HOW TO BUILD THE "FLYING FLEA"!

NEWNES

PRACTICAL MECHANICS

OCTOBER

6D.

Big Birthday Number!

VOL. III. No. 25
OCTOBER
1935

Practical Mechanics

Edited by F. J. CAMM

SUBSCRIPTION RATES :
Inland and Abroad, 7s. 6d. per annum
Canada - - 7s. per annum

Editorial and Advertisement Offices : "Practical Mechanics," George Newnes Ltd., Southampton Street, Strand, W.C.2.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

Notes, News and Views

A Flying "Bicycle"

THE first flight in a motorless aeroplane designed to be propelled by man power alone has recently been achieved. A German pilot, Herr Duennbeil, covered about 210 yards at Rebstock Aerodrome, near Frankfort-on-Main. He used a contrivance which enabled him to operate the propeller of his machine by pedalling. The flight was made about 3 ft. off the ground.

A Midget Glider

INVENTED and built by Mr. H. J. Penrose, test pilot of the Westland Aircraft Company, of Somerset, a midget glider recently made its first flight and stayed in the air one hour and twenty minutes. It has a wing span of only 30 ft.—about half that of many gliders.

Maps of New Guinea

TWENTY-FIVE million acres of New Guinea are to be surveyed by British aeroplanes, and from photographs taken, maps will be prepared.

An Invisible "Pedestrian Preserver"

THE above device may take its place among the devices used by the Ministry of Transport to promote road safety. Experiments are being conducted on the Kingston By-pass with an apparatus, worked by an invisible ray, which will cause the pedestrian to switch on the red traffic light as they approach the road crossing. The principle of the photo-electric cell has already been used extensively for burglar alarms, etc.

The New German Zeppelin

THE German airship, L.Z.129, the biggest airship ever built, will not be ready for launching until the end of November. The airship is 812½ ft. long and 135 ft. at her greatest diameter. She will have a crew of 35, and will carry 50 passengers and 10 tons of freight. The Zeppelin will be driven by four Diesel engines of an aggregate of 4,400 h.p. and will carry 130,000 lb. of fuel.

An Unlimited Electricity Supply

WE learn that a young Danish inventor has produced an ingenious device which will revolutionise the production of heat, light, and power for domestic and industrial purposes. The apparatus is amazingly simple and cheap, and once installed, the average home can be supplied with electric light and power at less than £1 a year. The invention consists of a series of metal plates and rods wired together in a metal container, which is placed in a tank of water and wired to electric points in other parts of the house.

Photographing Human Thought

BY using radio recording and amplifying apparatus, electrical impulses discharged by the human brain were photographed recently by Dr. E. D. Adrian, professor of the Royal Society, and Mr. B. Matthews of King's College. The impulses are believed to be due directly to thought waves in response to physical sensation as well as mental concentration itself.

A Foolproof Aeroplane

WE learn that an American inventor has produced a foolproof aeroplane. The fuselage is of all-metal construction and the seats, doors, etc., are designed similar to those of a modern motor car. It is powered with a 95-h.p. air-cooled Monasco engine, located at the stern end of the plane. It has a top speed of 110 m.p.h. and cruises at 95 m.p.h. with petrol consumption claimed at 13½ miles per gallon. The most interesting feature of the plane is that it is tailless.

The Smallest Submarine

MR. B. CONNAT has constructed a 10-ft. submarine, which has taken him three years to build. It is believed to be the tiniest practical submarine craft in existence.

Safety at Sea

PERILS at sea will be lessened by a new invention, now being produced by a Welsh shipbuilder. It consists of a rope net, with cork floats, which can be unrolled from the side of a ship, or floated alongside a ship in distress.

A New Bombing Plane

FRANCE'S newest bombing plane is capable of carrying 10 tons of high-explosive projectiles, and can travel 1,600 miles without a stop at 170 m.p.h.

A New Television System

IT is reported that L. Damas, a Belgian radio engineer, has invented a new system of television. The new system permits the transmission of image and sound on the same wavelength in complete synchronism. Moreover, it is said that Damas has succeeded in transmitting television images in natural colours.

A "Voice Searchlight"

A NEW loud speaker or what may be termed a giant "voice searchlight" has recently been made available for the U.S. Navy. It is so powerful that it can reproduce the human voice 1,000,000 times above normal strength and can project the sound in a "beam" over a distance of several miles. The sound as it leaves the loud speaker is 1,000 times as strong as the roar of Niagara Falls.

World's Largest Rectifying Valve

THE world's largest rectifying valve, recently demonstrated at Milwaukee, has an output of 1,000,000 watts at 25,000 volts D.C. It is capable of rectifying enough electrical energy to light every home in an average city of 65,000 people.

New London Subways

ONE of the City of London's most dangerous street crossings is expected to be replaced by pedestrian subways. These will connect five busy thoroughfares near Monument Station, at the London Bridge approach. The cost will be £25,000. Men have been working underground for months, coping with difficulties. They have had to divert 44,000 Post Office wires and a 24-in. gas main.

Fastest Train in Great Britain

THE Silver Jubilee, the specially built stream-lined express train which now performs the fastest long-distance run in Great Britain, will be a feature of the L.N.E.R. winter service, which started as from September 30th. It leaves Newcastle at 10 a.m. every week-day except Saturday, and, calling only at Darlington, covers the 268 miles to King's Cross in 4 hours at an average speed of 65 m.p.h. If an allowance is made for the stop at Darlington, the average speed is 70 m.p.h.

Bind Your Copies of "Practical Mechanics"

THE binding case for Volume II, complete with title page and index, is now ready and costs 3*s.* 6*d.* by post from the Publisher, George Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2. The index can be obtained separately if desired for 7*d.* post free. All readers should have their copies of Volume II bound, and thus be able easily to refer to the contents by means of the fully cross-referenced index.

How to Build the "FLYING FLEA"

The "Flying Flea," which has been successfully flown and demonstrated all over England by its designer, M. Mignet, is probably the first practicable attempt to provide the man in the street with an easy and cheap means of learning to fly and of building his own aeroplane. The "Flying Flea" may be built and flown by any home mechanic, and its total cost for engine and materials of about £75 brings it within the means of most. It is a safe machine for beginners for it has a low landing speed, a low cruising speed, and the construction does not call for a greater degree of skill nor of tool equipment than is possessed by most amateurs. Its span is only 13 ft. ! This first article deals with the construction of the fuselage. We shall be pleased to answer any questions which intending builders care to put to us.—Editor.

Full list of materials appears on page 7.

THE fuselage is constructed like a packing case. But since the plywood cannot be nailed on to itself, one has to interpose a lath of spruce in the angles as a means of receiving the nails, and these laths are glued over a large area on each surface. In this way, the sides of the plywood are united to each other, not by nails, which is not a solid form of construction, but by plenty of glue, which makes an efficient welded construction of wood.

These laths allow metalwork to be fixed to the angles of the box in places where plywood would only present a local and feeble resistance. These angles are nodes, or strong points, which are more or less irreducible in number and are firm bases for attachments. The laths at the rear end of the box prolong its solidity to the rear, and form a very strong triangulated pyramidal construction. At the risk of being a bit heavy, the fuselage is constructed in plywood 2 mm. thick.

The Glue

Make the glue ready for work in advance; for four hours in warm weather and for a whole day in winter, powdered glue and water are mixed in equal volumes, not heaped up, but measured exactly. Stir the glue with a wooden spatula. The mixture settles down into a smooth, viscous paste, about the consistency of thick oil. You do not need a brush.

Before you start to use it, test your wood. It must be sound and must not have any green colour, reminding you of worm-eaten stuff. Each lath and strip of wood, carefully chosen, is pinched in the vice at one end, and twisted lightly in the direction of its length. It ought not to break or crack. Examine it closely. The grain should be straight or very slightly slanting. Throw away any piece which has knots and/or splits in it.

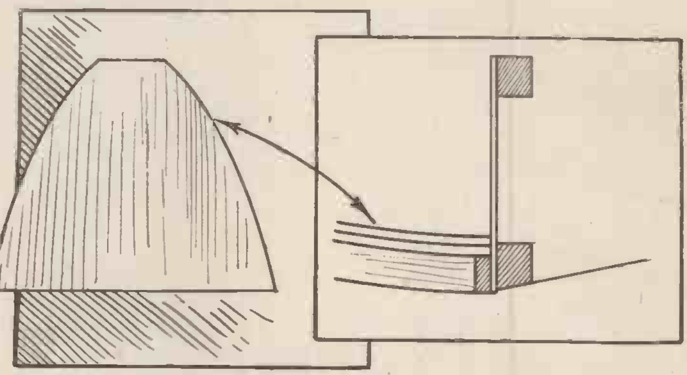


Fig. 3.—How the tongue is formed.

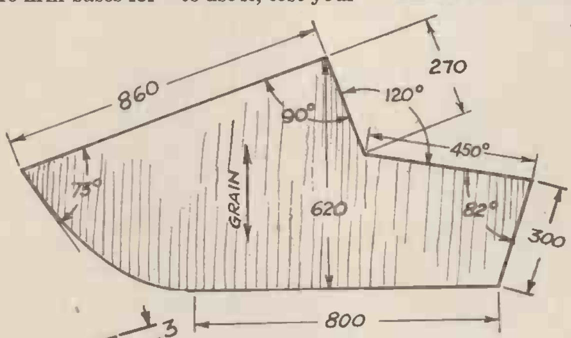


Fig. 1.—Details of the sides of the body.

The Body Sides

Draw out the first side on a piece of plywood 3 mm. thick, following the dimensions given in Fig. 1. The run of the grain is shown by arrows. All the dimensions are given in millimetres; mark out the angles with a protractor.

Cut out two sides exactly similar, with a fine saw.

One lath 2 metres 40 cm. long is nailed and glued in the position shown in Fig. 2.

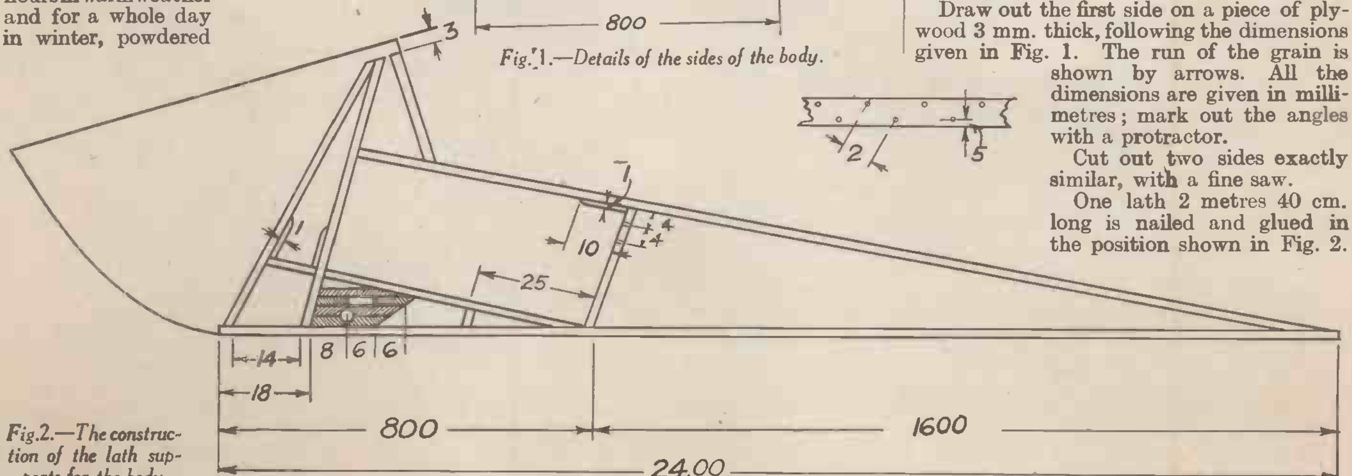


Fig. 2.—The construction of the lath supports for the body.

It extends beyond the body towards the rear for 1·6 metres. In order to glue it, proceed as follows:

Spread the glue on 800 mm. of the lath in such a way that after a minute the face of the wood is covered uniformly without any blank spaces. One nail at each end will keep it steady, and then nail it in zigzag fashion approximately every 20 mm. (see Fig. 2). After nailing it, the glue will ooze out along the edge. You can smooth it off when it is dry.

Proceed in the same manner with the other laths, which, as you see, leave 30 mm. spare along edge No. 1. Fix the other laths in the positions shown, and then the stops. The rear lath, before it is put in place, should be pierced with two holes at a

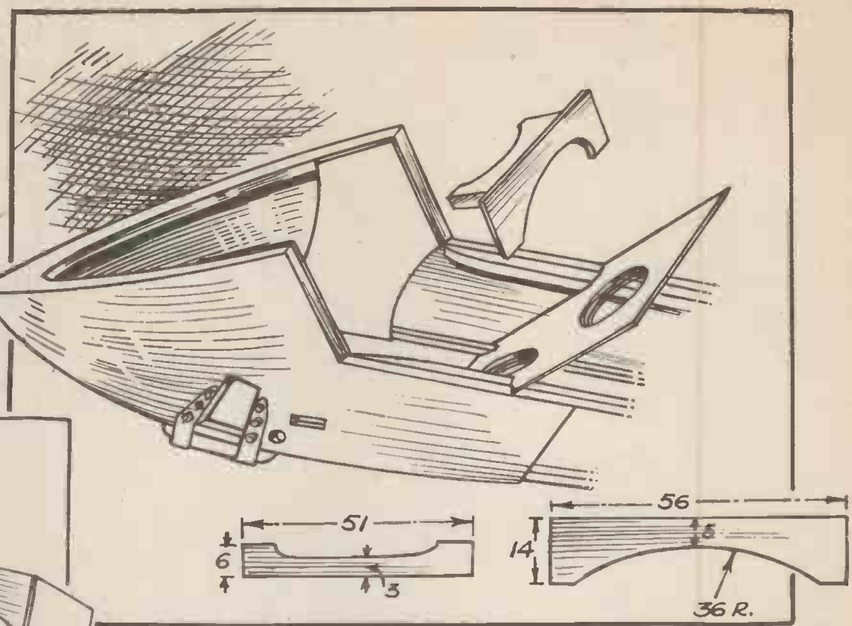


Fig. 5.—Showing further constructional details of the fuselage of the machine.

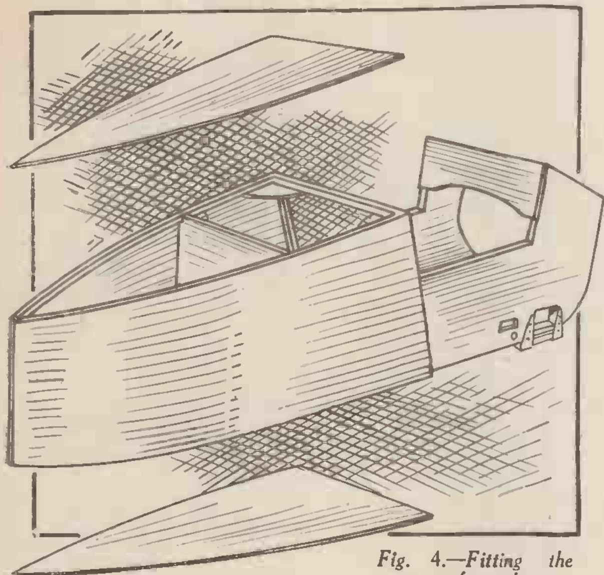


Fig. 4.—Fitting the parts to form the nose of the machine.

distance of 40 mm. These will receive, later on, the anchorages in the screwed rod of the harness. Take care that there is no empty space at the end of each lath.

Make the fillings (Fig. 2) with the ends of laths. With the point of a knife cut out the plywood sides opposite this empty space, where the pulley which takes the rudder cables is to be fitted. Cut out also the quadrilateral through which the axle will pass.

Cover all this assemblage with the panel (Fig. 7) in 3 mm. plywood. Prepare the other side exactly the same as the first, but in the reverse order.

It must be understood that where wood touches wood there is gluing and nailing.

From a piece of mild steel 1 mm. thick cut with shears two strips which, when folded, will clasp simply by gluing under the feet a skid (Fig. 12) in hard wood, such as oak, walnut or beech. The holes in these straps will be drilled beforehand on one side only. The other side will be drilled for receiving the bolts, after it is in place and solidly fixed by a binding or by a hand vice on the longeron. These bolts, in screwed rod, will fix as well the short strips which are inside the fuselage.

The skid and the straps are designed to reinforce the longeron when the axle strikes it after jolts. A block in hard wood is glued and screwed on the skid at an equal distance from the straps, to prevent the elastic shock absorber of the axle from slipping.

Glue the blocks —this last one made of hard wood— for bolting the metalwork

Fig. 6.—Showing the "Flying Flea" ready for flight.

Fig. 7.—The side panel.

for the wing bracing wires. The lath which serves as the reinforcement gets progressively thinner towards its end.

Joining the Sides

The two sides now have to be joined by the back of the pilot's seat, made of 3 mm. plywood as is shown in Fig. 13. The holes, reinforced with circles of plywood, give access to the luggage compartment. The holes and the plywood circles can be cut quite easily with a carpenter's compass, of which one arm has been ground to a knife edge. Any ironmonger's shop will provide one of these tools.

On the panel you should only place the bar and nail the sides in front of the laths. Then put on the crosspiece, making its edge bevelled and level with the underside of the longerons.

The short strips in front will then be joined by the panel (Fig. 8), cut out in such a way that the crossbar fits on to the block, and its crossbar on to the lower end of the short strips; thus, the crossbar and the ends of the short strips all come level with longerons. The height of the panel will be decided on the spot. Do not forget to reinforce the hole with a circle of plywood. File away anything which might obstruct the straps.

The short strips in the rear are also joined at their lower ends by a slat and double gussets. In the same way, the short strips are united by the panel with the crossbars. The slats are all on the same level, and serve to support the plank which forms the seat, of which the underneath view is shown in Fig. 10. This panel is fixed by 12 screws with round heads. It is double; that is to say, two thicknesses of 6 mm. are glued together under weights. There is no point in nailing it together.

Two strips connect the crossbars near the edges to the central hole in which the joy-stick works. At each end of these reinforcing strips use a wood screw with a washer.

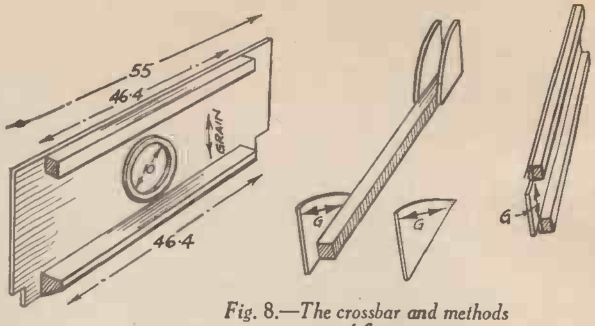


Fig. 8.—The crossbar and methods of fitting.

The Front Point

The lyre-shaped piece of wood will be cut out from a plank of 20 mm. of hard wood, as shown in the sketch Fig. 9.

Because of its sloping position to the fuselage it will be necessary to bevel off its outside faces in order to diminish the upper face. The arms of this piece of wood will be separated a distance of 550 mm. by adjusting the flat faces, and they will be joined underneath by a triangle of plywood which is glued to them; and again in the middle by the plank of hard wood of 40 mm., thinned down at the ends to 20 mm., well-fitted and held from underneath by the gussets, which are 6 mm. thick. All are fixed simply by gluing. This plank, later on reinforced by bolted metalwork, will support the motor.

Bevelling, adjusting, and fitting should be commenced with a plane and finished off with a large half-round file—a metal file bought and kept for this purpose. This file will be used only on wood. It is better than a wood rasp, and after the glue is dry the file eats into the wood just as well as a rasp, even if it hits up against some nails. The rasp or the plane would very soon be damaged if it struck projecting nails.

Enclose the two arms of the lyre between the bits of plywood (Fig. 9), gluing them together and nailing it in such a way that the two sides, when drawn together, go a little bit beyond the desired shape. Nail the plywood carefully all along the edge of the arms with one nail every 10 mm. Cut off the edges which go beyond the end of one lyre, and plane off the amount which extends above it. (This has been allowed for in Fig. 2 by using 30 mm. instead of 20 mm.) You now have a smooth joint which allows the whole to be covered by a triangular sheet of plywood.

From a plank of hard wood 20 mm. thick cut out a piece and nail it on to the panel, which is 6 mm. thick; this will join the two arms of the lyre and the laths.

Planking

Turn the skeleton upside down. Cut out the tongue at 20 mm. and fit it to the edge. Copy this fourteen times in plywood of 3 mm. thickness. Seven thicknesses glued together, one on top of the other along the edge, will make a longeron curved in two directions to which you can nail, one after the other, the two bits of 3-mm. plywood (Fig. 3). Put one on top of the other, and glue, which will make the planking of the cockpit.

The planking is supported at the rear with the batten adjusted in front of the panel. With a file, smooth off all the lower faces of the curved strips so that a piece of 3-ply 3 mm., curved in a triangular form, can be well glued everywhere from the point right up to the batten. This will make a part of the base of the fuselage.

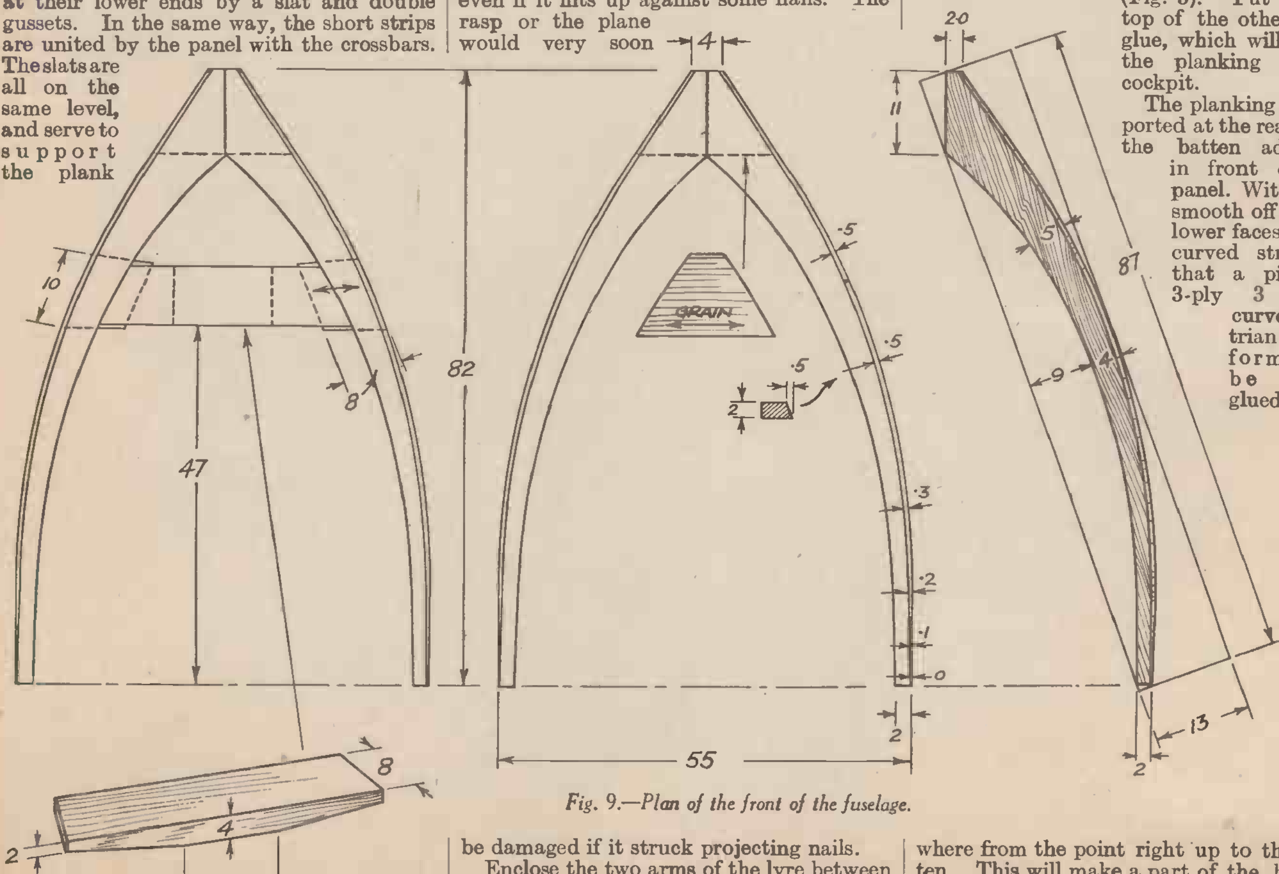


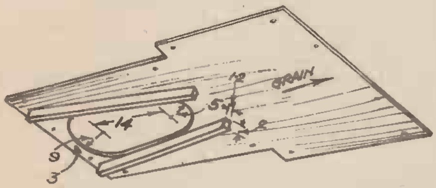
Fig. 9.—Plan of the front of the fuselage.

