapping, the motion of the sleeve on the needle should be both longitudinal and circular, a combination of the two.

Restoring Wellington Boots

CAN one restore the high gloss on rubber Wellington boots which were originally a glossy black? Does a suitable paint or varnish exist which would give a patent leather appearance?—R. J. Greenaway (Dorset).

THERE are quite a number of proprietary so-called patent-leather "restorers," the majority of which are of doubtful efficacy. They consist mostly of cellulose paints. You can make one up for yourself for trial quite readily by dissolving scrap celluloid in a mixture of approximately equal volumes of amyl acetate and acetone and then by adding 5 or 6 drops of either castor oil or butyl phthalate to it to act as a plasticiser for the varnish. This varnish is merely painted on with a soft brush to the leather, after thoroughly degreasing with soap and warm water.

If you want a manufactured varnish for the same purpose, you could use methyl methacrylate solution, which is now being produced by Vinyl Products, Ltd., Butter Hill, Carshalton, Surrey, but we think that your own cellulose solution, made as above, will be quite satisfactory. It could be applied by spraying or brushing, and would take about 12 hours to dry thoroughly. If it is softened too much by the castor oil plasticiser, it will always present a tacky surface. Hence, too much of the plasticiser must not be used. Tyre paints, rubber paints and similar preparations would give a dull surface.

The very simplest treatment which you could apply would be a thin coat of ordinary shellac varnish, made by dissolving shellac in about an equal quantity of warm methylated spirit. This varnish is thick but, with care, it can be brushed out to a thin, glossy film.

Removing Stamp-pad Ink

PLEASE tell me how I can remove violet stamp-pad ink from white paper.—F. R. Bull (Macclesfield).

MOST of the two-solution ink-removers will remove violet stamp-pad ink from paper quite readily. You can make such an ink-remover in the following way:

Grind up 1 teaspoonful of chloride of lime with about 2 teaspoonsful of *cold* water. Store this in a well-stoppered bottle and, preferably, in the dark. In another well-stoppered bottle, place 1 part of glacial acetic acid and 4 parts of water. To remove the ink markings, rub or brush over them a quantity of the chloride of lime solution, avoiding wetting the paper so far as possible. Then brush or rub over the same paper a little of the dilute acetic acid solution. The ink markings will quickly turn yellow, discolour and fade away. The process can be repeated until every trace of the ink markings has vanished. Whenever possible, it is always advisable finally to wash the paper in running water.

Information Sought

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

Mr. E. G. Skoines, of Exeter, writes: I would like to hear from any reader who has fitted a pedal-driven paddle drive for a small boat. I have one of the alloy aircraft tanks (the bomb-shaped kind which are used to give fighter 'planes extra range), which have been made into boats, canoes and motor-boats, but I would like to make a paddle-boat for river work. I have in mind a paddle on each side driven by cycle chain gearing suitably "mud-guarded."

Mr. R. C. O'Dell, of Bedford, writes: Please furnish me with details of a weathervane incorporating a figure working mechanically. A propeller drives a shaft to which is attached a figure of a man. As the propeller rotates, the shaft causes the man's arms to work, and it appears that the man is working the propeller.

CLYDESDALE

Bargains in Ex-Service Radio and Electronic Equipment

AIR POSITION INDICATOR UNIT. Mk. I Ref. 6B/248

Contains: 4 Rev. Counters with reset knobs, each reading 0-9999 Revs., also Small Selsyn Motor, Dial Lamp 24 v. 6 w., D.B.C. with holder, On/Off Toggle Switch, Push Switch, plus a host of gears and worm drives. Unit mounted on Die-cast Aluminium Frame with metal casing. Overall size, 12in. x 8in. x 6in.

ASK FOR NO. A/H913 **39/6** Each CARRIAGE PAID

MORSE PRACTICE BUZZER SET

Compact self-contained Morse practice set mounted on 6¾ x 6½ x ½in. base board. Requires 4½-volt battery for which clamps are provided: headphones can be used instead of audible note provided by fitted buzzer.

ASK FOR NO. A/E1X **7/11** Each POST 9d.

PLOTTER FIELD, MK. IV. Ref. OS 739A

A precision-made protractor unit, first-class condition, in soiled leather case, with carrying strap. Comprised two moving cross-arms with individual lock device. Cross-bearing scales marked 21-65 length, each 12⅞in., attached to two Protractor Scales 0-180 degrees, 9.5/16in., between centres (max.) will form any combination of internal angles, on two interlocked straight edge bases scaled 0-3500, fully extended a perfect 25in. length straight edge, closed 15⅝in. long, can be locked at any position. Case Dimensions: 16 x 5¼ x 2in.

ASK FOR NO. A/H864 **25/-** Each POST PAID

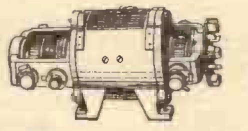
WE CARRY A FULL RANGE OF CYCLE ACCESSORIES — ENQUIRIES INVITED.

ROTARY CONVERTER (Type 1)

Input 24 v. D.C. Output 230 v. 150 watt A.C. Output terminated in 5 A. 3-pin socket. The unit is also complete with input leads. Complete in metal case with leather carrying strap.

ASK FOR NO. A/H914 **£5.19.6** CARR. PAID

MOTOR GENERATORS SUITABLE AS UNIVERSAL ELECTRIC MOTORS



For 200-250 volts, A.C. or D.C. Mains. By simple external wiring, full data supplied. New method gives better than 1/6 h.p., ideal for light bench work, a 1in. spindle is available (when fan is removed) for driving. Ex-R.A.F. Size: 11 x 5¼ x 5¼ ins.

Type 29. Ask for No. A/E880, **32/6** each.

Type 28. Ask for No. A/E880A, **32/6** each.

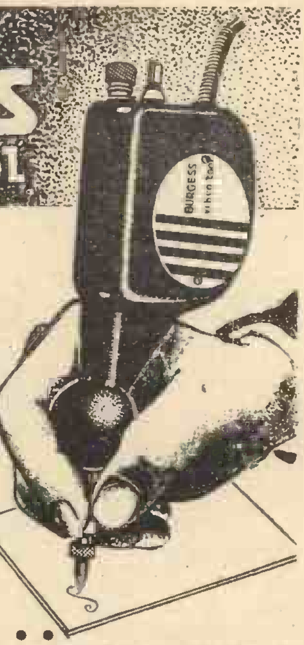
Type 30 (as illustrated). Ask for No. A/H488, 25/- each.

CARRIAGE PAID.

NEW CATALOGUE NO. 8D
Gives full details of ex-Service and other items. PRICE 1/6. (Credited on first purchase of 10/- value.)

Order direct from:—
CLYDESDALE SUPPLY CO. LTD. 2, BRIDGE STREET GLASGOW - C.5
Phone: South 2706/9 Branches in Scotland, England and Northern Ireland

the BURGESS vibro-tool



the ideal engraving tool for the handyman!

YOU will be really amazed by the Vibro-Tool—the power hand-tool that is as easy to handle as a pencil. With it you can write on steel, engrave jewellery, glass and plastics, tool leather, carve wood and cut stencils—and a host of other handicraft and workshop jobs . . . with speed and facility you never dreamed possible.

The V.250 Vibro-Tool complete with standard engraving point. **52/6**

Operating on the vibratory principle, the Vibro-Tool works off 200–250 volts, 50 cycle, A.C. supply. Just connect to any electric light socket or plug point.

Vibro-Tool De Luxe Kit **97/6**

Write for Brochure V.T.1 to: BURGESS PRODUCTS CO. LTD. (Vibro-Tool Dept.), HINCKLEY, LEICESTERSHIRE.

PRACTICAL BARGAINS

REAL TELEPHONE SETS.—Each a complete station with P.O. type handset, Morse Key and Buzzer. These sets work over LONG distances if necessary, on small dry battery. 65/- each. Postage 5/-.

TELEPHONE WIRE.—To connect your 'phone stations, Field type Don 3, as we supply to Army Signals. 55/- per mile. Carriage extra.

MORSE KEYS.—The totally enclosed R.A.F. "Torpedo" super-quality key. NEW. 4/6 each. Post 6d.

MICROPHONES.—Air Pilots Electro-Magnetic type 50 ohms with switch, lead and plug. NEW condition. 4/6 each. Post 6d.

ENGINE-DRIVEN GENERATORS. — 12v. 500 watt, at 50/- each. Carriage 2/6. 12v. 750 watt, at 50/- each. Carriage 2/6.

ALTERNATORS.—24v., 1,200 watt, at 35/- each. Carriage 2/6.

MAGSLIPS.—Transmitters 3-inch at 25/- each. Hunters 3-inch at 8/6 each. Post 1/-.

R.A.F. AERIAL WINCHES.—A reeling device with very many different applications. 3-position spring-loaded control handle, giving "Brake," "Free" and "Ratchet." With Electrical lead-in. NEW condition at 3/6 each. Post 1/-.