Now cover the lyre right up to the panel with plywood of 3 mm.

Rear Joints

Damp the longerons with a piece of rag soaked in water over one metre's length for ten minutes, starting from the rear point. Join them together in a point with a wood screw of 4 × 40, with a countersunk head, taking care to interpose at 440 mm. from the back a piece of 20 mm. × 20 mm. × 410 mm. Place into position the planking of the

Fig. 10.—Underneath view of seat platform.



tool chest, and also two stops of hard wood fixed by two screws of 4 mm. × 40 mm. with round heads, spaced at 40 mm., supported on the inside with plates of 3-ply of 3 mm. with the grain running vertical.

Cut out the two metal pieces in mild steel of 1 mm., which will be bent. One will do to fix to the rear points, by means of screws with round heads 4 mm. × 15 mm., and the other to the stern post made of hard wood 15 mm. × 40 mm. × 450 mm.

Place on the back piece the laths (Fig. 11), then the longerons, which are fixed on in front by two gussets, and joined together in the rear by a screw, with the crossbar of 410 mm. as for the lower point. The second piece of metalwork will join them on to the stern post.

During this work take care that the stern post is not out of line with the fuselage. Plane it and file it until it is exactly vertical with the fuselage. The upper crossbar is fixed on to the longerons by two gussets at 350 mm. from the bar.

In addition, this crossbar carries a piece of hard wood, screwed and glued. The whole is pierced with a hole of 7 mm. Carry on in a like manner with the cross-piece, which carries a piece pierced with two holes of 6 mm., spaced 40 mm. apart. Place in and glue into position the bulk-head furnished with laths. Bevel off with a file the plywood on the sides, following the shading so that you can apply over it, without getting the extra thickness, the plywood sides of the rear of the body, which will be at this spot similarly bevelled.

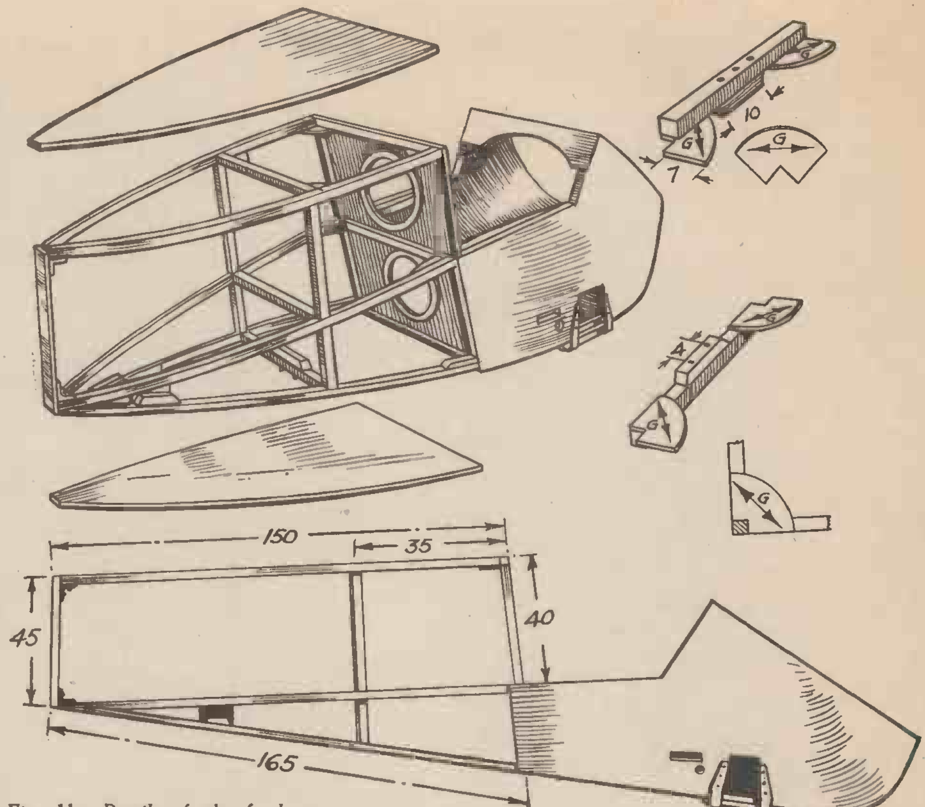
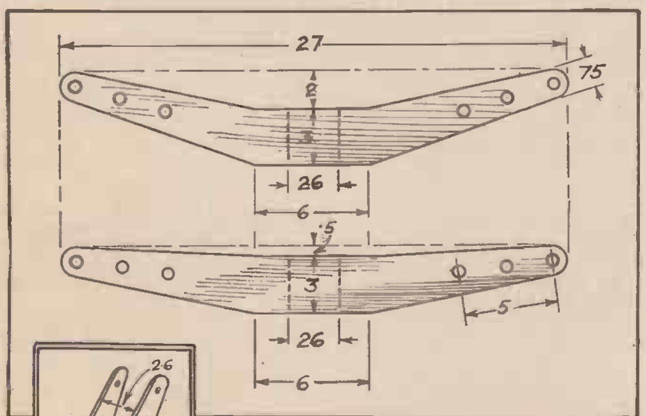


Fig. 11.—Details of the fuselage, showing the simple construction from 3-ply and laths.



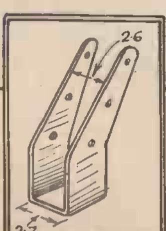


Fig. 12.—The skid and clip.

With the help of several nails apply a piece of 3-ply on each side. Mark it off, cut off, and nail it after having glued it everywhere. When you are gluing on the second panel, see that the stern post is still kept quite straight. After it is dry, finish off all the rough edges nicely with a plane or file. The construction then appears as in Fig. 11.

You can close up the box by the lid, which is pierced with a 7 mm. hole. Take the screws out of the rear blocks and mark their places exactly on the sides. Now place the bottom of the box into place and pierce with holes right up to the seat.

The piece of 3-mm. plywood which will form the base between the crossbars can be made ready, and will be placed in position later. The fuselage is now finished. It weighs 16 kilos.

The Landing Gear

The rear end of the longerons is joined by a metal strap, 2-mm. material, by three screwed rods (Fig. 14) of 5-mm. metal.

The pivot post of the rudder is of mild steel tubing. It turns freely with a play of 1 mm. in the metal strap which is closed by a little tube, 24-mm. material, fastened by a bolt. This tube is obtained by rolling in the vice a piece of material of 2 mm. around a rod of 6 mm.

The other end of the rudder post is inserted into a T, which carries the small axle for the wheels (Fig. 16). This T turns (with a play of 1 mm.) in an eye made from a piece of mild steel wire of 10 mm. diameter, heated to red heat and bent into an eye, or welded with the bar.

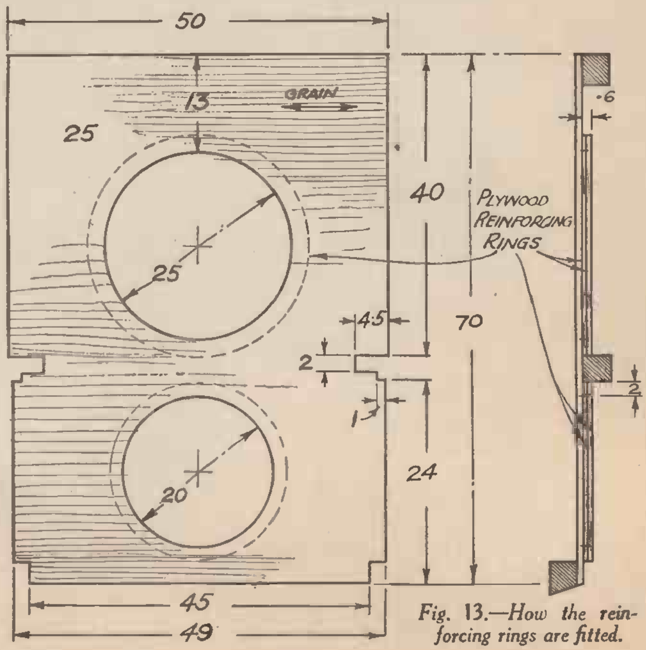


Fig. 13.—How the reinforcing rings are fitted.

The arms of this triangle are bent inwards, and the two ends, carefully aligned to one another, make the axle which works in the metal straps. These latter straps are placed against the holes of the bolts and marked off, taking great care that the rudder post is carefully aligned on the stern post. It is separated from the latter at the lower end by 40 mm. to 50 mm. and at the upper end by 10 mm. to 15 mm.

An opening cut in the sides gives access to the nuts of the bolts which fix a 2-mm. plate of steel on to the piece of hard wood. Little pieces of aluminium sheeting ·6 mm. in thickness, and some wood screws, close these openings.

The T holds the eye between metal and rubber washers, which are held from moving by the two bolts which join the T to the rudder post.

The rudder post is fastened to the rudder by the aid of four strips of 2-mm. metal which are bolted to it. At the spot where the bolts will pierce the rudder post, one will have strengthened it with a filling of hard wood, greased with wax or paraffin. The washers of metal and of rubber absorb the shock of the straps on the collar.

The metal strips are also fixed on to a tube of 24 mm. length by a bolt.

A rudder shock absorber of 12-mm. section, 500 mm. long, joins the rudder post to the base of the stern post, passes under a metal fitting, and is fixed by a plate and two big wood screws. The two ends of this shock absorber are pushed inside the fuselage through a 30-mm. hole cut in the bottom at a distance of 100 mm. from the stern post.

It is lightly stretched in such a manner that the weight of 30 kilos. placed on the fuselage begins to make the metal straps move.

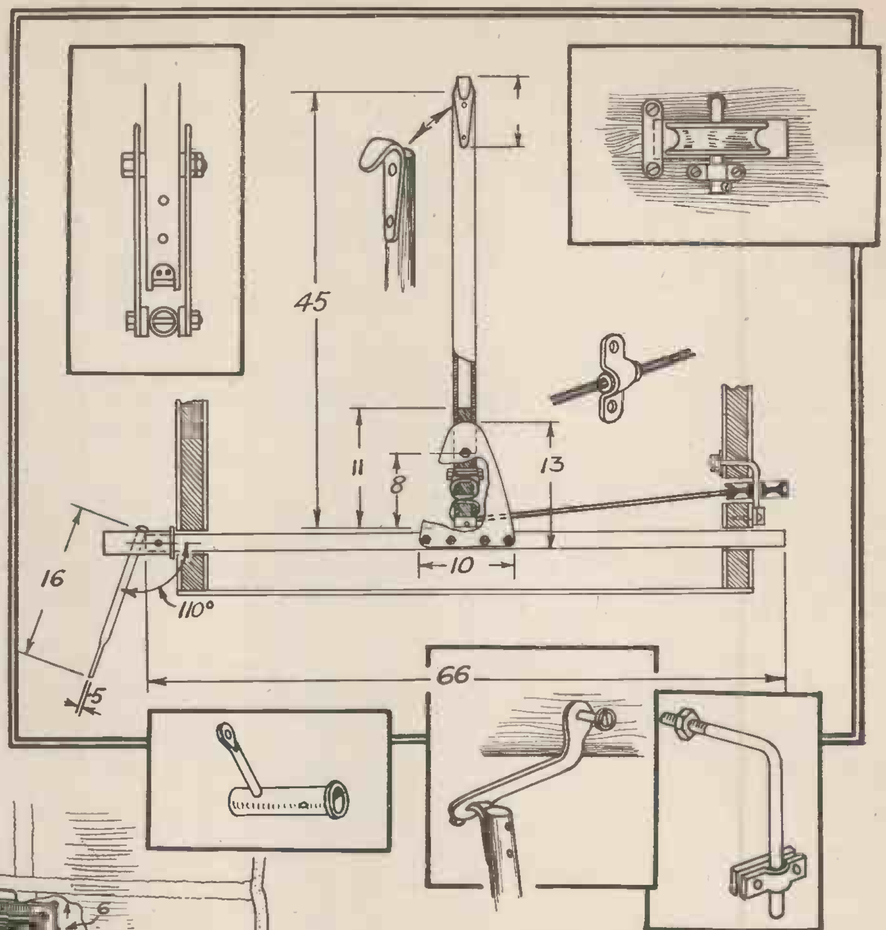


Fig. 15.—Constructional details of the stick control.

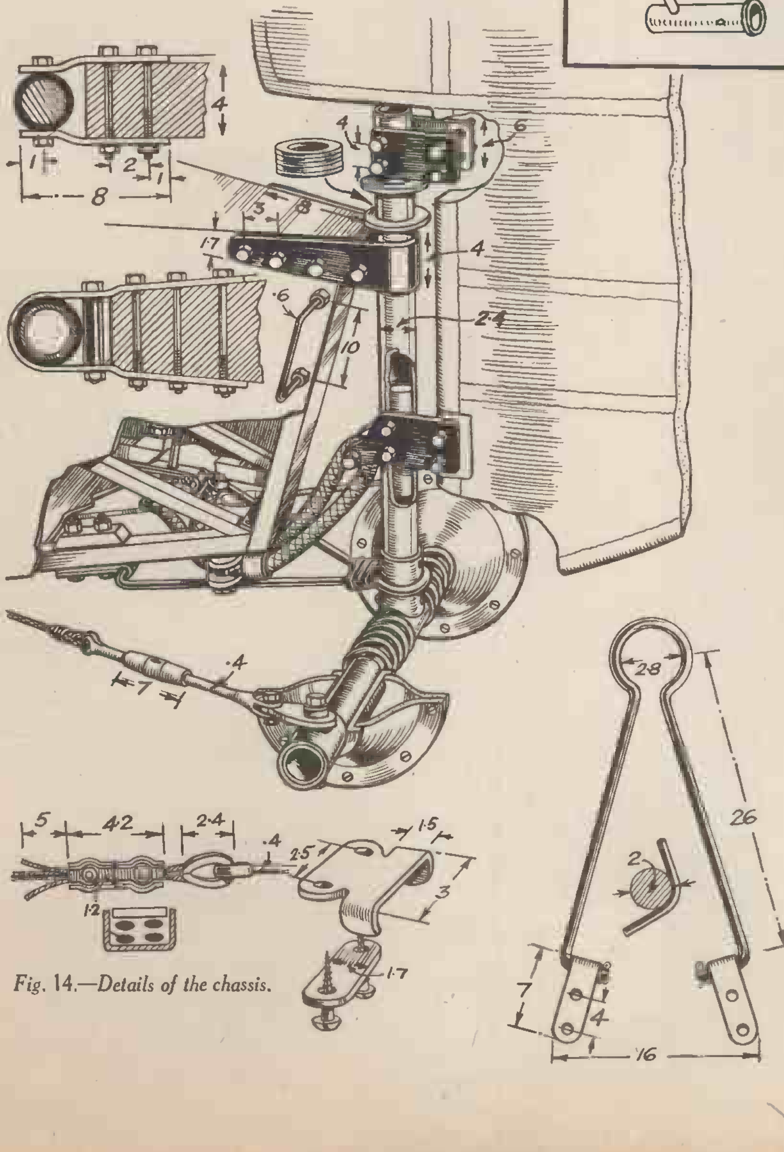


Fig. 14.—Details of the chassis.

Wheels

The rudder post of 24 mm. diameter, is pushed into the T of 24 mm. × 27 mm. section. Make this a good fit by smoothing up with a file and emery cloth the end of the tube; the fit should be a close one. The two bolts will keep the one from turning in the other.

The tube in 21 mm. × 24 mm. material is welded square on the tube.

Two rivets of 4 mm. fix the axle in the tube. These rivets will be flush with the tube.

The wheels are made out of two discs in 1·5 mm. material, which are embossed by a hammer, and joined along their circumference by twelve rivets of 4 mm., taking care that they are properly centred on the tube.

You can do this quite easily by hammering a sheet 200 mm. × 200 mm. on a piece of wood which has been hollowed out, using a round-faced hammer. After you have hammered out the material, you can then describe a circle.

The tube, with its ends slightly flared by hammering with little blows on the top of an anvil, goes through the middle of the wheel, and then one flares the other end in the same way. It would be a very good thing to weld all this together.

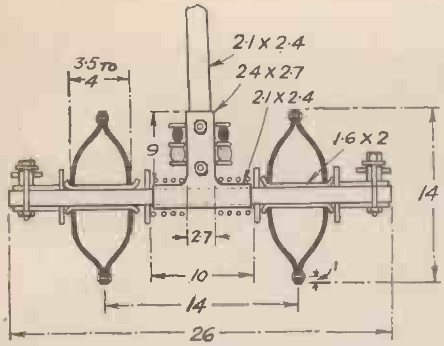


Fig. 16.—The rudder post and fixing.

A spring of eight turns in steel wire of 3 mm. is threaded on to the tube and capped by a washer next to the wheel. A sleeve is fixed level with the end of the axle by a 6-mm. bolt. This bolt goes through the little tube, which is 6 mm. high and 10 mm. in diameter, under the washer. This tube serves as an axis for the metal strap, to which one will attach the turnbuckle of the rudder cable.

All this mechanism may seem to you most complicated. It is clearly much more so than a simple wood skid fixed by two bolts, but how often would you break that ?

With wheels like these you will not worry about cross-wind take offs, and will take off correctly every time. You can avoid obstacles on the ground, and you can steer yourselves amongst the spectators who seem firmly rooted to it. That is the fruit of my experience, believe me. Sacrifice two days to realise this arrangement, which altogether weighs 2·5 kilos.

The hand grip in steel rod of 6 mm. bolted to the left-hand side of the stern post will enable you to lift the tail about without sticking your fingers into the covering of the rear wing or rudder.

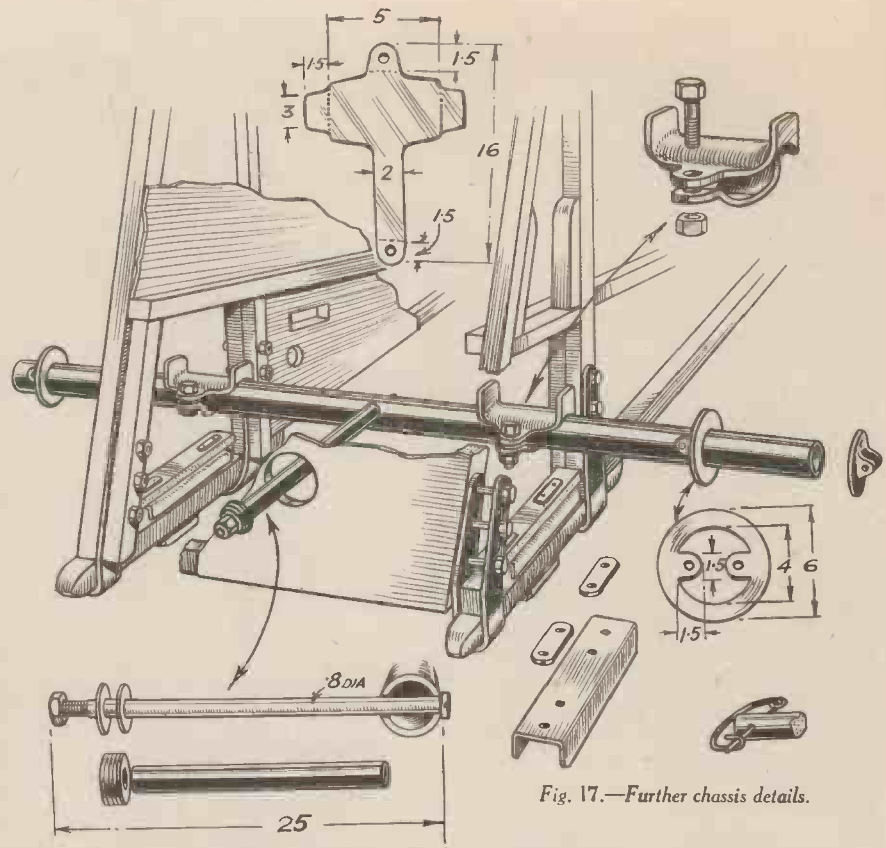


Fig. 17.—Further chassis details.

LIST OF MATERIALS

Materials should be o first-grade quality, but need not be special aviation materials, nor A.I.D. inspected. For example, steel tubing, bolts and nuts, and sheet steel for fittings are of good quality commercial mild steel, and not special high-tensile aviation specifications.

Plywood.

Birch or other good plywood of "superior" or "aviation" quality.

6 sheets 6 ft. × 3 ft. 3 mm. thick.
4 ,, 6 ,, × 3 ,, 1·5 mm. thick.

Laths.

Good quality spruce, straight grained, free from knots or shakes, capable of being twisted and bent, breaks with long fibres. You require:

6 lengths of 5 metres	15 mm. × 60 mm.	
(or 10 lengths of 3 metres 20cm.)	15 ,, × 60	,,
10 lengths of 4 metres	20 ,, × 20	,,
50 lengths of 3 metres	6 ,, × 12	,,

These can be obtained, sawed and planed to size.

Linen Fabric.

Only aviation materials are suitable. The linen fabric as used for full-sized aeroplanes is rather heavy, and strong covering material as used for gliders is approved. This is usually a strong nainsook material at about 10s. per piece of 12 yds. Cheaper stuff than this is likely to be low in strength.

You require 36 yds. fabric 38 in. wide; 100 yds. notched strip about 2 in. wide, obtainable from:

Messrs. Stevenson & Son.
Messrs. Woods, Sons & Co. (Nainsook No. 200 or higher).
Messrs. Abbott-Baynes Sailplanes.
Messrs. Aircraft Materials, Ltd.
Messrs. B.A.C. (1935), Ltd.
The Dunstable Sailplane Co.

Dope.

Clear glider dope is the cheapest; it should be suitable for use in an unheated shop. You need about 4 gallons.

Messrs. Cellon Ltd. (or any of the last four names given under "Fabric" above).

Wheels and Tyres.

These present for the moment some difficulty. M. Mignet insists on large sections—for example, 450 × 100 medium pressure.

Normal aeroplane wheels and tyres are very expensive.

Metalwork.

(*a*) Tubing drawn (not welded or jointed) of mild steel suitable for welding.

M. Mignet's Specification.	*British Equivalent.*
4 metres in 13 × 16 mm.	5/8 in. 16 gauge.
2 ,, ,, 16 × 20 ,,	3/4 ,, 14 ,,
2 ,, ,, 17 × 20 ,,	3/4 ,, 16 ,,
2 ,, ,, 21 × 24 ,,	15/16 ,, 16 ,,
0·5 ,, ,, 24 × 27 ,,	1 ,, 16 ,,
1·2 ,, ,, 31 × 35 ,,	1 3/8 ,, 14 ,,
1·2 ,, ,, 36 × 40 ,,	1 9/16 ,, 14 ,,
0·2 ,, ,, 40 × 44 ,,	1 3/4 ,, 14 ,,
Also tow bar if you wish.	
1·8 metres in 31 × 35 mm.	1 3/8 in. 14 gauge.

If the exact sizes are unobtainable take the next larger, e.g. for substitute 7/8-inch.

Mild Steel Sheet.

You require:

2 mm. or 14 gauge (about 3 sq. ft.).
1·5 ,, ,, 16 ,, small quantities as required.
1·0 ,, ,, 19 ,, ,, ,, ,,
0·6 ,, ,, 24 ,, ,, ,, ,,

Drawn Rods, Screwed Rods, Bolts and Nuts.

You will need a total of about 2 metres of mild steel drawn rod in

4 mm., 6 mm., 8 mm., and 10 mm. sizes.
or 3/16 in. 1/4 in., 5/16 in., 3/8 in. (or preferably 7/16 in.),

also about 3 metres of mild steel screwed rod in

4 mm., 5 mm., and 10 mm. sizes with nuts
or 3/16 in., 1/4 in. 3/8 in. (or preferably 7/16 in.)

also 50 bolts of 5 × 40 mm. or 2 B.A. × 1·6 in.

30 bolts of 6 × 40 mm. or 1/4 B.S.F. × 1·6 in.,

with their nuts and a large quantity of spare hexagon nuts particularly in 4 mm., size (for the screwed rod) and 5 mm. for the bolts—a lot of nuts get lost. You will want about 200 of each of the above popular sizes and 20 lock-nuts for the 10-mm. screwed rod.

In case of doubt take nearest size above the millimetre measurements.

Aircraft Steel Cable.

Extra flexible.

10 metres in 4·5 mm. for wing bracing, with 20- or 25-cwt. thimbles and 20 attachments for ends.
15 metres in 2·4 mm. for wing controls, with 15- or 10-cwt. thimbles and 15 attachments for ends.
10 metres of 5 cwt. for rudder controls, with 5 thimbles and 5 attachments for ends.

Glue.

Use casein glue, which is used cold and has marvellous adhesive and weathering qualities.

Shock Absorber Cord.

You require about 12 metres of 12-mm. diameter (1/2-inch) which should start to "give" at about 35 lb. pull.

Miscellaneous.

In addition you require an amount of piano wire, screws, nails, copper tacks for fabric covering, etc., which can always be bought locally as required. Use thin steel brads about 20 gauge for 3-mm. ply, and thinner still for the 1·5 mm.

Engines.

Carden 4-cylinder, water-cooled (converted Ford).
Douglas 750 c.c. horizontal air-cooled, 4-stroke twin.
Scott 2-stroke, air-cooled, inverted twin.

Airscrews.

The Airscrew Company can supply, if particulars are given regarding engine, h.p., rev., gear (if any), speed, and weight of aeroplane.

Cost.

Carefu lbuying should give the constructor a list of materials for about £25, excluding engine and proprietary articles.

THE EVOLUTION OF THE MODERN HOME

By G. Long, F.R.G.S.

The Subject of this Article Forms a Fascinating Story. Starting with the Gloomy Caves Which Sheltered the Earliest Man Thousands of Years Ago, we Progress Through the Ages Until we Come to the Splendours of Modern Architecture as it is To-day

The so-called King Alfred's cottage, Steyning.

HOUSING is the topic of the hour. The National Government proudly boasts that it has erected a million houses during its term of office, and so many long lines of brick and slate straggle into the countryside that "Ribbon-Development" has become a new and urgent problem. But if the *outward* progress of housing is dramatic and remarkable, the *internal improvements* are even more valuable and astonishing. A man of moderate means to-day can enjoy a score of advantages which even a millionaire could not purchase fifty years ago, and many that *kings* could not obtain a few centuries earlier. We take these things so much for granted that we scarcely realise the practical advantages we enjoy: wireless, television, the telephone, electric supply with its group of benefits—electric freezers, sweepers, irons, and washers. Still more important is modern water and sanitation, which have done more than anything else to promote public health in cities, and have stamped out the plagues which formerly claimed thousands and even millions of victims.

The evolution of the modern home is a fascinating story, starting with a damp and gloomy cave in which the earliest man sheltered many thousands of years ago, and rising through slow stages to the splendours of Babylonian monarchs, Roman Emperors, and Moorish Sultans. It was not till long afterwards that luxury and comfort became the birthright of the ordinary citizen, and that the million could enjoy advantages unknown to the Cæsars.

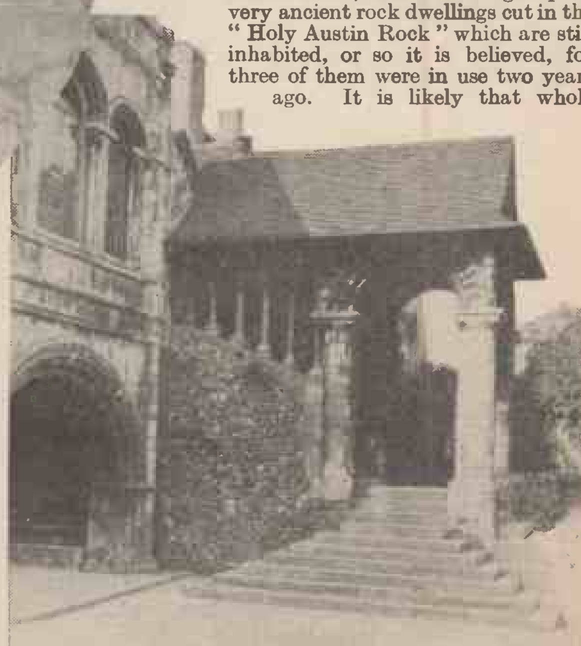
Central heating 2,000 years ago. A room in a Roman villa at Chedworth; note the mosaic floor and flue beneath for heating.

Sub-Human Ancestry

As man has risen by slow stages from a sub-human ancestry, it seems probable that the first human homes were modelled on those of the birds and beasts. When primitive man scooped out a cave for himself he was but imitating the burrow of the rabbit, and the earliest lake-villages may have been modelled on the dams and lodges of the beavers. The prehistoric marsh-village discovered near Glastonbury consisted of round huts of wattle daubed with clay or mud, and this was clearly copied from the work of birds. Wattle is but woven twigs (like the nest of the bird), and the clay lining can have been copied either from the nest of the thrush or that of the martin. Watch one of these birds at work, and you will see that she makes a cement of mud and straw and puts on a layer each day, carefully waiting for each to dry before adding the next. Another interesting point is this. The homes of wild creatures are all round, or nearly so, and primitive man copied them. The huts of prehistoric men in England, like native grass huts in tropical Africa to-day, were circular, and copied from the nest of the bird. It was only when man became partly civilised that he invented the *rectangle* in building, and he has stuck to it ever since.

Cave Dwellings

The earliest homes in Britain were caves, and at Nottingham we can see many such dwellings, scooped in the soft rock, which were inhabited when the Romans landed, and some of which have been used within living memory. There are cave dwellings which have been used until recently in many parts of the country, and at Kinver Edge, in Staffordshire, there is a group of very ancient rock dwellings cut in the "Holy Austin Rock" which are still inhabited, or so it is believed, for three of them were in use two years ago. It is likely that whole



A Norman staircase at Canterbury.

tribes once lived in vast underground cities, but little is known about them. At Chislehurst (Kent), however, there is an astonishing series of passages and caves hewn in the chalk, and containing a very ancient well. The caves and connecting passages form a bewildering maze of prehistoric homes, and extend for a distance of more than twenty miles. It is stated that to walk right through every cave means a journey of about 22½ miles! But caves were damp and gloomy places, and man soon took to hut-building. The earliest forms were made of wattle and daub, or sticks and grass. The latter is the typical African native hut, and there are hundreds of them in the tropical areas of the Dark Continent. No building could be simpler. A number of long flexible rods are stuck in the ground in a circle, and the thin ends are tied together at the top to a central pole, forming a conical hut, which is then covered with dried grass. Cooking, of course, is done outside, and the village is surrounded by a lofty palisade of sticks and thorn branches to keep out enemies and wild beasts. Even when civilisation approaches, the African native clings to his grass hut, and they can be seen even now, erected on pieces of waste ground, in the middle of a modern town.

Three Stages of House Development

In the development of the house, it has passed through three stages. The first thing desired was safety, or protection from savage beasts and still fiercer men. The tree-huts of savages, and the Norman castles, are examples of this.

The second was comfort, and it developed very slowly until it reached a very high level and then slumped back for more than a thousand years.

The third point aimed at was **refinement**, or more correctly, **privacy**. There is nothing more remarkable in human history than the way in which the clock of progress was set back after the fall of the Roman Empire.

Few people realise that wealthy Romans enjoyed many modern advantages which even kings could not obtain during many centuries afterwards.

These included a pure water supply laid on, central heating, glass windows, water-flushed lavatories with marble seats, private bathrooms, public Turkish baths, and a very high standard of internal decoration. Thus, the walls in ancient Roman villas were frescoed with beautiful paintings, the floors were covered with charming designs in a mosaic of coloured marbles, and the central court was embellished by spouting fountains.

The vast aqueducts which still stride across the Roman Campagna, and stretch for miles over the arid hills of north Africa, are sufficient evidence of the manner in which the Roman engineers brought pure water from long distances to their cities. Thus the Emperor Hadrian constructed an aqueduct from Zaghouan and Dougga to Carthage, which was 81 miles in length and carried a supply of six million gallons of water a day. Some of the cisterns in which the water was stored at Carthage can still be seen. Those at Bordj-el-Djedid are still used for supplying the neighbourhood, eighteen huge vaulted tanks holding about thirty thousand cubic yards of water. The still larger tanks at La Malga are unfortunately ruinous. There are twenty-four huge cisterns, each 140 yards long by 28 yards wide.

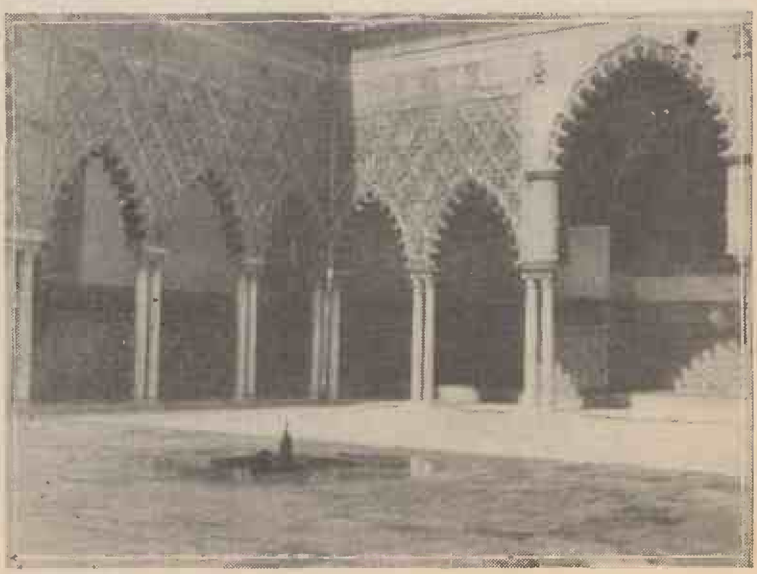
Roman Villas

Roman villas then had their water supply, with elaborate private baths and fountains, and, in some, windows of real glass. The houses were warmed by central heating, by means of hot air circulating under the floors, which were hollow. The furnace chamber was called the Fumosus, and gave its name to the month of December, when it was most used. The typical plan of a Roman villa, in which a square of rooms open upon a central court, has been copied all over the world. The Spaniards took it up, and so have spread the "patio" all over Central and South America, the Moors imitated it and gave us the glories of the Alhambra and of the Alcazar, and the Church used it in the cloisters of her monasteries.

After the Roman Empire had crashed to ruins, Britain—and most of Europe—went back to Barbarism, both in houses and everything else.

Saxon homes were huts of wattle and daub, while even kings' palaces were draughty wooden sheds, having a hole in the roof through which the smoke of the open fire partially escaped. The timber was not seasoned, it warped and shrank, and chinks appeared through which howled the winter

Skyscrapers in New York—typical example of modern architecture.



(Above) a croft in Skye and (right) the court of the maidens, Alcazas, Sevilla. This picturesque palace was built in the twelfth century, though some of the halls were built later.

wind. That good and wise King—Alfred—was so troubled by his guttering candle, that he invented a kind of lantern to protect the flame from draughts. I have seen houses still in use in rural parts of Norway which are very much like Saxon homes. The walls are of wood, and the roof consists of great slabs of turf supported on timber beams. In wet summers these turf roofs are ablaze with tiny flowers, and look like a garden in miniature.

Saxon and Norman Homes

Comfort and privacy were alike absent both in Saxon and Norman homes. Each building consisted of a large main hall, whose floor was of cold earth or colder stone, and covered with filthy rushes, which often were only changed once a year, and into which were flung bones for the dogs. Windows were open slits, or at best were covered with pieces of bladder or caul, so that the interior must always have been very dark. There were no chimneys, and some of the smoke from the great fire on the floor passed through a hole in the roof, while much remained partially to smother the worse odours caused by the unclean habits of the people. Even as late as the thirteenth century, there was an open drain running through the halls of the Royal Palace at Westminster, the stench from which caused much sickness, and if palaces were like this, the homes of the common people must have been far worse. No rooms were private, and the Great Hall was the general dormatory for both men and women.

Improvements came slowly, and seem to have commenced in the thirteenth century. The first chimney we can discover was built at Abingdon Abbey in 1250, and a few glass windows appeared in the same century, but were so expensive that their use was not general (except in churches) till hundreds of years later. The fourteenth century saw a great stride forward, for then we see the commencement of private rooms. In the *Vision of Piers Plowman*, published in 1362, the author makes an attack on the wealth and luxury of his times, and one of the new-fangled customs of which he complains is that the Lord and Lady of the Manor-house now take their meals in their private apartments instead of in the common hall!

Progress, however, was slow until public safety was assured. During the Wars of the Roses, and the difficult times which followed up to the Civil War, the rich still needed the protection of their castles, but when Cromwell had battered down the ancient keeps, and given England strong and honest government, *houses became homes instead of fortresses.*

There had been considerable progress, however, during the time of Good Queen Bess, when the new middle class were building their homes in the glorious gabled, half-timbered Tudor style, and many of the most beautiful old country houses in Britain to-day date from the days of Queen Elizabeth and James I. A few facts about *small* homes may be of interest. The oldest small private house is the Jew's House at Lincoln, the smallest house is at Conway (North Wales), and the smallest house in London is in the Bayswater road, overlooking Hyde Park. There are many old inns, but the dates painted on many of them are very inaccurate, and a long article would be necessary to deal with the subject.

The Alhambra and Alcazar

It is interesting to observe that in this country the evolution of the home was on lines of freedom without comfort; i.e. the women were free but had little or no comfort for many centuries. In some Eastern countries, and in Spain under the Moors, there was much luxury and comfort, but little freedom for the women cooped up in the harem, like birds in a gilded cage. No article on the development of the home would be complete without a brief reference to the glorious palaces of Moorish Spain, and especially the Alhambra and the Alcazar. The Alhambra was built in the thirteenth century, at a time when our own Royal Palace had an open drain running through it! It is a dazzling series of glorious halls, whose walls and floors are covered with rich mosaics, whose courts are filled with tinkling fountains, and cool swimming-pools, the whole combining to form a picture of indescribable beauty.

The Alcazar was built a century earlier, and is equally charming, but very much smaller. Some of the halls were built later, but all are lovely.

But the Sultans who lived in these glorious palaces lacked many of the solid advantages which every citizen can obtain to-day in a six-roomed suburban villa, and this is the best proof of the progress which we have achieved.

A NEW WELDING PROCESS

Details of a Novel Method of Repair

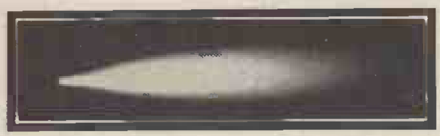
NO development in the engineering industry during the last twenty-five years has been more striking than the growth in the application of welding processes, both in production and repair work. Nevertheless, the field yet to be developed is greater than the ground already covered, and, while the standard of work turned out by skilled operators is very high, progress has sometimes been hampered by disadvantages that have not been overcome.

Two Pioneers

As long ago as 1903, two of the great pioneers of oxy-acetylene welding, Fouche and Picard, recognised that a mixture of coal gas, acetylene, and oxygen had definite advantages over a mixture of acetylene and oxygen only. It is generally accepted that the temperature of the inner cone of an oxy-acetylene flame, which is the part of the flame used for welding, has a temperature of between 3,300 degrees C. to 3,500 degrees C., and that this is unnecessarily high. The skill of the operator is usually able to overcome this disadvantage, but it is recognised that great benefit would accrue from the use of a similar flame with a somewhat lower temperature. The reason for this becomes apparent when it is pointed out that the melting point of iron is approximately 1,500 degrees C., and that it boils at a temperature of about 2,450 degrees. It has been found that by mixing a certain proportion of coal gas with acetylene, before the acetylene is in turn mixed with oxygen, the temperature of the flame can be reduced to about 2,600 degrees. Allowing for heat losses that occur through radiation, the flame temperature drops below the boiling point of iron, but is still well above the melting point.

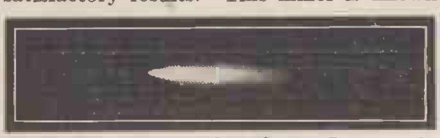
The "Sopromo"

Fouche and Picard, although they saw both the problem and its solution, did not succeed in devising a satisfactory mixer for acetylene and coal gas. Barimar Ltd., the welding engineers, who have been associated with the industry for nearly thirty years, are constantly investigating new



Showing the oxy-acetylene coal-gas flame.

developments in connection with the work in which they specialise, and they have recently installed in their works a mixer for acetylene and coal gas, which is giving very satisfactory results. This mixer is known



The ordinary oxy-acetylene flame. Compare this flame with the size of that shown above.

as the "Sopromo," and is patented in this country and abroad.

The outstanding advantage of the process is the remarkable purity of the weld, which is achieved without impairing the strength. This is due to the fact that the lower temperature of the welding flame reduces to a minimum the amount of oxide absorbed into the welded metal, and it also avoids the carbonisation that occurs when cast iron is subjected to great heat. It will therefore be seen that the original characteristics of the metal are not affected.

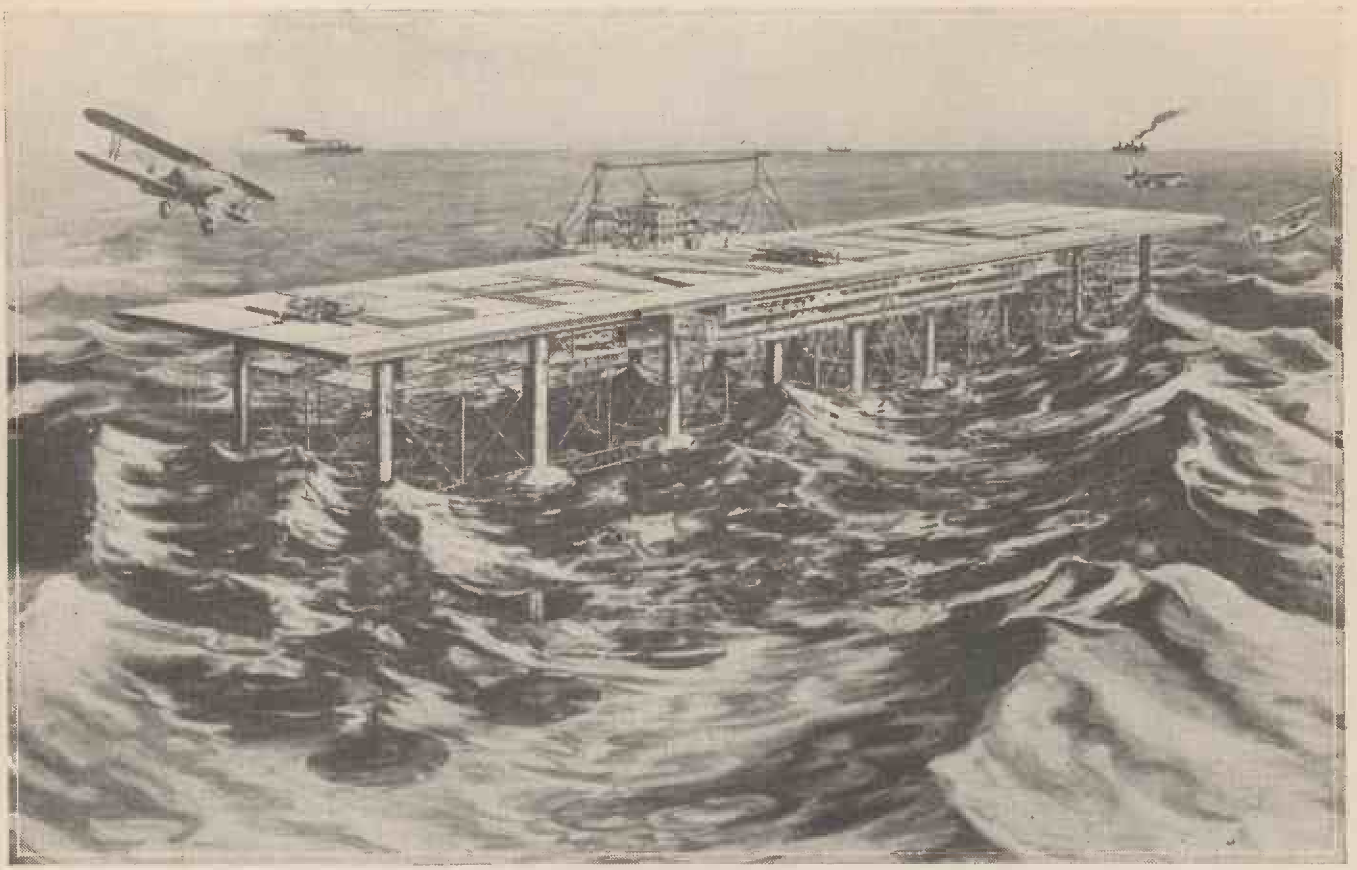
Great Heat Localised

Another advantage of the lower temperature is that the area of the casting subjected to great heat is localised, and this minimises the degree of expansion and contraction that occurs. In the oxy-acetylene flame, an excess of oxygen has to be used in order to carry along the acetylene. This is not necessary with the "Sopromo" mixture, and the flame is consequently softer.

No bubbling, therefore, occurs in the weld, and a much closer grain in the metal is obtained. The comparatively soft flame also spreads out over the metal, keeping the air away from it, and this reduces still further the risk of oxidisation. Barimar Ltd. emphasise that while it is possible that in time welding by the Sopromo method will be more rapid than by oxy-acetylene, the great merit of the new process is the remarkable purity and strength of the weld.

The Difference in the Flames

The two illustrations shown on this page, which were recently taken in the Barimar Welding Works, illustrate the difference in appearance between the Barimar-Sopromo oxy-acetylene coal-gas flame (at the top), and the ordinary oxy-acetylene flame (at the bottom). The illustrations show that not only is the outer cone of the Sopromo flame larger, but it is also much softer. As a result, it spreads out over the surface of the metal, greatly reducing oxidisation in the weld. The Sopromo flame, although possessing adequate heat for welding, has a considerably lower temperature than the oxy-acetylene flame.



Showing the appearance of the seadrome.

A Mid-Ocean Aerodrome

A Seadrome Where Aeroplanes Could be Refuelled Whilst in Mid-Ocean Would Undoubtedly be a Big Development in Aerial Transport. It Would Add to the Safety of Transatlantic Flights.

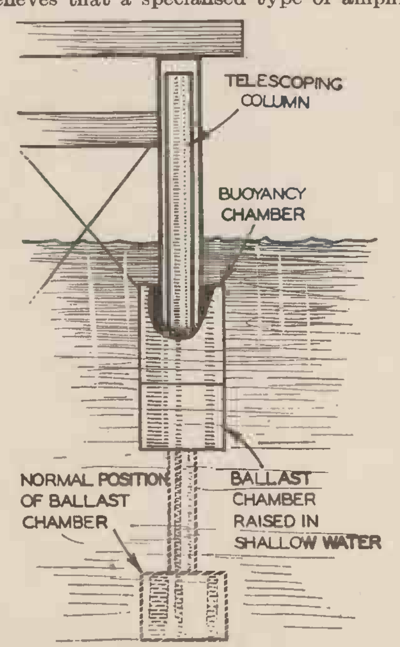
THE seadrome shown in the illustration on this page has been designed by an American inventor as a basis of a modernised plan to bridge the Atlantic with a string of artificial islands. Planes using these islands in stepping-stone fashion could transport heavy loads at high speed, since their loads of fuel would be light.

This 1,225-ft. aeroplane-landing platform (for such would be its size), supported 100 ft. above the water on twenty-eight submerged tanks, would not pitch and toss in stormy weather. The reason for its stableness, states the inventor, is because its supporting buoys float beneath the area of the sea that is subjected to wave motion, and its openwork structure allows waves to pass unhindered beneath its decks. These facts he has verified by experiments with models up to 35 ft. in size.

Accommodation for Travellers

Each seadrome would have overnight accommodation for one hundred travellers in addition to quarters for its own crew and hangar space for fifty large transport planes. Run on the same principle as a ship, the seadrome would have a captain, first officer, second officer, seamen, and engineers, as well as two meteorologists and a physician.

Any type of plane—land-plane, sea-plane, or flying boat—could use the seadromes as refuelling stations, although the inventor believes that a specialised type of amphibian plane will be developed for this purpose.