WIRING.—Standard new Electric Cable P.V.C. Single 1.044 at 18/6; 3.029 at 20/-; FLAT TWIN 1.044 at 37/6; 3.029 at 39/6; V.I.R. SINGLE 1.044 at 22/6; 3.029 at 29/6; FLAT TWIN 3.029 at 42/6; 7.029 at 57/6; all per 100 yds. Cables of all types T.R.S., V.I.R., P.V.C., Cellulose Lacquered over all, and Co-axial, in a wide range of sizes up to 37.103.

MAGNETIC RELAY UNIT.—5-Contact in beautiful mounting with 2 coils. NEW condition at 5/6 each. Post 6d.

WALKIE-TALKIE. — Transmitter/Receiver 58 (Canadian) 6-9 Mcs. NEW condition at £15 each.

LOUDSPEAKERS.—P.A. Twin Moulded Horn Parmeko Admiralty type. NEW condition at 75/- each. Post 5/-.

ALSO TELEPRINTER UNITS OF VARIOUS TYPES, VOICE FREQUENCY RINGERS, CARRIERS AND SMOOTHING UNITS.

R. GILFILLAN & CO. LTD.
52, SOUTH STREET, WORTHING, SUSSEX.
Telephone: Worthing 8719.
Telegrams: "GIL WORTHING."

GREATEST VALUE FOR MONEY *ever offered* HANDYMEN MODELMAKERS · HOME CONSTRUCTORS

Wolf Cub

HOME CONSTRUCTOR EQUIPMENT

Sold by all good Tool Dealers

You can start to build complete outfit for as little as **£5·19·6**

WRITE FOR FOLDER 'PROFITABLE PLEASURE'

WOLF ELECTRIC TOOLS LTD.
PIONEER WORKS, HANGER LANE, LONDON, W.5

Plastic Marble

KARLENITE—the entirely new Karlena artificial Stone for casting Bookends, Ashtrays, Wall-vases, Statuettes, etc. Sets rock hard with a scintillating crystalline structure like marble or alabaster for colour, veining, texture, density and hardness. It is enormously strong, highly resistant to heat, impervious to water. Natural "veining" can be simulated in any colour. A range of pigments is available for this purpose. Most attractive marble effect in models, plaques and statuary.

Make your own Elastomold

Rubber Moulds

ELASTOMOLD—high quality synthetic rubber for making flexible moulds which faithfully reproduce the most minute details of ornamentation and surface texture. ELASTOMOLD is permanent and ideal for repetition casting of plaques, bookends, ashtrays, and art models. Moulds can be taken from any type of material including Karlenite, wood, metal, plaster, cement, stone, glass, ivory. ELASTOMOLD has great dimensional stability, but flexes easily for the release of cast without damage to fine detail or undercuts. ELASTOMOLD is simple to use and fully recoverable.

Send for full details of this new, fascinating and profitable craft.

KARLENA ART STONE COMPANY LTD.,
PLASTICS 2.F. DIVISION,
KARLENA HOUSE, 270/272, OXFORD ROAD, MANCHESTER, 13

HERE'S VALUE!

NEW SMITH'S 8-DAY CLOCKS

Ex-R.A.F. Complete with TRIP Hands. Made to Air Min. specification. Model B. 2¼in. dial, in bakelite case. With 2¼in. base. (Worth Double.) *Post & Packing, 1/6.* **35/-**

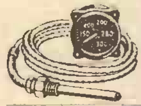
PLASTIC MALLETS

New and unused Ex.-W.D. Surplus. Ideal Tool for The Workshop. *Post and Packing 1/-.* **1/6**

NEW HAMMERS

Ball-peine Hammers. *Post and Packing 1/-.* **2/6**

NEW THERMOMETERS



Ex-Govt. 0-100 deg. C. 2¼in. dash-fitting, with approx. 20/40ft. tubing. Suitable for WATER or OIL. Union 2/6 extra. *Post and Packing 1/8.* **22/6**

PRESSURE STOVES

New British Army Paraffin Stove. Pressure pump flame adjuster. Folding metal arms give 10in. diameter. Spares kit. Very strong construction. Fitted metal container 9¼in. x 5in. Takes up little room in pocket or kit. Ideal for all purposes. *Post & Packing 1/3.* **25/-**

VOLTMETERS

Ex-Govt. Moving Coil, 0-20v., 2in. square dial. *Post & Packing 1/-.* **8/6**

USEFUL HAND SAWS

In finest quality cast steel. Ideal for all general purposes. Length 24in. Medium tooth blade. *Post and Packing 1/6.* **5/-**

NEW ILLUSTRATED CATALOGUE FREE.

PRIDE & CLARKE Ltd.
(Dept. P.M.) STOCKWELL ROAD, LONDON, S.W.9. *BRIxton 6251.*