Telescoping flotation gear permits the seadrome to be assembled near the shore and towed to a deep-water site.

A Radio Beacon

Aircraft will be guided to the island aerodrome by a standard type of radio beacon, which is mounted on an automatic turntable controlled by a gyro compass. No matter how the seadrome may swing at anchor, the beam would always point in a fixed direction. Another innovation is an emergency propulsion system that enables the seadrome to navigate like a ship if it is necessary to cast the seadrome adrift to ride out a storm of phenomenal severity, or if it should break loose from its moorings. This is provided by four propellers, each operated by a 500-h.p. electric motor that is supplied with current from the petrol-electric power plant installed in the seadrome.

Anchorage

To anchor this floating aerodrome the inventor proposes to float a 1,660-ton anchor of steel and concrete to sea, and sink it on the selected site by opening ports that allow water to rush into its inner chambers.

Heavy steel cables moor the seadrome to a buoy that, in turn, is attached to the anchor. A tension engine on the seadrome takes up the slack on the cable so that it will not foul the understructure, paying it out automatically in response to a sudden strain.

CALCULATING

Without the Modern Calculating Large Industrial Concerns would and, in Fact, Modern Commercial the Calculating Machine as it is on

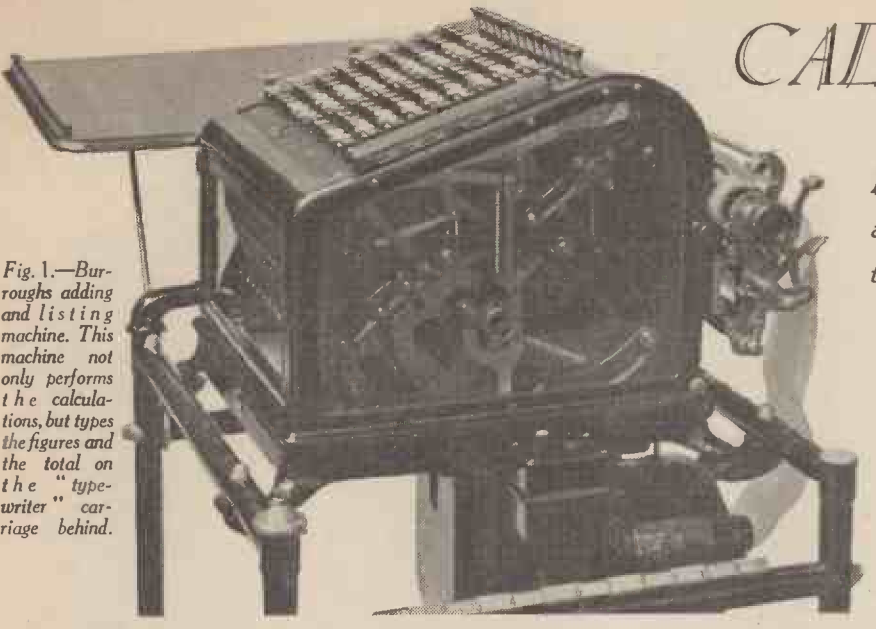


Fig. 1.—Burroughs adding and listing machine. This machine not only performs the calculations, but types the figures and the total on the "typewriter" carriage behind.

ALTHOUGH it is nearly 300 years since the first calculating machine was invented, it is only during quite recent times that they have become familiar articles of office equipment. During the last thirty or forty years their use has been extended by insurance companies and others for calculating statistics, and they have become invaluable for the production of nautical and astronomical tables, which could only have been compiled at immense cost without their aid. To-day, indeed, they are in use at almost every bank, and in almost every office where much calculation has to be performed.

How the Machine Operates

Before describing a calculating machine, we must briefly consider the task it is required to do, because the machine performs the various mathematical operations somewhat differently from the usual processes.

To be of practical service, a machine must be capable of multiplication as well as addition, subtraction, and division, but it is important to realise that multiplication and division are really only extended or repeated additions or subtractions. For example, suppose that we wish to multiply 6758 by 324. Worked out normally, the calculation looks like this :

```
   6758
    324
-------
  27032
 13516
20274
-------
2189592
```

What we have actually done is to multiply 6758 in turn by 4, by 20, and then by 300, finally adding all three products together.

Not being capable of direct multiplication, however, the calculating machine proceeds by repeated additions. First, 6758 is added to itself four times. To this total is added 67580 twice and finally 675800 is added three times. The process would therefore look like this :

```
   6758
   6758
   6758
   6758
  67580
  67580
 675800
 675800
 675800
-------
2189592
```

The important thing to notice is that the same figures occur in each line, and whereas in ordinary addition we have to take careful note of every single figure, on a calculating machine we can set the figures 6758 on the dials and merely turn a handle or pull a lever a certain number of times and the answer appears automatically. In the above case we should have to turn the handle only nine times, once for each line, and we should have the answer in about four seconds !

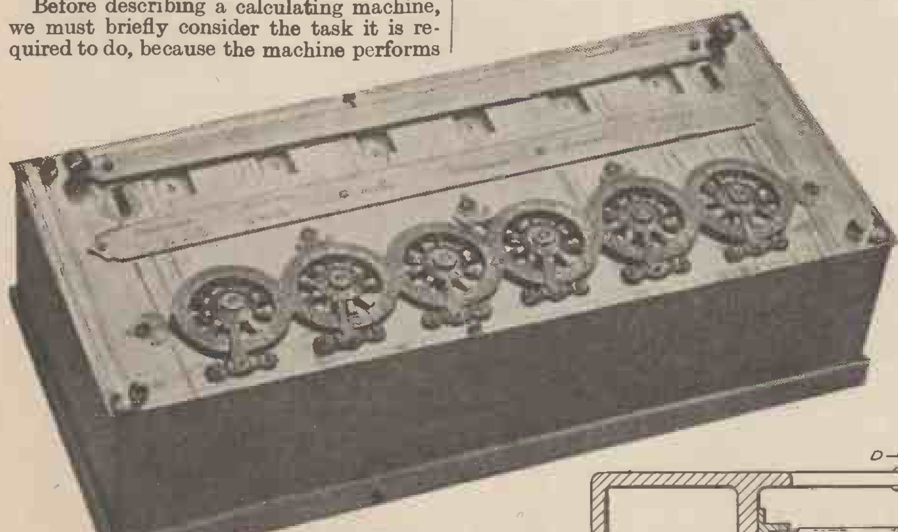


Fig. 2.—Replica of an early machine made by Blaise Pascal, the first inventor of a calculating machine. It was operated by putting a pointed peg into the star-wheels in front and pulling them round like the dial of an automatic telephone.

Pascal's Machine

Bearing the mathematical processes in mind, let us examine some of the more simple machines. The first calculating machine ever invented was the work of a Frenchman, Blaise Pascal, when only 19 years of age. But although he made many machines before he died at the early age of 39, they were all primitive and could only add by taking every single figure individually, a process only slightly less laborious than adding up the sum mentally. Pascal's machines are important, however, because they show that he was the first to solve the chief difficulties, and some of his mechanisms are used to this day. The chief of these is his "tens-carrying" mechanism.

It is quite easy to add, say, 3 to 5 by moving on a toothed wheel three divisions from position "5" to position "8," but it is another matter to add, say, 8 to 5. Unless our wheel had more than ten divisions, which is impractical, we have got to bring the

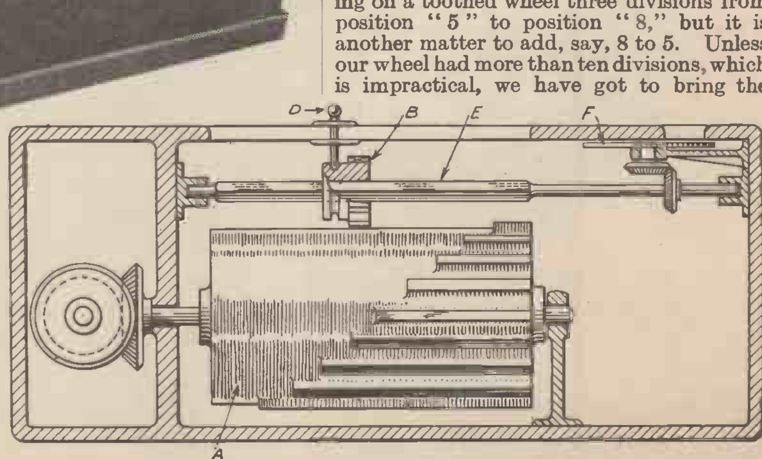


Fig. 3.—Diagram showing principle of the Leibnitz wheel —the invention which made rapid calculation possible.

MACHINES

Machine, the Rapid Expansion of Have Been Almost Impossible, Life is Almost as Dependent on the Telephone or the Typewriter

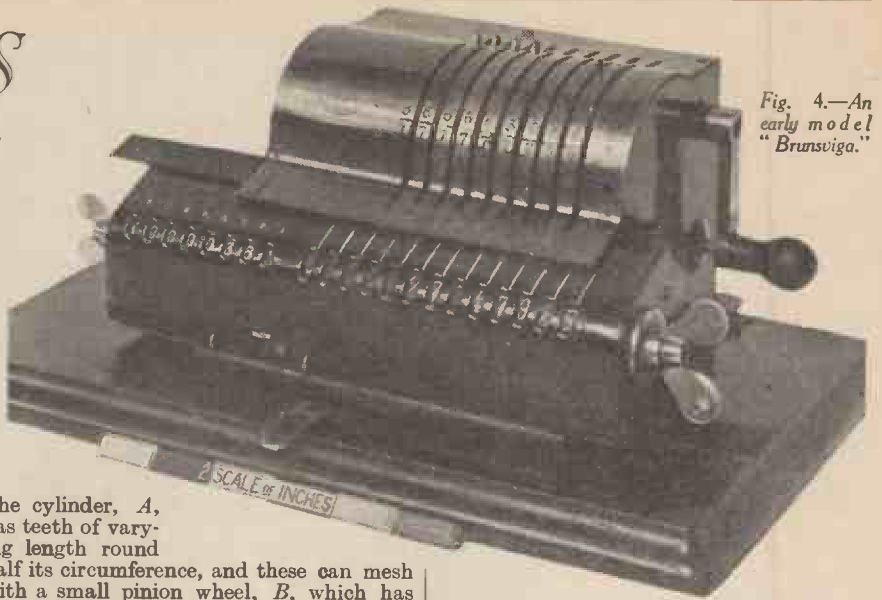


Fig. 4.—An early model "Brunsviga."

next wheel into action in order to show the "1" of the answer "13" exactly the same way as a Veeder counter. The Veeder problem is easy, however, because only units are added at a time, but in a practical calculating machine we have got to add the tens, hundreds, thousands, etc., simultaneously, and the tens must be carried from one dial to the next automatically during the process.

A replica of one of Pascal's machines is preserved in the Calculating Machine section of the Science Museum, and it is illustrated in Fig. 2. The face of the instrument carries six ten-pointed wheels which can be rotated through various positions by putting a pointed peg into one of the gaps and pulling the wheel round to the stop, rather like the dialling device on an automatic telephone. These star-wheels are connected inside by gearing to small number cylinders, which can just be seen beneath the small windows at the top. Each cylinder bears the number 0-9 round its circumference, only one number being visible through the windows at any one time, and as the star-wheels are turned round, the number cylinders rotate to show the total. When any particular cylinder passes from 9 to 0, the mechanism causes the next cylinder on the left to move on one division.

Pascal's machine is very laborious to use, as every single figure requires a separate operation of one of the star-wheels. To add, say, 6758 to itself four times (*i.e.*, to multiply 6758 by 4) would require sixteen separate operations, and such a machine is of little practical utility.

The Stepped Wheel

The invention which made really rapid operation possible, and which forms the principle of almost all modern machines in one form or another, is that of the "stepped wheel," which was invented by Leibnitz in 1671.

The operation of this important device will be seen by reference to Fig. 3. The cylinder, *A*, has teeth of varying length round half its circumference, and these can mesh with a small pinion wheel, *B*, which has ten teeth. The position of wheel, *B*, is adjustable along its square axle shaft by means of the pointer, *D*, while the axle shaft, *E*, is geared by 1 : 1 bevel gearing to the number disc, *F*. Setting of the mechanism is performed by adjusting the pointer, *D*, to the appropriate point indicated by a scale on the surface, and the addition is performed by giving one turn to the stepped wheel, *A*. Suppose that pinion wheel, *B*, is set by the pointer to position "5." This position corresponds with that part of wheel, *A*, which has five teeth, and thus, when wheel, *A*, is rotated once, pinion, *B*, and also number disc, *F*, are rotated through five-tenths of a revolution, or, in other words, five digits are added to the number which was previously showing at the window of number disc, *F*.

It should be understood that there must be as many units such as that shown in Fig. 2 as there are figures in one of the numbers to be multiplied. It is usual to provide at least six sets of stepped wheels, and they are generally all connected by bevel gearing to a common shaft, so that a single turn of the handle rotates all the stepped wheels.

The "Arithmometer"

The first calculating machine to be manufactured on a commercial scale was that of Thomas de Colmar. His "Arithmometer" was first made in 1820 and is still manufactured in France. The instrument employed the Leibnitz stepped wheel, and an early example is shown in Fig. 5. It will be seen that the front of the instrument carried six sliders or pointers, which set the pinion wheels to mesh with the Leibnitz wheels. The handle for rotating the Leibnitz wheels is on the right, while the two sets of counters for recording the multiplier and the product are fitted in the hinged part at the top. The recorder unit is capable of sideways movement to facilitate multiplication by tens and hundreds.

The actual operation of multiplying 3042 by 536, for example, is performed as follows. First set all the figure discs on the recorder to zero by turning the two milled knobs on the recorder, and set the recorder to the extreme left-hand position. Set the number 3042 on the sliders as shown in Fig. 5, and turn the handle six times. The top recorder discs will now show 18252, six times 3042. Now move the recorder unit one

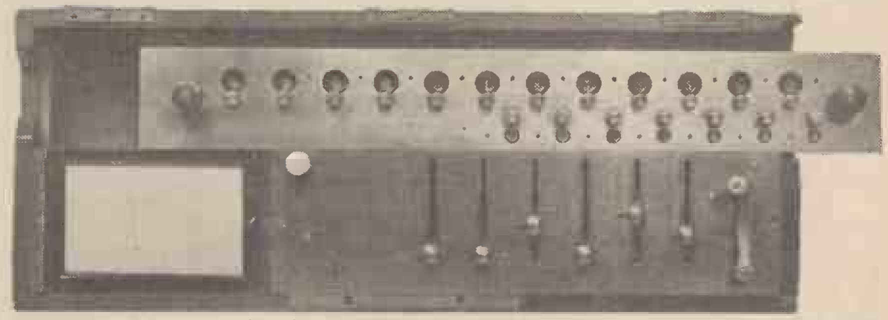


Fig. 5.—An "Arithmometer" made by Thomas de Colmar in 1820. This was the first calculating machine to be manufactured on a commercial scale.

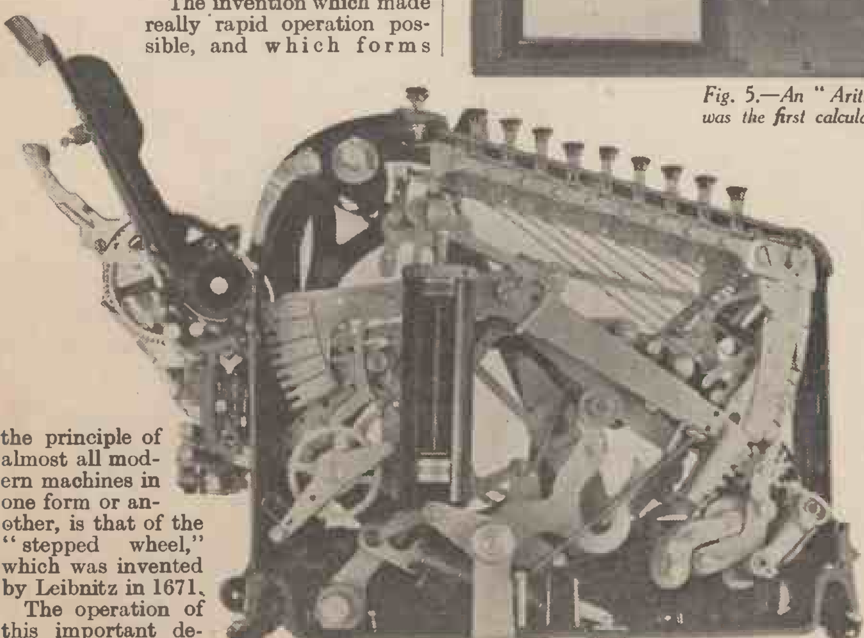


Fig. 6.—Sectional view of a single unit of the Burroughs machine.

place to the right for multiplication by the tens digit, and turn the handle three times, The top recorder will now read 109512, which is the sum of 18252 and thirty times 3042. Now move the recorder one place farther to the right for the hundreds multiplication and turn the handle five times. This adds five hundred times 3042 to the previous reading, and the final product, 1630512 now appears on the top recorder, while the lower recorder reads 536, the number by which 3042 has been multiplied.

With a little practice, this operation would take about five seconds, and the process is practically identical with the most modern types of calculators.

The "Brunsviga" Machine

Another type of calculating machine, which has been manufactured in very large quantities, is the machine known as the "Brunsviga," an early model of which is shown in Fig. 4. Although the principle is the same as that of Thomas's "Arithmometer," the mechanism is very different, and in place of the Leibnitz wheels, a thin "disc" wheel is used from the periphery of which project an adjustable number of teeth. The "Ohdner" wheels, as they are called after the name of their inventor, fit neatly and closely together, and the setting levers project through the slots in the front of the case. If a lever is set to any figure, a corresponding number of teeth, or pins, project from its wheel, and when the operating handle is turned these pins mesh with the small toothed wheels of the product register, which in turn gear with the number wheels in front.

Such machines as the Thomas and the "Brunsviga," and quite a number of similar machines, are of the greatest service for ordinary numerical problems, the calculation of nautical tables and similar work, but modern tendency is towards the "push-button" type of mechanism, an example of which is shown in Fig. 8.

The commercial machine of to-day has to be capable not only of addition and multiplication with extreme facility, but it is also generally required to deal with pounds, shillings, and pence, and for such purposes the push-button type is more serviceable.

The Push-button Type of Machine

The Burroughs Adding and Listing Machine is one of the most interesting of this class of machine, since it not only performs the calculation but automatically types the figures and the total as well.

Fig. 8.—The Monroe. A modern machine capable of almost any calculation.

Such a machine is shown in Fig. 1, and the essential mechanism is shown in Figs. 6 and 7. Referring to Fig. 7, it will be seen that it consists of a lever, *A*, pivoted near the middle and carrying at one end a set of figures from 0 to 9, held in slides by springs, while the other end is attached to a segmental rack, *B*, with which a number wheel, *C*, can be thrown in or out of gear.

The upper end of this rack is arranged to move between a couple of guide plates, *D*, in which curved slots are cut concentric with the point of oscillation of the lever, *A*.

Into each slot fits a projection from the top of the rack, *B*, the other end of which is secured to *A*, and so any possible motion is a true circular motion about the pivot of *A*. A number of slots are cut in the edge of the guide plates, and in these slots lie the ends of a number of wires as shown. If a key is depressed, the corresponding wire moves to the left, and its bent-in end moves to the bottom of the slot, where it catches the projections shown on the top of sector, *B*, and thus limits its possible downward movement. The other end of lever, *A*, is now raised, so that the figure corresponding to the depressed key is in position for printing. Printing is effected by the release of a small spring-actuated hammer, which, striking the right-hand end of the type-block, draws it forward against the type-ribbon and paper. The same effort which produces the downward movement of the rack throws out of gear with it the number wheel, *C*, which therefore undergoes no rotation during the downward motion. The wheel, *C*, is now thrown into gear (after printing), and as the rack is raised to its topmost position, this wheel will be turned through a number of teeth equal to the number of the key originally depressed.

If this series of operations is repeated, a second figure will be printed on the paper, and the number wheel fed forward an additional number of teeth.

How the Total is Obtained

The total is obtained by depressing the totalising key, which is arranged so that no other key on the keyboard can be depressed at the same time.

The number wheels, *C*, are fitted with pawls which prevent them being rotated backwards beyond the zero position, and so the taking of a total clears the machine, setting all the number wheels to zero. The machine is also provided with a locking device, so arranged that whenever a key is depressed, all the keys in the same column are locked and cannot be depressed until the registering one has returned to its original position.

Space forbids a more detailed description of the further refinements of this machine, or of the latest types of electrically operated sorting and tabulating machines. Enough has been said, however, to show that the calculating machine was not built in a day. Its development has taken nearly 300 years, and for anyone with a gift for inventing mechanisms, the calculating machine still offers almost unlimited scope for further development.

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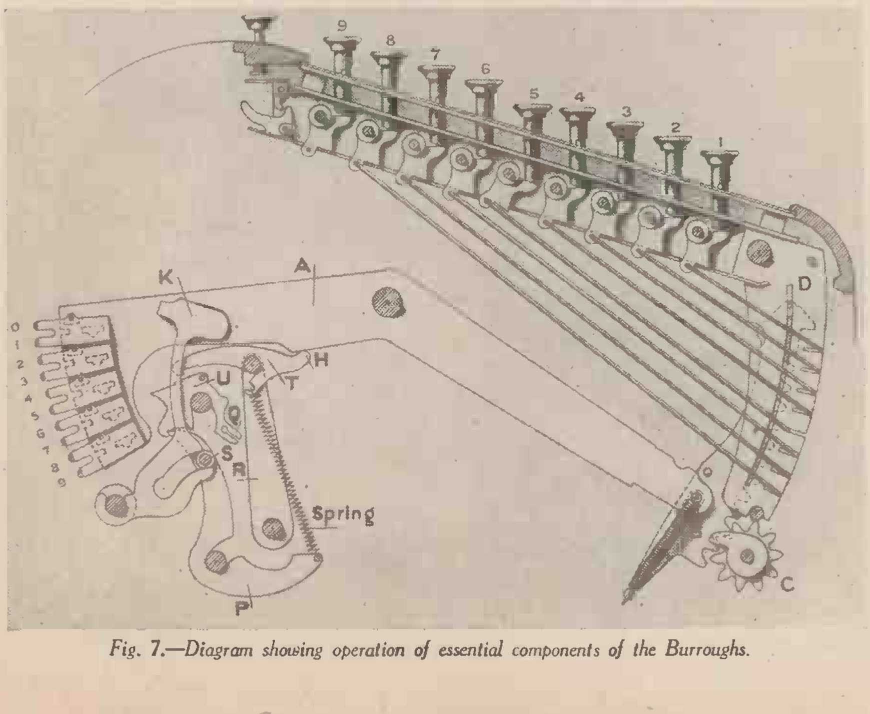
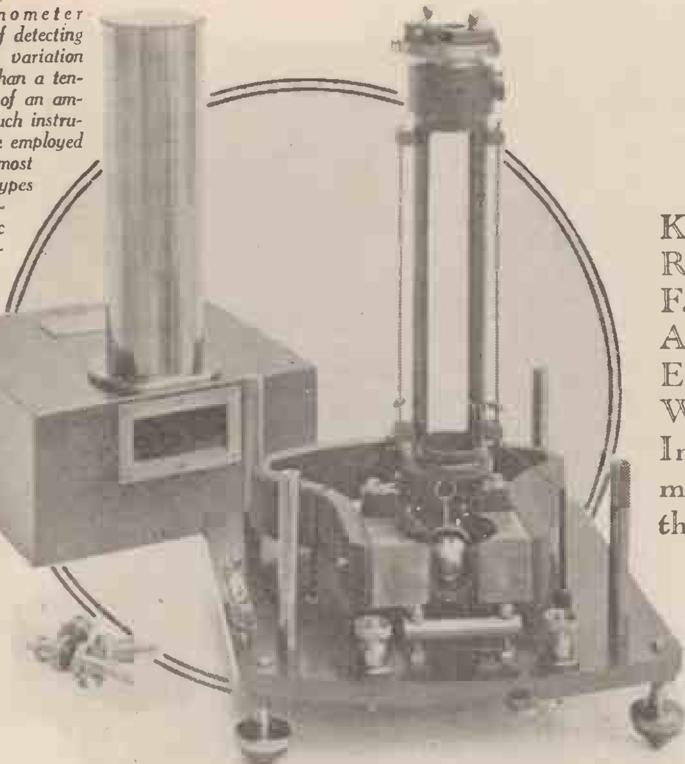


Fig. 7.—Diagram showing operation of essential components of the Burroughs.

The Differential Analyser

A WONDERFUL calculating machine of entirely new design has recently been installed at Manchester University. It can solve the most complicated equations and will be of great service to research scientists. Among many other problems, it can solve equations dealing with: atomic structure and properties, transients in electrical circuits, the transmission of radio waves in the Heaviside layer, cosmic-ray radiations, motion of bodies in any resisting medium, astronomical phenomena, etc.



A galvanometer capable of detecting a current variation of more than a ten-millionth of an ampere. Such instruments are employed in the most sensitive types of psycho-galvanic reflex apparatus.

THE LIE MACHINE

Known to Science as the "Psycho-Galvanic Reflex," but sometimes Familiarly and Facetiously called "The Lie Machine" on Account of its Ability to Register the Secret Emotions of the Mind, the Apparatus Which is Described in This Article is Indicative of the Progress Which is Being made in the Application of Electricity to the Study of the Human Mind and Body

FOR thousands of years it has been well recognised that there is a definite connection between mind and body. Mind reacts on body; body influences mind. Such facts are well known to everybody and they will not need stressing here. It is only, however, within comparatively recent times that it has been discovered that all emotional states of the mind, besides producing certain delicate chemical changes in the blood and various bodily organs, actually initiate variations in the electrical resistance of the body. The stronger the mental state or emotion, the greater the change in the body's electrical resistance. This being the case, it follows that if we can devise some means of measuring these variations in the body's electrical resistance under the influence of mental emotion, we shall have provided ourselves with a valuable means of penetrating still further into that jungle of scientific mysteries which the mechanism of the mind presents to the scientific enquirer.

The psycho-galvanic reflex, so called because, as it were, it provides an electrical reflex for every state of mind, is the instrument which has been developed to study mind-states by electrical means. The instrument has been brought to a high degree of perfection and in certain psychological clinics up and down the country its use is common.

The Principle Involved

The principle of the psycho-galvanic reflex is extremely simple. We all know that if an electric current flowing along a wire comes across two conducting paths of different resistances, the current will tend to choose the path of least resistance and the current-flow in each path will be inversely proportional to the resistance of the path. If we connect a galvanometer at the junction of the two current paths, the needle will be deflected in the direction of the path along which the most current flows. If the two paths are of identical

The lie machine in use. A subject being tested by means of psycho-galvanic reflex apparatus.

resistance, the galvanometer needle will not be deflected at all, since the two portions of the current counteract each other.

In the psycho-galvanic reflex apparatus the above electrical principle is utilised. One of the current paths is the patient's—or, rather, the "subject's"—body, the other path comprising a series of very accurate resistances which are capable of exact adjustment.

The "subject" is requested to sit comfortably in a chair. Sometimes he may be blindfolded in order to cut out from his mind many external and interfering impressions, although this procedure is now usually dispensed with. The subject may either have both hands immersed in baths of saline water, leads being taken from these baths to the apparatus, or, alternatively, he may have attached to the palms of his hands metal plates which are held in position by salt-solution-saturated linen wrappings. In this instance, the electrical connections are taken from the metal plates. A third means of making the necessary electrical connections to the subject's body is by a specially-devised glove which slips over the subject's left hand. This glove contains two metal plates, one of which makes contact with the upper side of the hand, and the other with the palm of the hand.

The Galvanometer

The galvanometer used in the psycho-galvanic reflex apparatus is an extremely sensitive micro-amperemeter capable of indicating less than a millionth of an ampere of current. In the portable form of the apparatus, the micro-amperemeter presents the appearance of an ordinary electrical meter, being enclosed in the usual circular type of brass case. In the most delicate forms of apparatus, the indicating galvanometer is mounted on a concrete base to avoid vibration. Attached to its moving armature is a very light mirror which reflects a beam of light on to a calibrated scale. Thus the slightest motion of the galvanometer mirror is at once indicated by the moving light-spot on the scale.

The psycho-galvanic reflex apparatus is energised by a small battery or accumulator of approximately 1·5 volts. Usually, an accumulator of reliable make is chosen on account of the extremely steady current which it delivers.

After the subject has been connected up to the apparatus the current is switched on. Immediately a galvanometer deflection is indicated. This is because the apparatus has not yet been "balanced." Balancing is effected by adjusting the variable resistances of the apparatus so that they exactly equal the resistance of the subject's body. This done, the galvanometer indication remains steadily at "neutral" because the current flowing through the subject's body and that passing through the resistances of the apparatus counteract each other in their deflections of the galvanometer needle.

The apparatus, having thus been accurately "balanced," is now in an extremely sensitive condition. The most minute change in the electrical resistance of the subject's body will give rise to a needle movement in the galvanometer. Ask the subject any question you like, preferably a personal one. If such a question produces the slightest trace of emotion, conscious or sub-conscious, in his mind, the galvanometer needle will be deflected.

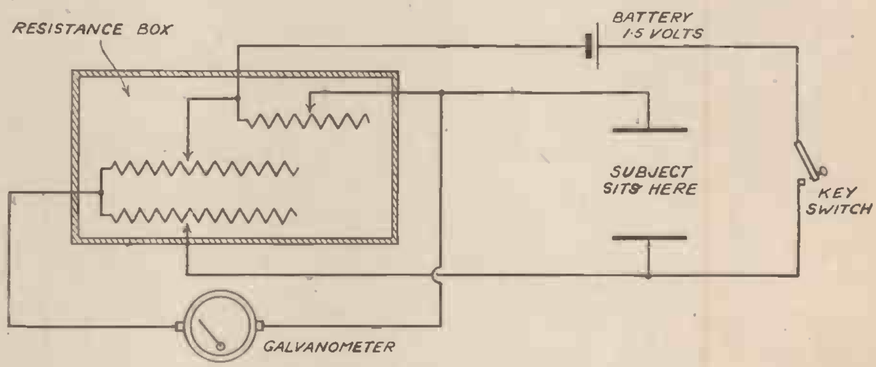
The Strongest Emotion

Ask the subject if he is in love, whether he has ever been in love or if he hopes to fall in love. In nine cases out of ten, you will get very large galvanometer deflections when such personal questions are hurled at the subject—for is not love one of the strongest emotions of the human mind?

Hate, fear, dread, anxiety, apprehension, pain, hunger, humiliation, loathing—these and many other mental states are all revealed by the psycho-galvanic reflex apparatus. What is more, the subject, one connected up to the apparatus and accurately "balanced," can do very little to inhibit the indications of the apparatus.

Very few of us can tell a lie without a twinge of conscience. Connect your subject up to the psycho-galvanic reflex apparatus, therefore, and ask him a question, a question which, of course, must be an important one and in some way reflecting upon his habits, nature or characteristics. If the subject answers truthfully and the subject-matter is devoid of great emotional-content, the galvanometer needle will remain fairly steady. If, however, the subject endeavours to hedge the question or tells a direct lie, his mind-state is at once registered by the immediate strong deflection of the galvanometer. Naturally, the psycho-galvanic reflex apparatus cannot be claimed infallibly to detect lies, because it is impossible to differentiate between the emotion registered by a lie and that proceeding from some other cause. However, in many instances, the psycho-galvanic reflex has been employed judiciously to detect suspected untruthfulness.

Anticipation or apprehension is plainly registered by the psycho-galvanic reflex. A subject may be connected up to the apparatus and it may be suggested to him in all seriousness that he is going to be pricked with a pin and that the pin is going to be plunged down to the bone of his finger or hand. Usually, this suggestion will produce a much greater deflection of the galvanometer needle than would be the case if the pin were actually driven deeply into the flesh suddenly and without any previous mention of it.



The electrical circuit of the psycho-galvanic reflex apparatus.

Different Reactions

Different people, of course, react differently to the psycho-galvanic reflex apparatus. As would be expected, the emotionally-minded people give the most marked reactions. One would, perhaps, expect women to be the better subjects in this respect for psycho-galvanic experiments, but this is by no means the case, the male mind very frequently being far more emotional than the female. The psycho-galvanic reflex apparatus can be employed with almost any type of subject. Children, lunatics, savages, healthy and diseased people, strong and normal-minded adults, persons suffering from nervous afflictions—all these come within the scope of the apparatus, although, as would be expected, each class of subjects has a type of reactions peculiarly its own.

The psycho-galvanic reflex apparatus is not a tester of intelligence or capability or even, normally, of character. All it does is to indicate the presence of emotions in the human mind. It is for the skilled operator of the instrument, who is usually a medical man or a psychological expert, to interpret the indications of the apparatus.

ITEMS OF NEWS

MISCELLANEOUS PARAGRAPHS FROM ALL SOURCES

Heavy Hydrogen

THE discovery of the isotope of hydrogen, or "heavy hydrogen," is becoming more than a scientific curiosity. The latest research indicates the possibility of an entirely new group of organic chemicals, many thousands in number. New drugs and medicines, new dyes, and new compounds of every type are probable, and the discovery is likely to affect the life of everyone in some practical way within the next five years.

Aluminium Wire

A NEW process for drawing aluminium wire has been developed, by the aid of which the wire can be drawn to a diameter of only ·0001 in. One pound of the wire would reach nearly round the earth.

Safety for Swimmers

STERILISATION of swimming-pool water is performed by the addition of chlorine gas, which must be in the proportion of one part by weight of gas to 3,000,000 parts of water. A new apparatus has just been devised for continually testing samples of the water, and the machine is now being installed by most of the large swimming-pools, so that bathers can see for themselves that the correct proportions are being maintained.

Harrison's Chronometers

BY the courtesy of the Admiralty, the Science Museum, South Kensington, has secured on loan all four of the famous pioneer chronometers made by John Harrison between 1729 and 1759.

With these instruments Harrison was the first to show that it was possible to construct a portable timekeeper which would be sufficiently accurate at sea to be of use in determining a vessel's longitude.

MICROMETER AND VERNIER GAUGES

An Interesting Article on the Principle and Method of Using These Instruments for Measuring Small Lengths, Diameters, etc.

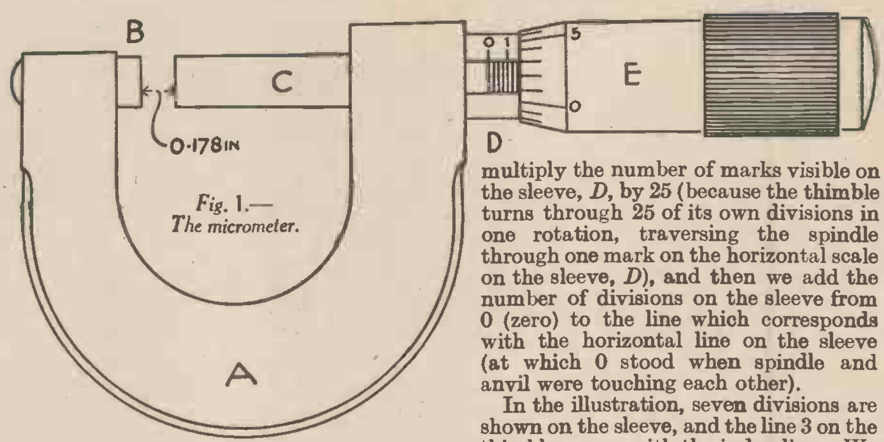


Fig. 1.—The micrometer.

ACCURACY of measurement of parts which have to fit or work together is one of the prime essentials of good engineering work. This accuracy is obtained by the use of the micrometer. The principle on which this device works may be explained in simple terms by taking first a screw fitting into a screwed hole as in Fig. 2. If the screw has ten threads to the inch and we rotate it through exactly one turn, it will obviously travel forward one-tenth of an inch. If we were to mark ten equal divisions around the head of the screw and move it round through the amount equal to one of the divisions, it would travel forward one-tenth of one-tenth of an inch, *i.e.*, one-hundredth of an inch.

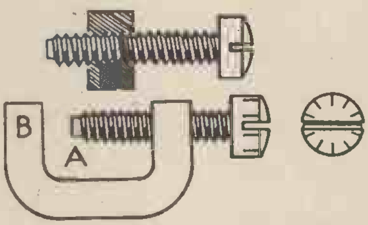
Thus, if the screw was fitted into a horseshoe as shown in Fig. 3, we could measure anything between one end, *A*, and the end of the shoe, *B*, by noting how many turns and how many tenths of a turn were required to allow space between the screw and the end of the horseshoe to exactly accommodate the piece to be measured.

The Micrometer Described

In Fig. 1 is shown a micrometer which comprises a frame, *A*, carrying a fixed measuring point or surface, *B*, which we call the anvil. A spindle, *C*, passes through a sleeve, *D*. This sleeve has an internal thread, and a thread on the spindle, *C*, engages accurately with it without the slightest shake or back lash. This spindle, *C*, has fixed to it at its outer end a second sleeve or thimble, *E*, which fits closely over the outside of the sleeve, *D*, and moves along it and around it as the spindle, *C*, is screwed into the sleeve, *D*.

Both sleeve, *D*, and thimble, *E*, are marked with graduations. On the sleeve they are marked along a straight line and show the distance the thimble, *E* (and therefore the spindle, *C*), moves along. The spindle, *C*, has forty threads per inch, so that one turn of the thimble moves the spindle along $\frac{1}{40}$ in., or ·025 in. The number of turns given to the spindle is shown on the scale of divisions on the sleeve, *D*, each fourth division—marked 1, 2, 3, etc.—representing $\frac{1}{10}$ in.

The bevelled edge of the thimble has twenty-five divisions, every fifth line being figured.



Figs. 2 and 3.—(Above) A screw fitting into a screwed hole aptly illustrates the principle on which the micrometer works, and (below) a screw fitted into a horseshoe is a micrometer in a miniature form.

Taking a Reading

Rotating the thimble from one of these divisions to the next moves the spindle one twenty-fifth of $\frac{1}{40}$ in., that is, one twenty-fifth of a turn, and since there are forty threads to the inch, one twenty-fifth of $\frac{1}{40}$ in. is, of course, $\frac{1}{1000}$ in., or ·001 in.

Therefore, to take a reading we place the object to be measured against the anvil, *B*, and rotate the thimble, *E*, until the end of the spindle, *C*, touches the object. The distance between the end of the spindle, *C*, and the face of the anvil, *B*, will be the size of the object being measured, and that distance will be indicated by fortieth in. on the scale along the sleeve, *D*, and twenty-five thousandths around the end of the thimble, *E*.

To get the measurement, we multiply the number of marks visible on the sleeve, *D*, by 25 (because the thimble turns through 25 of its own divisions in one rotation, traversing the spindle through one mark on the horizontal scale on the sleeve, *D*), and then we add the number of divisions on the sleeve from 0 (zero) to the line which corresponds with the horizontal line on the sleeve (at which 0 stood when spindle and anvil were touching each other).

In the illustration, seven divisions are shown on the sleeve, and the line 3 on the thimble agrees with the index line. We multiply 7 by 25 and add 3, which equals 178 and is read as ·178 in. We can read it in another way. Read the figured division on sleeve, *D*, nearest the thimble as 100 and then count the succeeding subdivisions as 25, 50, 75, etc. In the case described we have 100 + 75 = 175, and if we add 3 for the reading on the spindle, *E*, we get 178 or ·178 as before.

The Vernier Gauge

The vernier gauge shown in Fig. 4, which is a calliper for taking outside and some inside measurements, works on a different principle. It consists of two parallel jaws—one, *A*, fixed to a straight bar, *B*, and the other, *C*, sliding along the bar. It is between these jaws that the object to be measured is placed: the jaws being closed on to it.

The bar, *B*, with the fixed jaw has a scale marked along it in inches and tenths, and each tenth is divided into four parts so that there are forty divisions to the inch. On the sliding jaw, *C*, there are twenty-five divisions on a vernier scale, which correspond in extreme length with twenty-four divisions on the bar. Therefore, each division on the sliding vernier is smaller than each division on the rule by

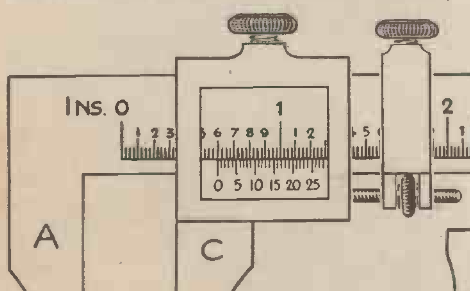
$$\frac{1}{25} \times \frac{1}{40} = \frac{1}{1{,}000} = 0{\cdot}001 \text{ in.}$$

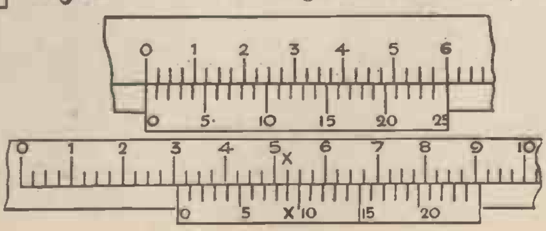
When the line marked "0" on the vernier corresponds with the line marked "0" on the rule, then the two next lines to the right will differ from each other by ·001 in. This difference continues to increase by ·001 in. for each division until the lines again coincide on bar and vernier scale at 25 on the vernier and 24 on the scale. This is shown enlarged in Fig. 5.

Reading the Vernier

To read the measurement, it is necessary to note the number of inches, tenths of inches, and parts of tenths the "0" point on the vernier has been moved from the "0" point on the bar, and then to count on the vernier in the same direction the number of divisions until one is found (there will only be one) which coincides with the line on the bar. The latter number gives the number of thousandths to be added to the amount already read off; the result being the required dimension.

In the illustration of the vernier (Fig. 4), the reading shows that the calliper jaws are ·6 in. apart.





Figs. 4 and 5.—These two sketches show the main details of the vernier gauge.

Fig. 1.—A side view of a Handley Page "Heyford." The cockpit is right up in the front fuselage, just behind the front gunner's cockpit.

THE PILOT'S COCKPIT

By "Aircraftsman"

Although to the Average Person the Number of Controls in the Cockpit of an Aeroplane May Seem Unnecessary, They are Essential to Enable the 'Plane to Move in Three Dimensions

ALTHOUGH I have been a pilot for quite a number of years, I never cease to wonder at the amazing variety of instruments and gadgets with which the cockpit of the average modern aeroplane is equipped. Surely no one man, with the possible exception of Mr. Heath Robinson, could ever have conceived them all, but with the combined efforts of a multitude of aircraft and instrument designers, the average cockpit is now so full that even Mr. Robinson would have difficulty in inventing a new gadget. And he would certainly have even greater difficulty in finding the room to install it.

The complicated equipment of the modern aircraft is not the result of a misguided wish for both necessary and unnecessary instruments, but is the natural result of the ability of the aircraft to move in three dimensions. This freedom of movement automatically requires additional controls for the aircraft itself; the range of temperatures and pressures encountered necessitates additional instruments and controls for the engine, and in order that the pilot may find his way, he must be provided with an extensive range of navigational instruments—a compass, a turn indicator, air-speed indicator, and altimeter, to say nothing of oxygen equipment, radio, or heating controls.

Simple Controls

The actual aircraft controls are very simple and are practically identical in every machine. They comprise the control column, or joy-stick, and the rudder bar.

The control column may be clearly seen in Fig. 2, fitted with a ring-shaped handle. It moves on a universal joint at the base, and is so connected by control cables that a backwards or forwards motion operates the elevator planes and so controls the angle of climb or dive, while a sideways motion controls the movements of the ailerons, and so controls the rolling or banking of the machine.

The rudder bar, which may also be seen in Fig. 2, is operated by the pilot's feet. The rudder is always used in conjunction with the control column because the one reacts on the other. Suppose, for example, that one wishes to make a simple banked turn. The pilot first applies the rudder to start the machine turning, and then, to prevent the machine skidding outwards, he banks the machine by pressing the control column to one side. If the turn is a fairly steep one, however, the elevators and the rudder begin to exchange functions on account of the banking of the aircraft, and thus, on a steep turn, the pilot must partly use the elevators to control the turning and the rudder bar to control the level.

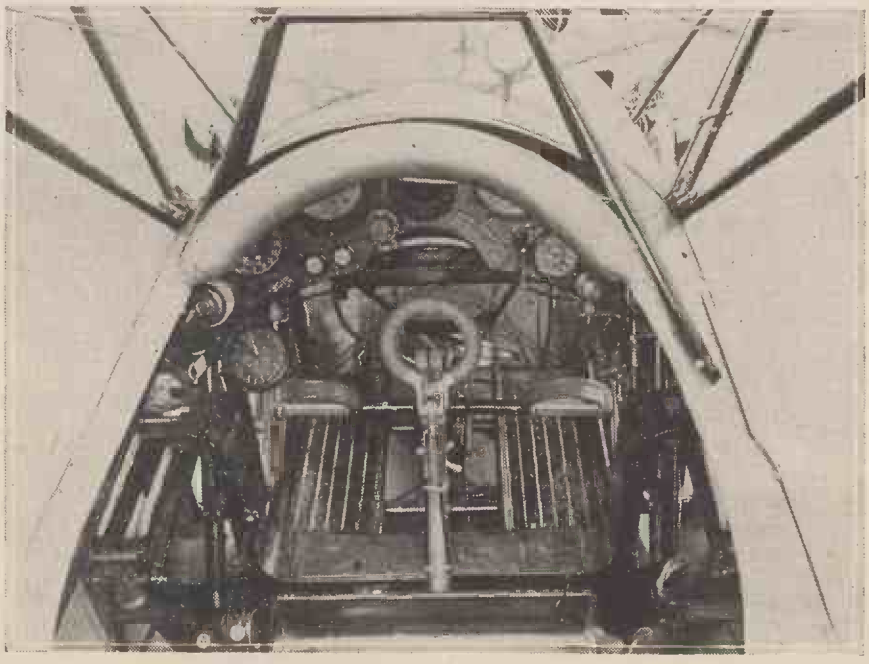


Fig. 2.—The cockpit of a Bristol Bulldog two-seater.

Looping the Loop

While on the subject of the aircraft controls, it is permissible to remark that

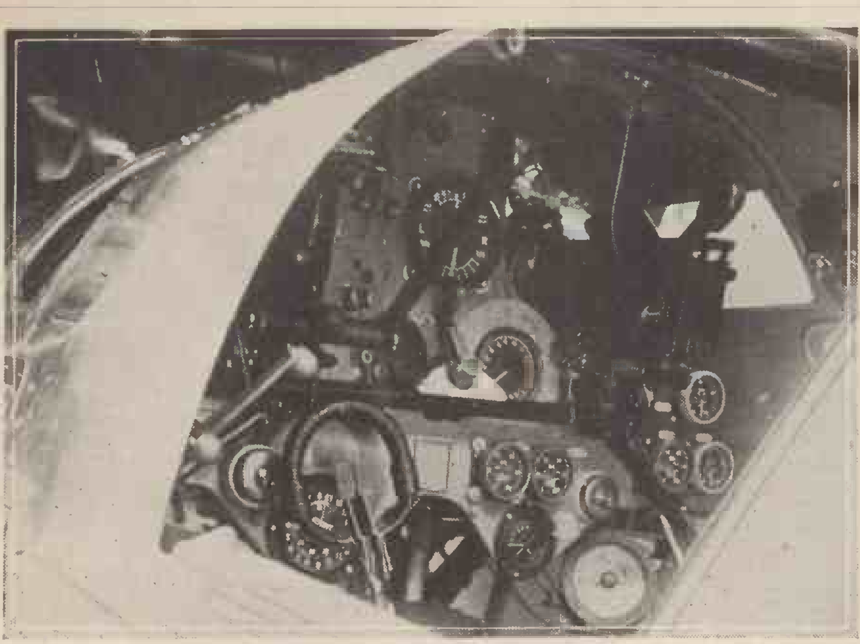


Fig. 3.—The cockpit of a Hawker Fury.

the popular stunt of looping the loop is, in reality, the most simple manœuvre. It is achieved by first diving the machine slightly to gain speed and then pulling back the control column fairly hard. The nose of the machine rises rapidly and, on reaching the top of the loop one sees the horizon exactly upside down. At this moment, the throttle must be closed to prevent too rapid a dive as one comes out of the loop, and when one regains a level attitude, the throttle is reopened and level flight continued.

If the actual controls are simple and more or less standard in every aircraft, the accessory equipment most certainly is not. No given instrument can be relied upon to be fixed in the same position on two different machines, and a pilot flying a strange machine must always spend some minutes in locating the various instruments and understanding the functions of any which are unusual.

Every aeroplane must carry a compass, an air-speed indicator, an altimeter, and an engine-speed indicator.

The compass used is a special type of magnetic compass with a very long vibration period. A long period is necessary because a quick-period compass is too erratic for aircraft use and is very liable to indicate a turn in the wrong direction when flying on a Northerly course. This fault is known as the Northerly Turning Error and is much reduced on compasses with a period of 30 seconds or longer.

The air-speed indicator is really a differential pressure gauge and measures the difference between the static air presssure and the air pressure due to the forward speed of the aircraft.

The altimeter is nothing more or less than an ordinary aneroid barometer with a very extended range. On ascending to any altitude, the air pressure falls appreciably on account of the decrease in the weight of the air above. Near ground-level, the rate of the fall of air pressure is approximately equivalent to 1 in. of mercury for every 1,000 ft., but the rate gets less at greater altitudes. It will thus be seen that an ordinary aneroid, calibrated from 28 in. to 31 in. of mercury, would only serve for height measurement up to about 3,000 ft. The air pressure at 20,000 ft. is approximately 13·7 in., while at 30,000 ft. it is only 8·9 in. of mercury.

The Turn Indicator

One of the most useful instruments, particularly when flying in clouds or at night, is the turn indicator, one of which may be seen at the top of the dashboard in Fig. 3. When flying out of sight of the ground, it is difficult to tell when the machine is turning or to keep it on a straight and steady course by the use of the compass, since the compass itself is unreliable unless one is flying straight. In order that the pilot may be able to detect a turn, an instrument which incorporates a small high-speed gyroscope is used. The gyroscope is pivoted about a horizontal axis in such a manner that if the aeroplane turns, a pointer on the scale shows the actual rate of turning. By watching the pointer carefully, the pilot can use his rudder so as to keep the machine on a dead straight course for long periods.

Unless a pilot has a turn indicator, there is always some risk of his losing control in rough weather with poor visibility and the instrument is therefore always fitted to passenger-carrying aircraft.

The modern aircraft engine generally requires a multitude of controls and instruments, and the cockpit of a twin- or triple-engined machine becomes a bewildering maze of knobs and dials. There is usually a fuel pump for priming the engine before starting; there are the magneto switches and the starter magneto, or sometimes there is a compressed-air arrangement for starting, in which case there are extra cocks and pressure gauges.

If the engine is a supercharged one, there will be a boost pressure gauge, as the engine must not be run under full supercharge at low altitudes. Then there is generally a fuel pressure gauge and a petrol depth gauge to show the quantity of petrol in the tanks, and if there are several tanks there is generally a complicated system of petrol cocks.

The Oil-pressure Gauge

There is always an oil-pressure gauge —one of the most important instruments so far as the engine is concerned—and there is nearly always an oil-temperature thermometer.

If the engine is a water-cooled one, there are generally two radiator thermometers, one to show the temperature of the water entering the radiator and the other to show the exit temperature. The first radiator thermometer is always marked off to show the boiling-points of water at various altitudes. Water boils at a lower temperature at high altitudes—for example, at 20,000 ft. the boiling-point is only 85° C. —and the pilot must watch the thermo-

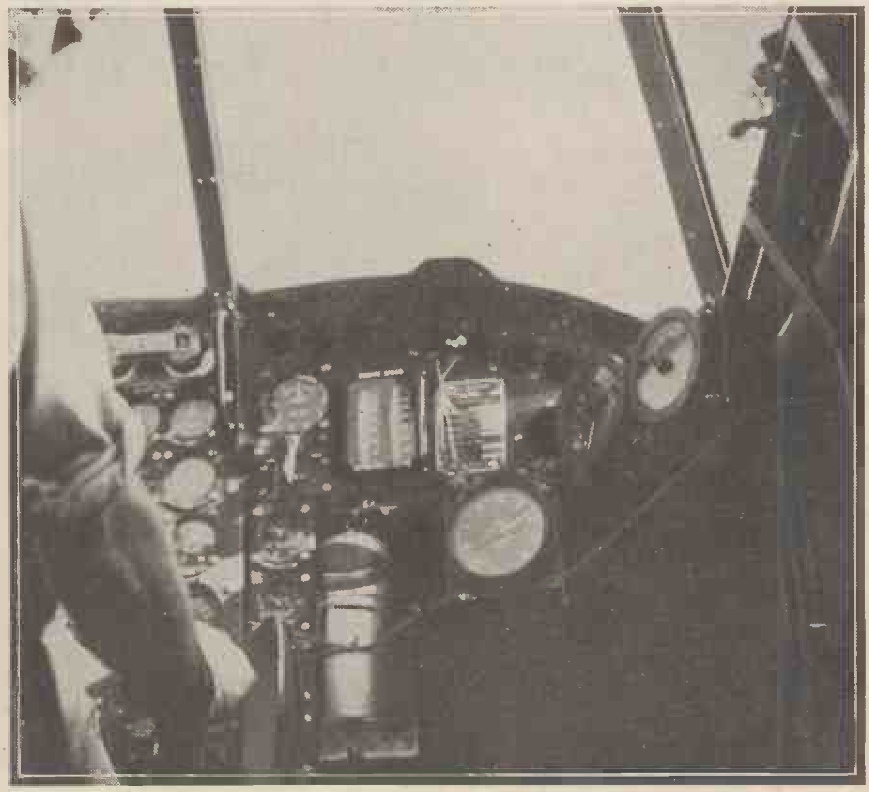


Fig. 4.—Part of the cockpit of a Heyford night bomber.

meter and adjust his radiator to ensure that the boiling-point is not exceeded.

Another part of the cockpit equipment in a high-altitude machine is the oxygen supply apparatus, and this requires careful attention if accidents are to be avoided. A pilot requires oxygen breathing apparatus if he is to fly above 20,000 ft., and the quantity of oxygen taken must be adjusted according to his altitude.

Failure of the oxygen supply, or an insufficient supply, is a very dangerous happening, as unconsciousness develops suddenly and without the least preliminary warning or discomfort. The pilot would thus lose all control and he might or might not return to consciousness before the machine crashed. Shortage of oxygen does not of itself cause rapid death, as was proved a few months ago by Fl.-Lt. Stainforth, the recent holder of the world speed record. He was flying with a passenger in the rear cockpit at 30,000 ft., and after half an hour at that altitude, he descended and landed. His passenger was found unconscious and almost dead, due to a failure of his oxygen supply on the ascent. His notes showed that he had been conscious on the ascent as far as 25,000 ft., but there was nothing later, and he had thus been dangerously short of oxygen for nearly an hour. Happily he recovered consciousness about six hours later, and after two days in hospital was none the worse for his adventure, but the incident showed the extreme danger of any mishap or carelessness in dealing with the oxygen apparatus.

Small Items

Besides the principal equipment already mentioned there are countless small items of various natures to be found in different cockpits. A machine which flies at night will be fitted with magnesium wing-tip flares in case of a forced landing, and these are controlled by electric buttons on the dashboard, two of which may be seen in Fig. 2. A fighter aircraft will usually carry two machine guns, which are fitted into the sides of the fuselage just in front of the cockpit. The machine guns require certain equipment for their operation—and their triggers are usually mounted on the joy-stick, as may be seen in Figs. 2 and 3.

Many aircraft are equipped with radio apparatus, and although this is usually installed in some other part of the machine, its use introduces several additional fittings for the cockpit. The electrical circuits require a special switchboard and the voltmeters, ammeters, and tuning controls have all to be fitted to accessible positions.

The above remarks will show that the average aircraft pilot of to-day has something more to do than steer his machine. He must be the chief engineer, navigator, radio operator, and pilot all rolled into one, and though constant practice may render his duties largely automatic, he should always remember that upon his constant attention and watchfulness must depend the lives of his passengers and himself.

A Remarkable Engineering Feat in Sweden

A Brief Description of the Gota Canal Which is 347 Miles in Length

(Left) The Trollhattan Falls, Gota River. These falls have lost much of their might and beauty, for the water is used to drive the turbines of the power station shown below. (Right) One of the passenger steamers that make the journey in three days from Gothenburg to Stockholm.

VISITORS to Sweden are no doubt familiar with the wonderful Gota Canal which runs across that country, from Gothenburg to Stockholm. A chain of rivers and lakes were linked up to form this long waterway of 347 miles, of which only one-third is artificial. Work was originally begun in the early part of the sixteenth century. It was a royal scheme taken up by successive rulers during three centuries, and the water rises to a height of 91½ metres above the North Sea, by a series of twenty-five step-locks, and down to the Baltic by thirty-nine.

The Trollhattan Falls

One of the most interesting parts of this canal is seen at Trollhattan Falls. The Gota River had to be diverted to pass these very high and rapid falls, and the three different systems of locks still to be seen give evidence of the work that was entailed before perfecting a system that is navigable for ocean-going vessels. Steamers make the journey between Gothenburg and Stockholm in three days.

The turbines of the gigantic power station which create 190,000 h.p.

Steamer Accommodation

The boats are very comfortable, as they are provided with sleeping accommodation aboard; and at each of the important towns, travellers can leave the boat for sight-seeing. These steamers take a matter of two hours to get through the locks, and it is whilst at Trollhattan one can visit the gigantic power station which has taken most of the water from the falls to drive the turbines creating 190,000 h.p. of electrical energy, which is distributed to the greater part of West Sweden.

From Trollhattan the steamers continue up the river, and after passing through a short stretch of canal reach Vanern — Europe's third largest lake, a wonderful panorama of a fresh-water sea. Leaving this lake, one finds himself in the locks between Sjotorp and Toreboda with a wall of foliage on either side, and this ever-changing scenery is a source of delight to all tourists who make this waterway trip to Stockholm.

HIGH-VOLTAGE STREET LIGHTING

A night scene on the Albert Embankment. The main thoroughfare is illuminated by 400-watt lamps, while the "Dolphin" standards which stud the whole length of the parapet have been adapted to accommodate 250-watt "Osira" lamps.

Details of an Electric Discharge Lamp Which is Being Used Extensively for Public Lighting Schemes

MANY readers of PRACTICAL MECHANICS must have seen the new electric discharge street lamps which are now rapidly replacing the old type of street lamp all over the country, and bringing a tremendous improvement to road safety at night. Some, no doubt, have wondered how they work, and below we give a brief description in simple language.

The first electric light was the arc lamp—very bright, but very expensive to keep going. Then came the carbon lamp, good in its day, but now used only for what it really is—a heater. After that came the first metal filament lamp, which really did convert some of the current supplied into light, but still wasted a considerable amount as heat. The gas-filled or "half-watt" lamp was next produced, which was better, but still was much more of a "heater" than a "lighter."

"Cold Light"

A great deal of experiment was done to try to produce "cold" light; that is, light only, with no waste of heat. It was found possible to approach this ideal with tubes filled with various gases, and we have all watched the progress made in the Neon sign business. The type of tube used for signs, however, has the great drawback that a high voltage has to be used.

At this point comes the "Osira" lamp, developed by the G.E.C. This is a combination of three principles, very ingeniously worked together. It consists of a glass tube about 6 in. long, at both ends of which are sealed-in pieces of special wire. This tube is mounted inside another larger tube, and the space in between is made a vacuum to keep in the heat, on the same principle as a vacuum flask. The inner tube contains some rare gas called argon, and also a little mercury.

Switching on the Lamp

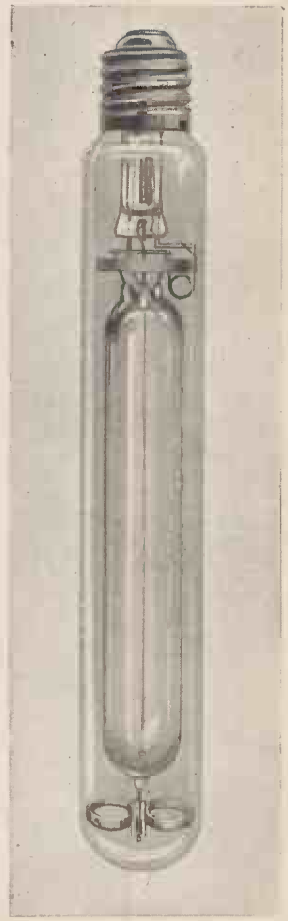
When the lamp is switched on, the voltage causes a current to flow through the argon between the special wire at one end and a small starting wire near to it. This current makes the special wire warm up, and it thereupon acts like the filament of a wireless valve and starts shooting off electrons. These electrons are attracted to the special wire at the other end of the tube, and move at high velocity. But, freely moving about the tube, are odd atoms of mercury. Inevitably there are collisions, and the impact of the electrons against the mercury atoms is so severe that they give out light, and even set free other electrons, which also start to collide with further atoms. In a little while the whole tube becomes filled with "lit up" electrons and atoms of mercury. As is to be expected, the atmosphere becomes heated and the mercury, still left liquid, evaporates and adds more atoms to those already inside the tube.

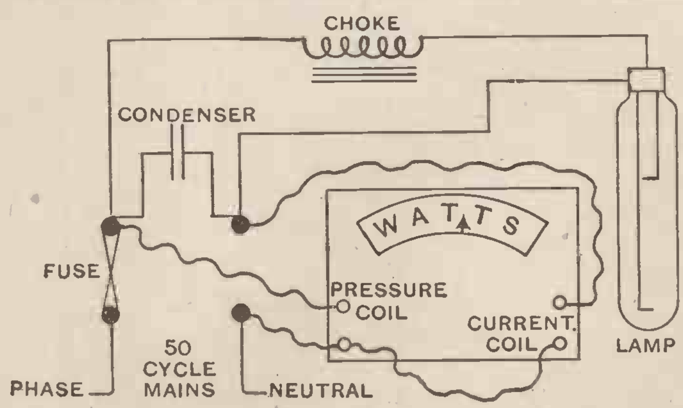
At this point the argon is parted from the electrons and mercury atoms, the two latter being left to a central pencil, which by this time is emitting an enormous amount of light in proportion to the current being used.

The Advantages of the Osira Lamp

Besides its high efficiency it has the great advantage that the light comes from a fairly large area (about 6 in. by ¼ in. diameter). It is therefore much less "glaring" than arc lamps, high-wattage filament lamps, or even gas mantles, and so is ideal for street lighting. Because it gives so much light for less current, the light can be used as it should be and the whole road and footpaths given a bright and even illumination.

It has rightly been named "accident-proof lighting," for it enables not only motorists but pedestrians as well, to judge the speed and position of other road users as easily as in daylight.





(Above) The "Osira" lamp. The actual source of light is a luminous cord of gas about ¼ in. in diameter, which stretches between the two electrodes. The lamp must be burnt in a vertical position with the cap up. (Left) Theoretical diagram showing the method of measuring the overall wattage of the "Osira" lamp unit.

Small Tools and Cutters—3

By W. H. Deller

The First and Second Articles on this Subject Appeared in Our June and August 1935 Issues Respectively

TWIST DRILLS when properly ground and applied have many advantages over those of other types, and therefore are found in common use for work of a general character. In operation their chief characteristics are rapid cutting, self-clearing, and as this form of drill is also self-guiding, a deep hole can, providing that the drill is rotated and fed in a fixed line, be drilled with reasonable assurance that the resultant hole will be straight throughout its depth. Further than this, the fact that re-sharpening may be carried out until almost the whole of the fluted portion of the drill has been utilised makes them most economical in use.

In order that the information may be rendered reasonably complete, and that relevant to the operation of regrinding made readily understandable, a brief survey of the different forms and sizes manufactured, together with the leading features of the design of twist drills in general, will be dealt with first.

Sizes and Types

Most of the drills of the types mentioned can be had in two varieties, carbon and high-speed. This refers, of course, to the material from which the drills are made, but it would be as well to mention at once that those made from high-speed steel cost approximately twice as much as the others, and unless means are at hand to make full use of the special properties of the more expensive kind, no real benefit will result from their use. In fact, with the drilling speeds usually available in small workshops, carbon drills will give better service, inasmuch as the breakage of smaller drills will be a far less frequent occurrence.

The type of twist drill commonly stocked by the local tool shops is known as "jobbers" straight shank. The first word serves as a reference to the standard lengths to which the drills are made, and the shanks are equal in diameter to the nominal size of the drill. Such drills run up to $\frac{1}{2}$ in. or equivalent diameter, and are made from $\frac{1}{32}$ in. or smaller, advancing by $\frac{1}{64}$ths, upwards. An idea of the range of sizes covered may be gathered from the fact that it also covers metric, letter-gauge, and wire-gauge sizes.

Parallel Shank Drills

For sizes above $\frac{1}{2}$ in. diameter to be used in a hand drill, or drilling machine having a chuck up to $\frac{1}{2}$-in.-diameter capacity, there is a range of parallel shank drills, and although it is not suggested that they can all be driven in the manner mentioned, they run up to $1\frac{1}{2}$ in. diameter. Some of the heavier forms of hand-drilling machines have, in place of the usual chuck or taper socket, a simple form of chuck which will hold one only, namely, $\frac{1}{2}$ in. or $\frac{5}{8}$ in. diameter. The drive is effected by means of a set screw, hence the flat which is milled along the shank of this particular type of drill.

Drills from $\frac{1}{16}$ in. diameter upwards are also made with Morse taper shanks. The particular number of the taper is governed by the most economical size of steel that can

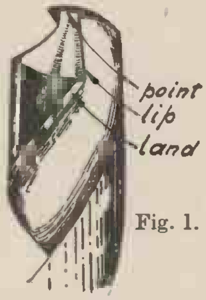


Fig. 1.—If the groove of a drill is cut to the angle shown it forms a top rake to the cutting edge and feeds the swarf upwards out of the hole as the drilling proceeds. Fig. 2.—A drill with an excessive grinding clearance. Fig. 3.—Showing a slight hump left in front of the cutting edge.

be used, having in mind also the diameter of the drill.

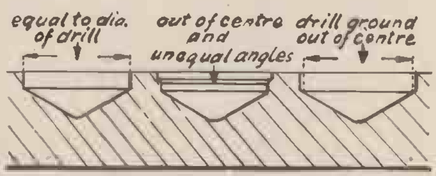
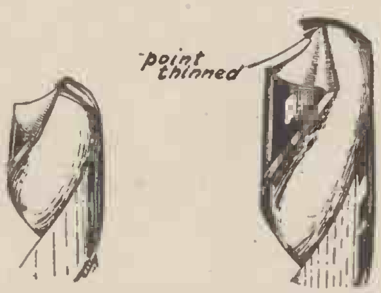


Fig. 4.—For important work, the drill should be tried out on an odd piece of scrap material. In this way faulty grinding can easily be checked.

In total length these drills conform to the same standard as those known as "long series" straight-shank drills, and where an extra long drill is required these are worth remembering. A comparison as to their length may be gauged from the fact that whereas the overall length of a $\frac{1}{4}$-in. "jobber's" drill is 4 in., that of the same size in the "long series" is $6\frac{1}{2}$ in.



Figs. 5 and 6.—(Left) A drill suitable for drilling metal. (Right) If the point is too thick it retards the piercing action of the drill, and can be thinned to advantage by grinding as shown.

Fig. 7.—A drill intended purely for centring purposes.

Fig. 8.—A straight flute drill.

Apart from these types, there are those made with square shanks to suit ratchet braces, and also in the same shape for a carpenter's type of brace.

Any of the drills mentioned may be purchased singly or in sets.

Points Regarding Design

The usual form of twist drill has two flutes. These flutes are helically milled on opposite sides of the drill blank, the lead angle being approximately equal to the drill diameter multiplied by six. The flutes or grooves are milled with a special-shaped cutter, which generates a flat surface on the side that is to form the cutting edge, and the "hand" of the spiral is such that the positive rake is formed in relation to the cutting edge; this will be made clear by reference to Fig. 1. As the groove is cut at this angle it forms top rake to the cutting edge and feeds the swarf upwards out of the hole as the drilling proceeds. So that the sides of the drill do not bind when drilling, the drill is very slightly back tapered and also relieved until only a narrow "land" along the leading edges of each flute is left. The web left between the grooves forms the point of the drill, and the lips or cutting edges, for most purposes, fall away on each side to an included angle of approximately 120 degrees.

The Cutting Action of the Drill

For any cutting action to take place, it is only natural that the cutting edge or lip must be higher than the part of the drill immediately in the rear. It is probably the grinding of this clearance that represents the greatest difficulty to those not thoroughly acquainted with the requirements. The angle at which the clearance is ground governs the rate of feed. Thus a definite clearance of 1 degree would permit little more than a scraping cut being taken and requiring considerable pressure to make even that possible. On the other hand, excessive clearance is definitely bad, as it weakens the drill point and causes the cutting edges to wear rapidly. For the general run of work 10 degrees of clearance at the edge of the drill will be about right, the angle being made relative to the surface of the work. The clearance must increase towards the centre of the drill, and if the angles formed by the cutting edges and the line of the "point" connecting them are about 130 degrees, when looking at the drill end on, it may be taken for granted that such is the case.

Although the clearance angle given will be suitable for most purposes, it may to advantage be varied to suit widely different materials, and as a guide it can be remembered that the harder or tougher the material the less is the clearance required.

Drill Grinding

Re-sharpening or grinding becomes necessary after the cutting edges have become dulled by wear or through breakage. After a drill has been in use for some time, it may be that even after grinding the cutting edges, the tool will not cut freely and tends to bind in the hole. Where this trouble is experienced, examination will show that the lands have worn down on the front, so making a short part of the drill undersize in diameter. The binding or squeaking is caused by the larger portion of the lands following being made to force their way into an undersize hole. Unless the drill is corrected at once, the whole of the land will wear off, or perhaps cause the drill to seize and break off in the hole. To put the matter right, the drill must first be ground back to remove the bad part. Bearing in mind what has already been said regarding clearance, the most important factor in accurate drilling is to grind the drill so that it will cut a hole of the intended diameter. To do this, it means that the point of the drill must be central and also the slopes forming the cutting edges have to lie at equal angles with the axis of the drill. The special rests fitted to some small grinders are intended to facilitate this operation, and while such a rest certainly does serve to keep the drill steady, particularly where the grinder is hand operated and used single handed, it must not be regarded in the same light as a proper twist-drill grinding attachment.

"Touching Up" a Drill

It is a comparatively simple matter to "touch up" a drill that has lost its edge, as the original existing surfaces can easily be followed, but where the grinding follows cutting back or breakage, it is suggested that it be done in the following manner, at all events until one is thoroughly accustomed to drill grinding.

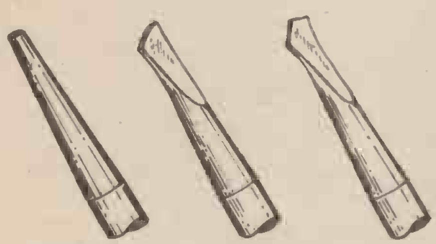


Fig. 9.—Three stages in making a small drill.

After having ground off the end of the drill flat, proceed to grind the slope on both sides of the point. Aim at getting both angles equal, the included angle correct, and both slopes of the same length. Do this by presenting the drill straight at the wheel at the required angle, ignoring for the moment the question of clearance. When satisfied that the grinding is as near as possible to requirements, grind the clearance by starting away from the cutting edge and grinding towards it, slightly rolling the drill backwards and forwards in the fingers while so doing. In this way the clearance can be brought up to the lips already ground without interference with the angle.

Faults in Grinding

Common faults in grinding clearance are shown in Fig. 2, which is excessive, and Fig. 3, where there is a slight hump left in front of the cutting edge. For important work, the drill can be tried out in an odd piece of plate; the first part of the section in Fig. 4, shows what should result from a correctly-ground drill, and the second from a drill ground out of centre and with the slope angles unequal. Providing that the hole is not drilled too deep, it is quite easy, by placing the drill in the hole again after it is removed from the machine, to see which slope requires correction. Where the drill is merely ground out of centre, it will produce an oversize hole, as in the third position, and here again it will be quite easy to see where the trouble lies.

The web between the flutes of a drill often increases in thickness towards the shank, so that as the drill becomes shorter the point is correspondingly wider. If the point is too thick, it retards the piercing action of the drill, and can be thinned to advantage by grinding as in Fig. 6.

For drilling metals such as brass, where the tendency is for the drill to feed too fast or "dig-in," the rake of the lips may be reduced advantageously by grinding small flats on the front in an almost vertical plane, as in Fig. 5.

Other Drills

The type of drill seen in Fig. 7 is intended purely for centring purposes, and is known as a "combination centre drill." In size, they run from "A" to "S" and from No. 1 to 10. Size "A" has a body $\frac{3}{16}$ in. diameter × $\frac{3}{32}$ in. and $\frac{1}{8}$ in. diameter points, "S" being $\frac{1}{8}$ in. diameter × No. 57 points. The number sizes run from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. diameter on the body. The speed at which centre drills should be run coincides with that suitable for a drill of a diameter similar to the point. Straight flute drills of the type shown in Fig. 8 are useful for brass and aluminium work, and are ground in the same manner as a twist drill. A set of such drills is usually included with a small "American" wheel brace, or can be bought separately, although not a generally-stocked line.

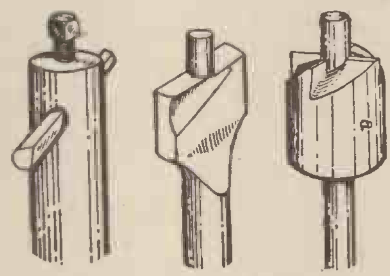


Fig. 10.—Cutters with interchangeable pilots.

Harpoon or flat-type drills are extremely easy to make where a special size is required. Large drills are forged from round bar smaller than the finished size required, the point and sides being turned true and to size before hardening. Small drills, however, must from a need for strength be made from larger silver-steel rod than the actual size of the drill. Fig. 9 shows the three stages in making a small drill. A piece of rod is first tapered down to about half the diameter of the finished drill, and the end then flattened out to give sufficient width. After hardening and tempering, the point is ground on to run true with the shank and the sides, and is afterwards ground to correct diameter. After cleaning up the flats by grinding, the point is "backed off." For tiny drills stoning may be substituted for the grinding operations.

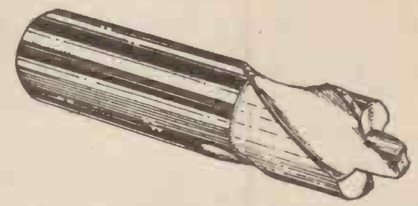


Fig. 11.—A useful set of counterbores can be made from short ends of twist drills as shown.

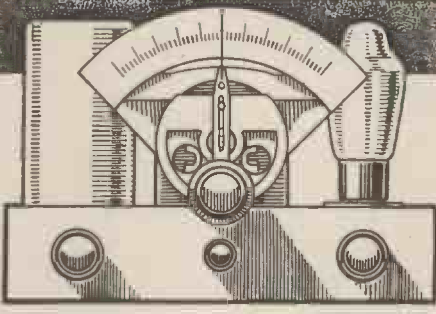
Counterbores

The simplest method of counterboring small holes is to open out the mouth of the hole with a larger drill, finishing with the same drill ground to cut a flat bottom. This cannot be done unless the depth of the counterbore is fairly considerable, and for anything in the nature of spot facing or counterboring from an uneven surface, a pilot cutter is required.

There are many such types of cutters put up in sets with interchangeable pilots and cutters, or they may be made in any of the forms shown in Fig. 10. That on the right is similar to a hollow mill, excepting that the bore is parallel and the cutter is pinned to a plain steel pilot and shank. For such a cutter to act as a deep counterbore, the sides of the teeth should be provided with relief. On the left is a plain cutter bar, which is suited to spot facing and counterboring larger diameters. The cutter is positioned and held by a pointed screw in the end of the bar, and re-sharpening is carried out by the removal of the cutter. The solid type of pin-drill in the centre is another useful form, but in order to make it economically, a forging is required. When used for working steel, the cutting edges should be slightly lipped in the manner shown. Any of the types of cutters illustrated may be modified for radiusing or countersinking operations.

A useful set of counterbores can be made from short ends of twist drills as in Fig. 11. Unless means are available for cylindrically grinding the pilot, the job will have to be carried out on a lathe, in which case only the ends of carbon-steel drills should be used. After annealing, the pilot is turned a shade smaller than the size of the hole in which it is to work. Back off the cutting edges close up to the pilot before hardening and tempering. It is an advantage, where the pilot is sufficiently large in size, to undercut at the back to make the filing of the relief and subsequent sharpening easier. It is surprising how soon a useful range of such cutters is accumulated, if one is made as the occasion demands.

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



THE "ULTRA-SUPER"

An Up-To-Date Ultra-Short-Wave Superhet. Five-Valve Receiver

As suitable valves for straightforward circuits for the reception of the ultra-short waves are not yet available, the choice of a circuit for these frequencies lies between the superheterodyne and the super-regeneration systems.

The latter is decidedly more simple and cheaper to build, but suffers from the disadvantage that weak signals are very difficult to hear on account of the quench-noise background. As most of the signals heard at the present time on the ultra-short waveband are lacking in strength, it is considered that the most suitable receiver for the amateur is of the superheterodyne type. Many difficulties, however, had to be overcome before a receiver could be produced which would be sensitive on weak signals, and at the same time, reliable and easy to control.

Stages of Amplification

The ultra-short-wave superhet-five employs an intermediate amplifier tuned to a frequency of 12 megacycles. This may be considered very high, but it was found, after considerable experiments, that, with the lower frequencies usually employed, the oscillator frequency was too close to the signal frequency, thereby causing interaction and "pulling." This resulted in a very unstable output and, at the same time, made tuning very difficult. With the I.F. units employed, however, these troubles are completely overcome, and the reduction of volume obtained with this frequency was overcome by means of another stage of amplification.

The band width of the intermediate amplifier may be varied by altering the coupling between the primary and secondary coils of the transformers, means for which are provided. The maximum width possible is 2½ megacycles. It will, therefore, be possible, by replacing the audio-transformer by a resistance, to adapt this receiver for use on high-definition television programmes.

An autodyne first detector is employed without any previous signal amplifier, as it was considered inadvisable to complicate the building of the receiver by the inclusion of ganged tuned circuits. The coil used for oscillating is wound on a tube of low-loss material, and the tuned winding consists of one turn of heavy gauge wire which is silver-plated to reduce its resistance to the high-frequency currents.

Wiring as Short as Possible

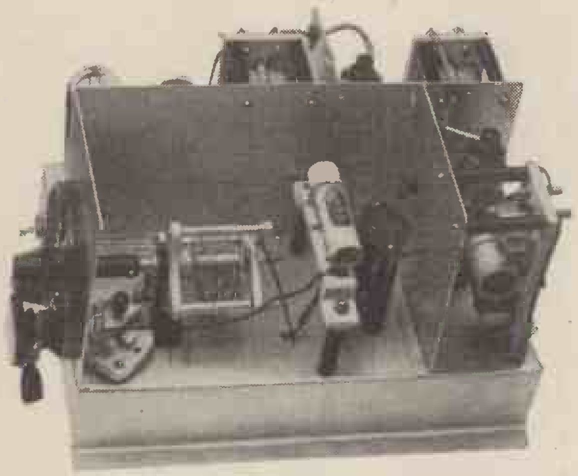
The tuning condenser has a maximum capacity of 67 m.mfds., and is also of the low-loss type, incorporating as little insulating material as possible. It should be noticed from the diagrams that the layout is so arranged that all wiring in this circuit is as short as possible, the valve and coils being both mounted on pillars to bring them close up to the tuning condenser terminals. With the arrangement as shown, the tuning range of the receiver is 5 to 8 metres; this band may be altered by plugging suitable coils in the sockets provided.

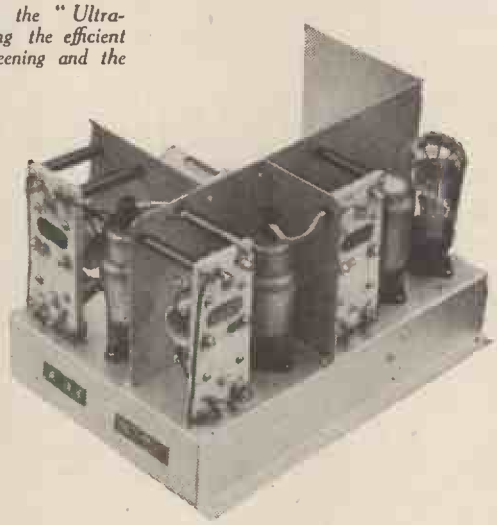
A triode valve is employed as a leaky-grid second detector and is fed by means of transformer coupling to the pentode output. The H.F. choke in the anode circuit of the detector has been specially designed to prevent the intermediate frequency from filtering to the output valve.

The Volume Control

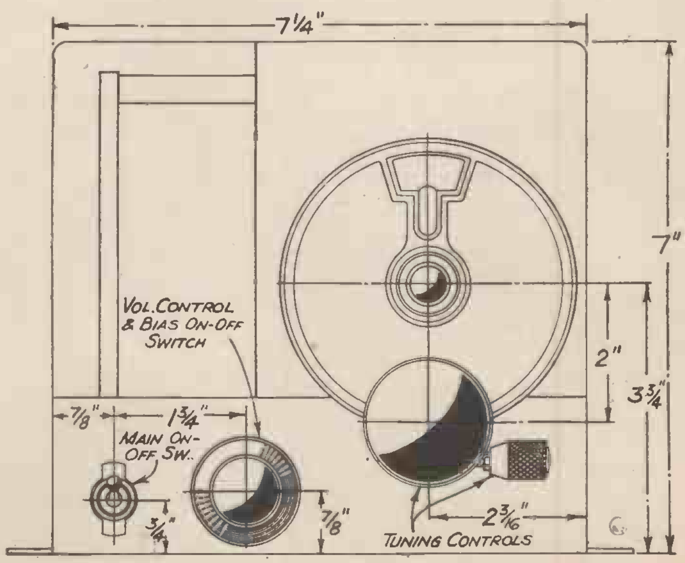
Volume control is effected in the intermediate amplifier by variation of the grid bias applied to the variable-mu I.F. amplifying valves. This enables a very smooth control to be obtained without sacrificing quality and, at the same time, prevents overloading of the second detector.

It cannot be stressed too strongly that the layout shown in the diagrams must be strictly adhered to, and that all leads, especially in the oscillator stage, must be kept as short as possible. It is important also that all

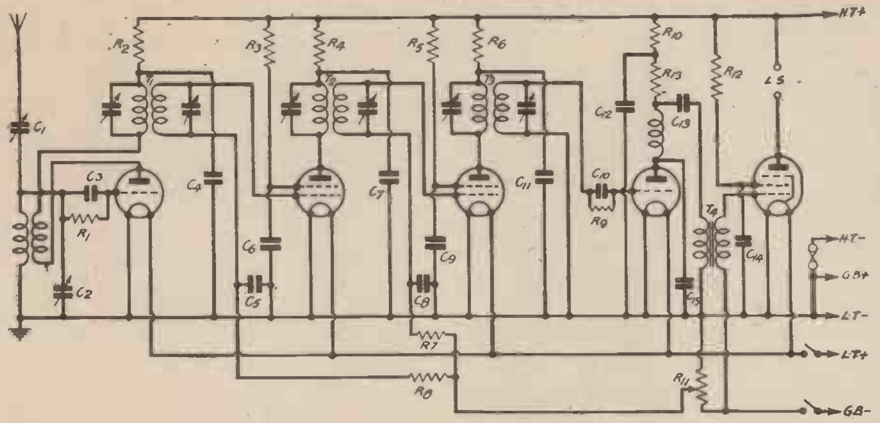




Two views of the "Ultra-Super," showing the efficient method of screening and the neat arrangement of the components.



The panel layout



The circuit diagram of the " Ultra-Super."

the earth wires in any individual stage must be connected to one point on the chassis as shown on the circuit diagram. If this is not done, voltage drops will occur in the leads with consequent loss in efficiency, and in the case of the oscillator section " blind spots " will occur.

LIST OF COMPONENTS FOR THE "ULTRA SUPER"

- Ultra-short-wave Coil, with base (B.T.S.).
- Short Wave Condenser, 67 m.mfd., with Slow-motion Drive, *C*2 (B.T.S.).
- Aerial Series Condenser, *C*1, 20 m.mfd. (B.T.S.).
- Three 12 m.c. I.F. Transformers (B.T.S.).
- Thirteen Fixed Condensers: three ·0001 mfd., *C*3, *C*10, *C*15; seven ·1 mfd., *C*4, *C*5, *C*6, *C*7, *C*8, *C*9, *C*11; three ·5 mfd. tubular, *C*12, *C*13, *C*14 (T.M.C.).
- Twelve Fixed Resistances: two 1 meg., *R*1, *R*9; one 5,000 ohms, *R*12; two 50,000 ohms, *R*3, *R*5; four 10,000 ohms, *R*2, *R*4, *R*6, *R*10; two 100,000 ohms, *R*7, *R*8; one 30,000 ohms, *R*13 (Amplion).
- One 50,000-ohm Potentiometer with Switch, *R*11 (Orion).
- One Short-wave Choke, No. 983 (Eddystone).
- One L.F. Transformer, Type Niclet (Varley).
- One On/off Switch, S.80S.B. (Bulgin).
- Five S.W. Ceramic Valveholders, four 4-pin, one 5-pin (Clix).
- Two Valveholder Supports (B.T.S.).
- Two Terminal Strips, A.E. and L.S. (Clix).
- One Insulated Bracket, No. 1007 (Eddystone).
- One Fuse, 60 mA., with Holder (Microfuse).
- Four Plugs: H.T. —, H.T. +, G.B. —, G.B. + (Clix).
- Two Spades: L.T. —, L.T. + (Clix).
- Metal Chassis (Peto-Scott).
- Twelve inches of Screened Lead (Ward & Goldstone).
- Five Valves: two D210, two VP215, one Y220 (Hivac).
- One 120-volt Battery (Drydex).
- One 9-volt G.B. Battery (Drydex).
- One 2-volt Accumulator (Exide).
- One Loud Speaker (Amplion).

RANDOM NOTES

Glass Boring Tools

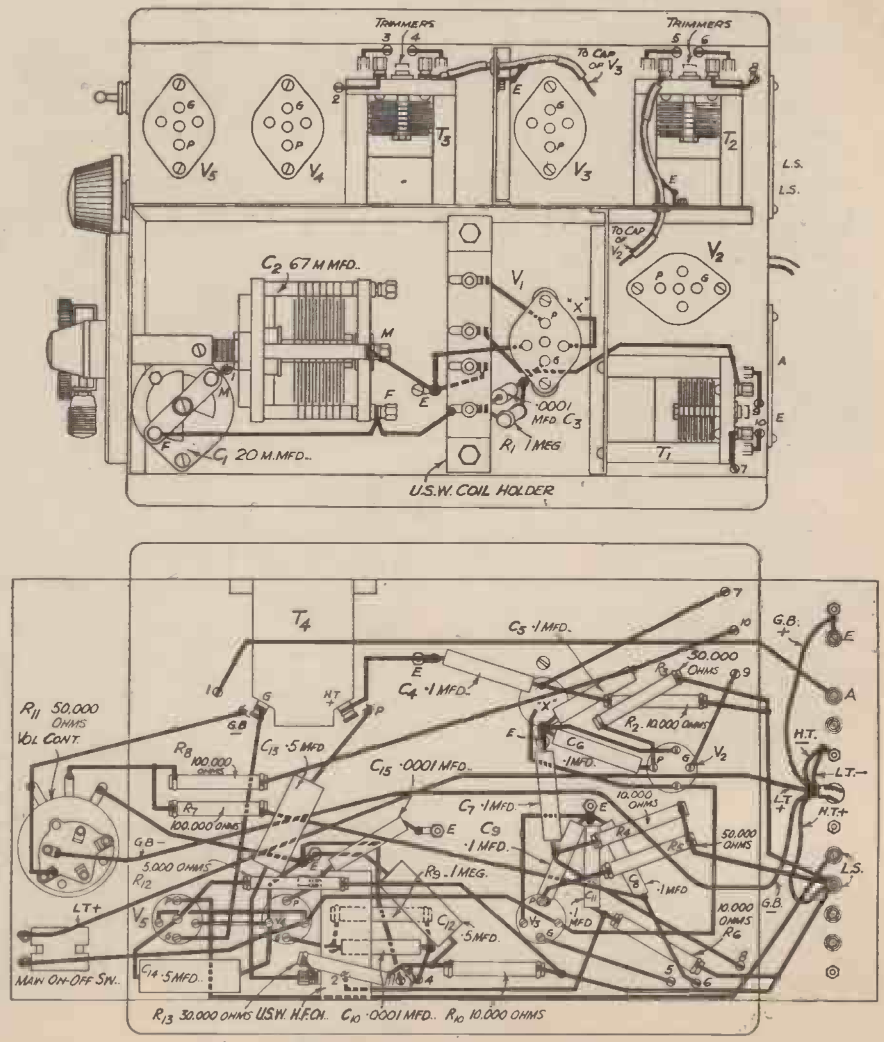
A DRILL designed and made of a special material for boring glass is now being manufactured. With this type of drill a ½-in. hole can be drilled through ¼-in. plate glass in 2½ minutes, using an ordinary hand brace. The pressure required to make the drill cut is not great, and windows, shelves, car windscreens, etc., can be bored without removing from the frame. The drills should be worked at about eighty revolutions per minute, using camphor dissolved in turpentine as a lubricant. The drills are taper, and consequently only two sizes are required to drill holes from ⅛ in. to ¾ in. The drills cost 1*s*. 3*d*. each.

Britain's Largest Photo-Mural

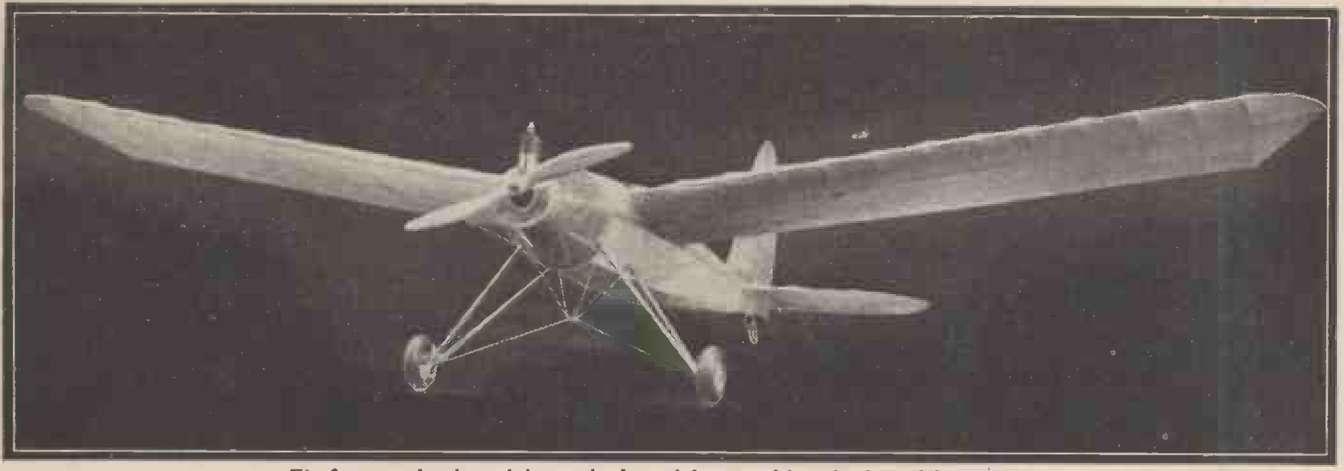
AT this year's Professional Photographers' Association Congress was shown the largest photo-mural ever made in Britain. There were 960 square feet of picture, covering three walls of a room.

The mural, entirely photographic, consisted of twenty-four panels, each 12 ft. by 40 in.

During the course of the production 300 negatives were made, and giant enlargers were specially constructed capable of making, in a single exposure, an enlargement measuring 12 ft. by 8 ft.



The top and underneath chassis wiring plan of the " Ultra-Super."



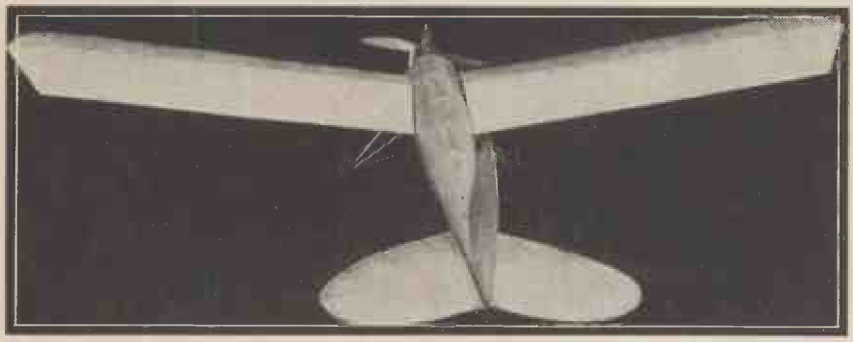
The fine up-to-date lines of the completed petrol-driven model can be observed from this view.

A Petrol-driven Model Monoplane

Covering, Proofing, and Adjusting

By F. J. Camm.

THE photograph at the top of this page indicates the attractive lines of the finished model, blueprints for every part of which are now ready and are listed to the left. Unproofed silk is used to cover the fuselage, and the following is the order in which the fabric is attached. First, carefully cover the underneath part of the fuselage with one piece of silk which extends from one horizontal fuselage member round to the other horizontal fuselage member. This single piece of fabric should be attached with drawing-pins to bulkhead F, since the chassis will not permit the underneath portion to be covered entirely in one piece. The bays between which the chassis is secured will have to be covered afterwards with two small pieces of silk. After attaching the drawing-pins, pull the silk as tautly as possible and attach further drawing-pins into the fuselage and the stern post. It will be found, if the silk is properly stretched, that the fabric will take on the tapering conical formation of the fuselage. Smear some glue along the horizontal fuselage members and gently work the fabric round, carefully effacing all wrinkles and puckers. Drawing-pins lightly pressed into the fuselage will ensure the tension on the silk



Rear view of the model.

BLUEPRINTS OF F. J. CAMM'S PETROL-DRIVEN MODEL MONOPLANE

The following full-size blueprints are now ready and may be obtained, at the prices mentioned, from the publishers: George Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2:

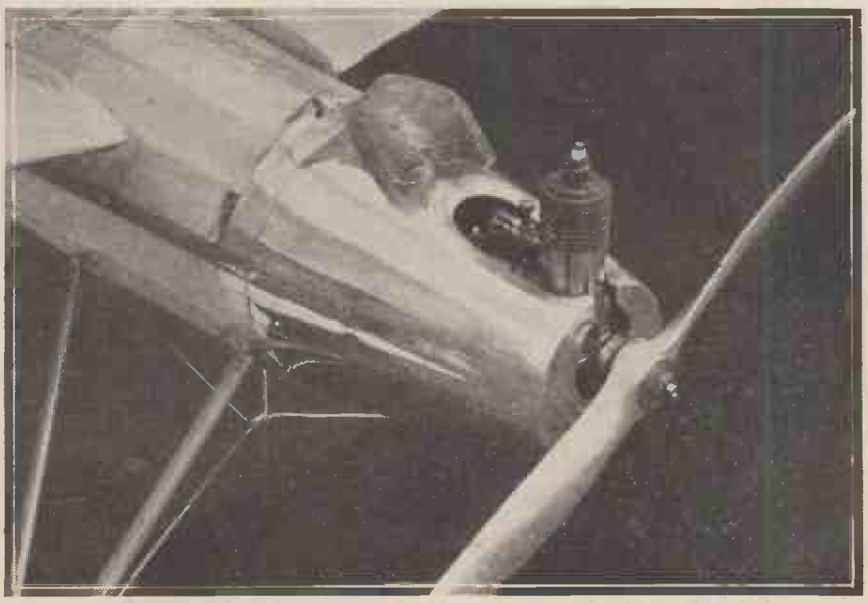
Sheet 1, price 1*s*.
This blueprint gives the shape of each bulkhead, the engine cradle, and the stiffeners.

Sheet 2, price 1*s*.
Shows the rudder and tail full size with methods of fixing.

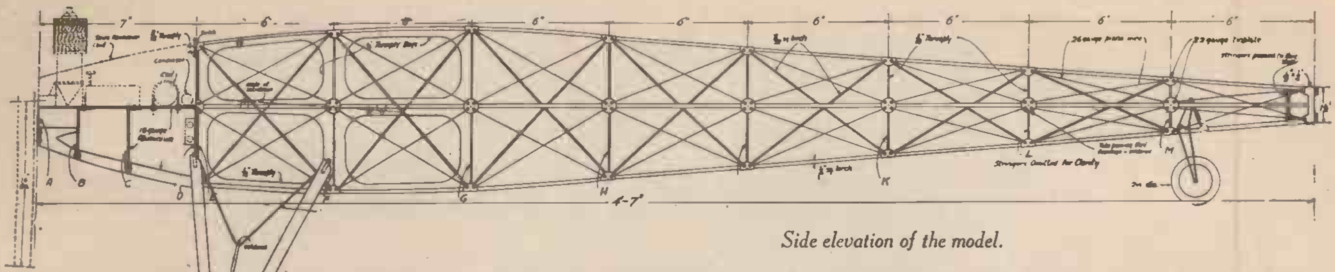
Sheet 3, price 4*s*.
Shows the fuselage full size in side elevation and plan, the holding-down strap for coil, chassis construction, rear wheel and suspension, switch and ignition circuit, wing fixings and method of bracing.

Sheet 4, price 1*s*. 6*d*.
Full-size plan of the mainplane, full-size rib section and wing couplings.

Sheet 5, price 6*d*.
Full-size plan of engine adapter for the Atom Minor, Hallam, Grayspec, and Economic engines.



The nose of the model, showing the aluminium engine cowl and removable lid.



Side elevation of the model.

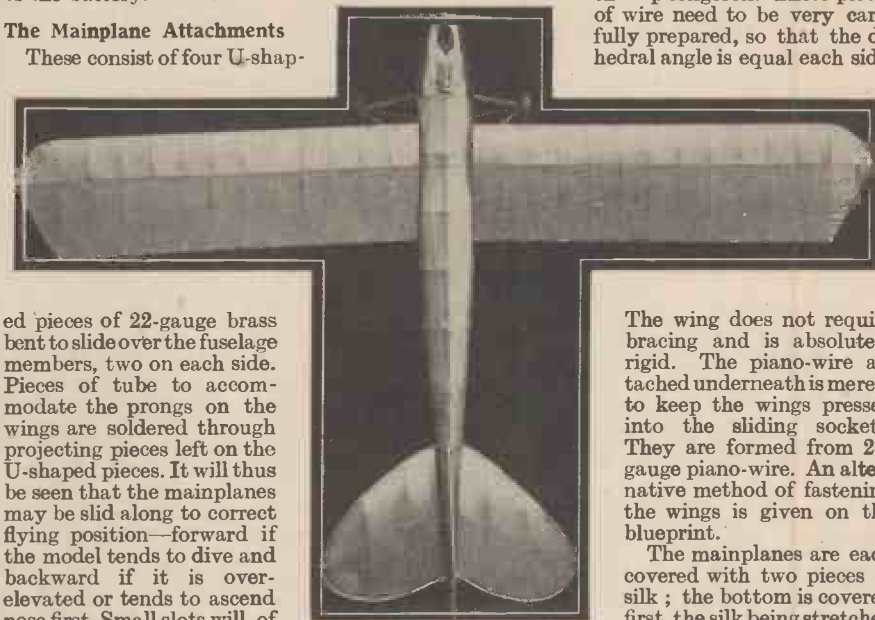
being maintained until the glue is dry. Then carefully cut away the superfluous silk with a safety-razor blade and cover the top of the fuselage in the same way. Only one piece of silk will be necessary for the top. In order to hide the edges of the silk, a narrow piece of ribbon may be glued over after the silk has been doped. Next cover in the two bays at the bottom of the fuselage between the chassis. The silk is best applied damp, and when dry, should be given one coat of clear dope and two coats of aluminium dope. The ribbons may then be glued over the join in the silk. Allow each coat of dope to dry by leaving it for at least two hours.

Connecting the Wing Sockets

The fuselage is completed by connecting the wing sockets, details of which are given on Sheet No. 3, and then wiring up the switch, a plan of which is also shown on the blueprint. Finally, a spun aluminium cowl passes over the engine and cradle, thus completing the streamlined form. This cowl will need to be cut at the front, as shown in the illustration, to clear the advance and retard lever, and at the top an oval slot will need to be cut for the cylinder to pass through and to leave the carburetter and tank exposed. In this condition the engine is ready for running, and when adjusted so that the maximum engine revs. are obtained, a 26-gauge aluminium lid closes the hole. This may be bent by the fingers to the requisite shape. If necessary, an aluminium spinner can be attached. Personally I do not think this to be necessary. In order to start the engine, two leads from a 4-volt accumulator are plugged into the sockets fixed to the side of the fuselage. As soon as the engine starts, the switch is thrown over, thus cutting the accumulator out of circuit and cutting in the dry battery. This latter should consist of two small micro-cells joined in series and disposed under the cowl or secured by rubber bands to the piano-wire axle stays. They had perhaps best be enclosed in a small streamlined case in the latter position, so that the model can be trimmed by slight movement of the battery.

The Mainplane Attachments

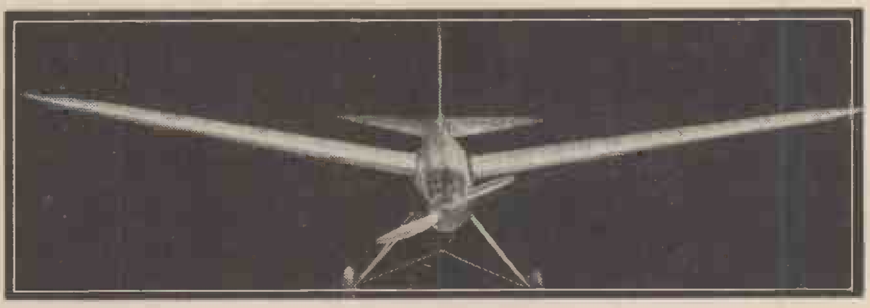
These consist of four U-shaped pieces of 22-gauge brass bent to slide over the fuselage members, two on each side. Pieces of tube to accommodate the prongs on the wings are soldered through projecting pieces left on the U-shaped pieces. It will thus be seen that the mainplanes may be slid along to correct flying position—forward if the model tends to dive and backward if it is over-elevated or tends to ascend nose first. Small slots will, of course, need to be cut in the silk to permit of this movement. Small screw eyes are fixed to the top mainspar, and short pieces of piano-wire with hook-shaped ends clutch these to a similar screw eye fixed to the top longeron. These pieces of wire need to be very carefully prepared, so that the dihedral angle is equal each side.



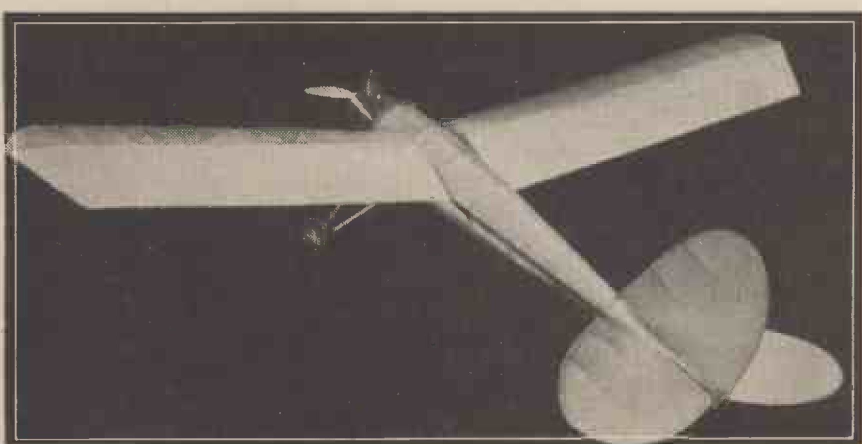
Plan view.

The wing does not require bracing and is absolutely rigid. The piano-wire attached underneath is merely to keep the wings pressed into the sliding sockets. They are formed from 20-gauge piano-wire. An alternative method of fastening the wings is given on the blueprint.

The mainplanes are each covered with two pieces of silk ; the bottom is covered first, the silk being stretched from end to end and then over the leading and trailing edges. Glue should also be applied to the edge of each rib. Next apply the silk in the same way to the top surface of each wing, and then give one coat of clear dope and two coats of aluminium. I recommend that you work from the full-size blueprint when laying out the various ribs and spars. The print gives the full-size rib section, which can be transferred direct on to the material.



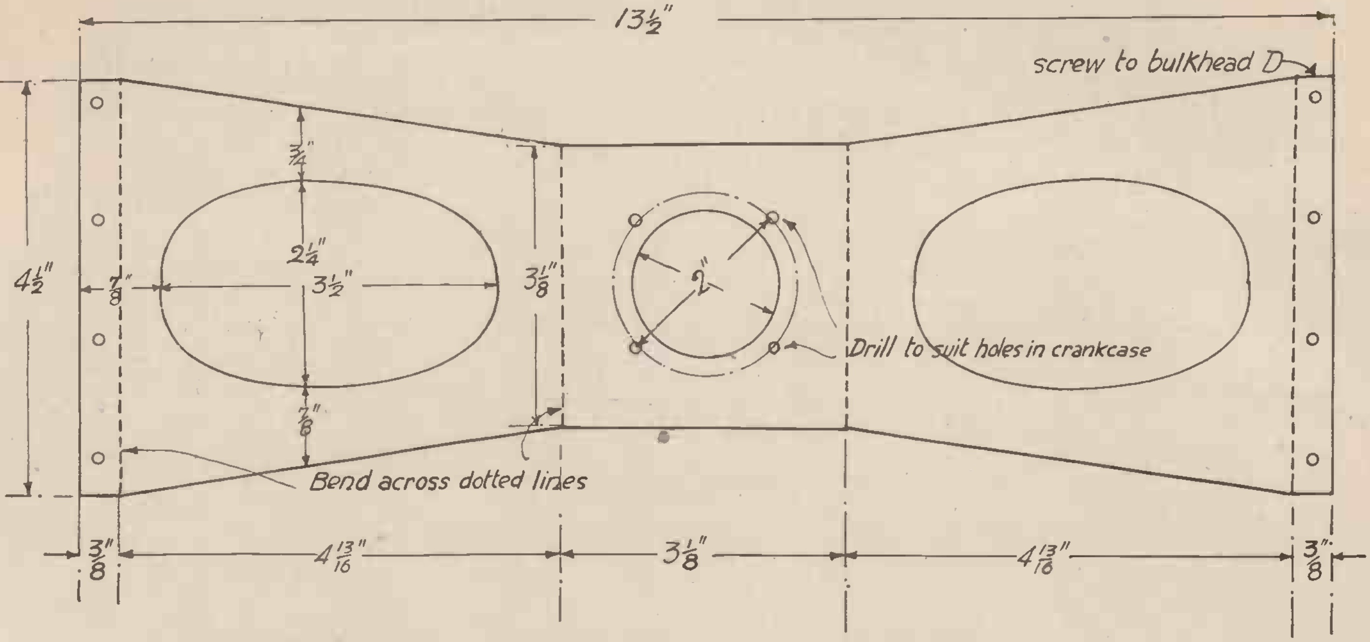
Front view.



Three-quarter rear view.

Adjusting the Model for Flight

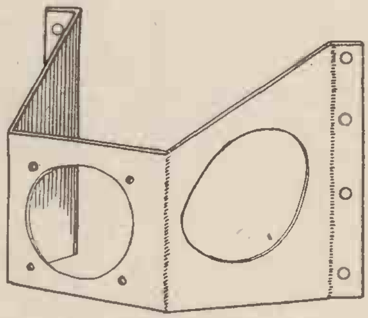
The model is now complete and ready for flight, and a fair amount of time should be expended in adjusting the model before releasing it for flight. In a later issue I shall show how to fit a time-control in the ignition system to limit the flight to some predetermined duration. The first test should consist of gliding the model, and for this purpose I recommend that you should remove the airscrew and clamp a



Plan of the 18-gauge aluminium engine adapter for Atom Minor, Hallam, Grayspec, and Economic engines.

piece of lead on to the propeller shaft of weight equivalent to that of the airscrew. This will avoid breakage in the early stages. When satisfied that the position of the wings is correct, refix the airscrew, adjust the rudder to counteract propeller torque (with an anti-clockwise airscrew the torque reaction will tend to turn the model to the left, and the rudder should therefore be set to the right, and vice versa), and start up the engine. Attach about four yards of twine to the sternpost and let the model taxi; the twine will permit you to arrest its movement should the adjustment not be correct.

I do not recommend hand-launching the model in the early stages. A thick leather glove should be used when starting the engine, as a smack on the hand from an airscrew when the engine backfires can be very painful.



How the engine adapter is bent.

This is the first detailed design for a Petrol-driven Model Aeroplane to be published, and I hope readers will agree that I can fairly claim that it is superior in design and construction to anything yet produced. The scale drawings, sketches, and illustrations accompanying this series were prepared by myself, and have been triple checked. Every detail has been thought out so that it can be made even by the unskilled amateur, and I have also endeavoured to smooth away his difficulties by producing a complete set of full-size blueprints of every part by dealing with the construction in an easy-to-follow order, and by making the design adaptable to all of the engines at present on the market.

I loaned the model to the Model Engineer Exhibition, where it attracted considerable interest, and I shall be glad to help any reader who is building this model (I have had letters regarding it from all over the world), provided that a stamped addressed envelope is enclosed for reply.

J. Campbell (Twickenham).—Glad to know that the petrol model built from my book flew straightway.

Three-quarter front view of the model—probably the best design yet produced.

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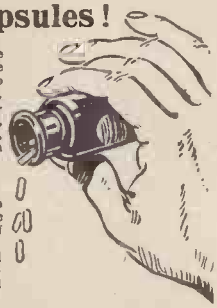

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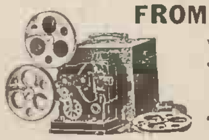

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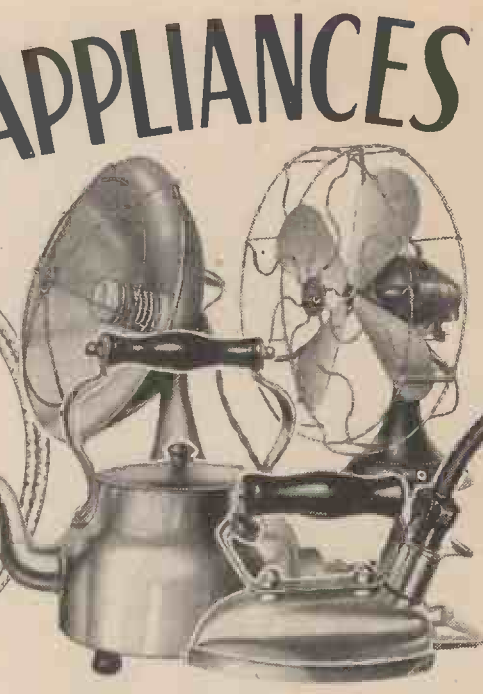


An Instructive Series on Installing Electric Bells, Improving Existing Bell Installations by Fitting Indicators, and Obtaining the Greatest Service from Electrical Apparatus which Constitute One of the Main Items in a Modern Home

PRIOR to 1921 the generation and distribution of electricity in England was in a state of chaos, there were nearly 600 separate and distinct supply boards, each offering power in various forms as direct, single, two and three phase, and in frequencies ranging from 25 to 100 cycles per second. The Central Electricity Board was appointed to control and examine the state of affairs and decide on a national frequency and supply voltage. Hence, the "National Grid" was evolved, and to-day single-phase electricity at 200–250 volts 50 cycles is the domestic source of power. Although the methods of generating and distribution have marched forward almost too rapidly for the demand, the local contractor still lives in the past, his methods are good and his work excellent, but he is still content to instal single switches and lamps, and two-point control is his crowning achievement. Who is to blame? Not the householder, for his very ignorance exempts him; then we must turn to the contractor. A little extra consideration and thought, and an extra switch or two will save electricity as well as time and trouble. All stairways should have two-point control, and generally this could be improved beyond measure by fitting a third switch. Consider the case of stairs leading from one floor to the next with several rooms opening on to each landing: a convenient installation would have a switch by each door so that each individual controls the light. Electric bells have also stayed in the past: one still sees a single bell and push; and although it serves its purpose quite well, the extra convenience obtained by adding another push is almost unbelievable.

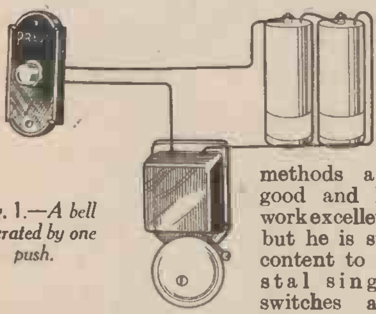


Fig. 1.—A bell operated by one push.

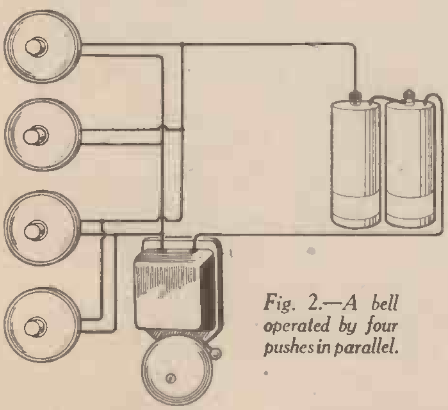


Fig. 2.—A bell operated by four pushes in parallel.

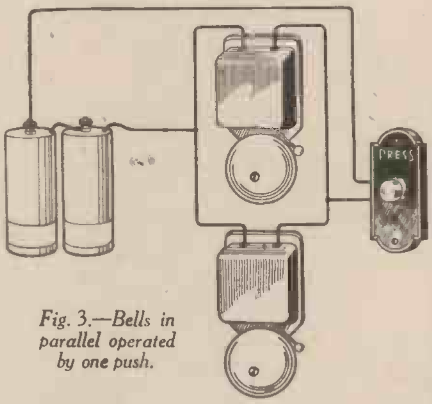


Fig. 3.—Bells in parallel operated by one push.

Fitting a Door Bell

Start with the simplest case; namely, a single push and bell for the front door. To commence, examine the site, and then choose a place for the bell and a suitable place in which to conceal the battery. It will now be necessary to estimate the length of wire and the manner in which it must be run. For exterior work, select a brass weather-proof push of the flat back type (with these it is not necessary to make a recess in the door), drill a hole through the door to enable the wire to pass through, and the push is then fixed over the hole with two screws.

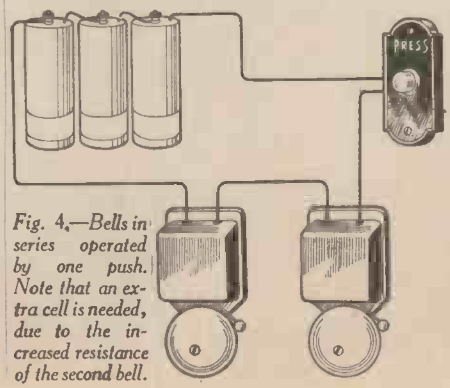


Fig. 4.—Bells in series operated by one push. Note that an extra cell is needed, due to the increased resistance of the second bell.

Conceal the wire attached to the push behind picture rails, skirting boards, and under floors, and fix it into position with insulated staples. When wiring in damp places, as under floor boards, etc., arrange the wire in a slack loop between adjacent staples so that moisture will not drain down on the staples and cause corrosion. Figs. 1 to 4 illustrate various simple circuits.

Wire Sizes

Various sizes and brands of single and double bell wire are on the market. The latter consists of two wires bound up in the same sheath, and insulated with rubber and cotton impregnated with paraffin wax. This is suitable for most work, but in cellars where damp walls cannot be avoided, a variety of tough rubber-sheathed wire is necessary. This wire can be buried directly in plaster when wiring up new buildings, and is suitable for all damp and exposed work. The sizes are generally Nos. 18 to 22 S.W.G., and the wire selected will depend on the current necessary to work the bell, and also the length of the runs. It will be found that the resistance of a circuit of No.

Fig. 5.—Three types of bell push. That on the left is a "pear," and the other two are for exterior work.

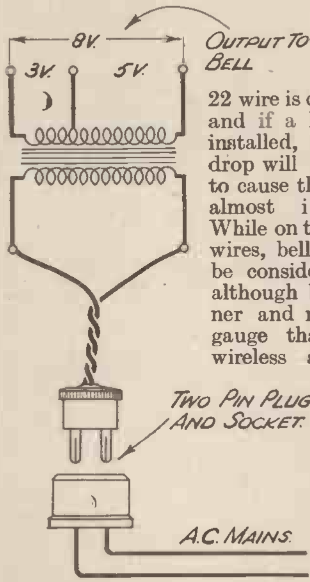


Fig. 6.—Transformer connections for an A.C. bell.

22 wire is considerable, and if a large bell is installed, the voltage drop will be sufficient to cause the bell to be almost inaudible. While on the subject of wires, bell flexes must be considered, which, although being a thinner and much lighter gauge than ordinary wireless and electric lighting flex, are far more flexible, being rather like a soft string in appearance. The insulation consists of twisted silk, there being no inner rubber covering. The size most suitable for domestic purposes is generally 10/40 gauge, with either thick or thin insulation. If it is necessary to put a push in some position where it will be subjected to hard work and rough usage, as in a garage or workshop, use ordinary electric lighting flex of the best quality.

The Bell

It will be found that bells fitted with $2\frac{1}{2}$-in. or 3-in. gongs will serve for all average installations. Breakdowns caused by bad contacts, etc., can all be reduced to the absolute minimum by careful selection of the components. Bells are made with self-cleaning contacts, and all adjusting screws must have lock nuts fixed. For exterior work, an enclosed watertight bell is needed, and if this is liable to mechanical damage, then it should have a cast-iron frame and cover.

The Power Supply

For the power supply, there is only one method which gives absolute satisfaction when installed, and that is the bell transformer. Accumulators should only be used when they can receive expert attention, and on bell work, even though special cells are made, these are liable to be neglected, and consequently ruined. Wet or dry leclanché cells are eminently suitable, as, once installed, they never need attention until run down, when either a new zinc or cell is needed.

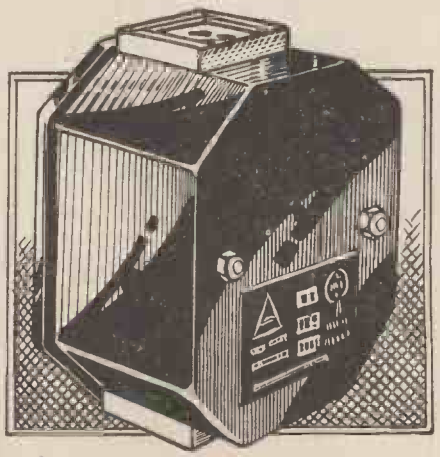


Fig. 7.—A typical bell transformer.

The wet cell is the cheapest in the long run, as it only occasionally requires a new element, and solution costs a matter of a few pence. Primary installations can be considerably improved by observing some very simple precautions. Place the batteries in a dry place where they will not be interfered with, grease all terminals, solder all connections with a non-corrosive flux, and bind the joint with insulating tape, making sure that the terminals are well screwed down. To prevent evaporation of fluid, pour paraffin oil to a depth of $\frac{1}{2}$ in. in the open jars. A position where variations in temperature are liable to occur should be avoided. The ideal battery for a bell installation is a nickle iron accumulator, as these do not sulphate or lose their charge, and have an unlimited life. Whatever your type of battery, use good-quality vaseline on all screw connections.

Alternating installations offer many advantages over battery sets, the chief of which is that, once installed, they never need any attention. Ordinary bells, pushes, wire, etc., can be used, as the external characteristics are the same as for a battery set, but a much better plan, however, is to use a proper A.C. bell, as this has no contacts, and thus one of the frequent causes of trouble is eliminated. Their cost is the same as for direct-current equipment.

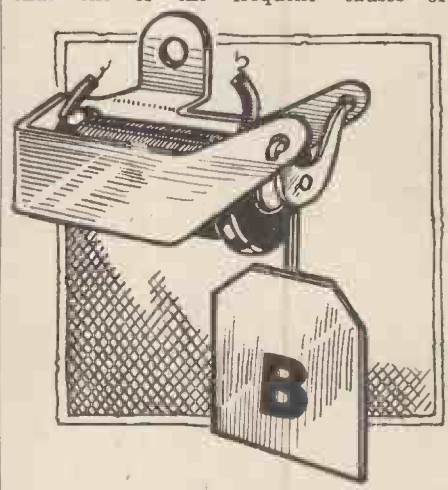


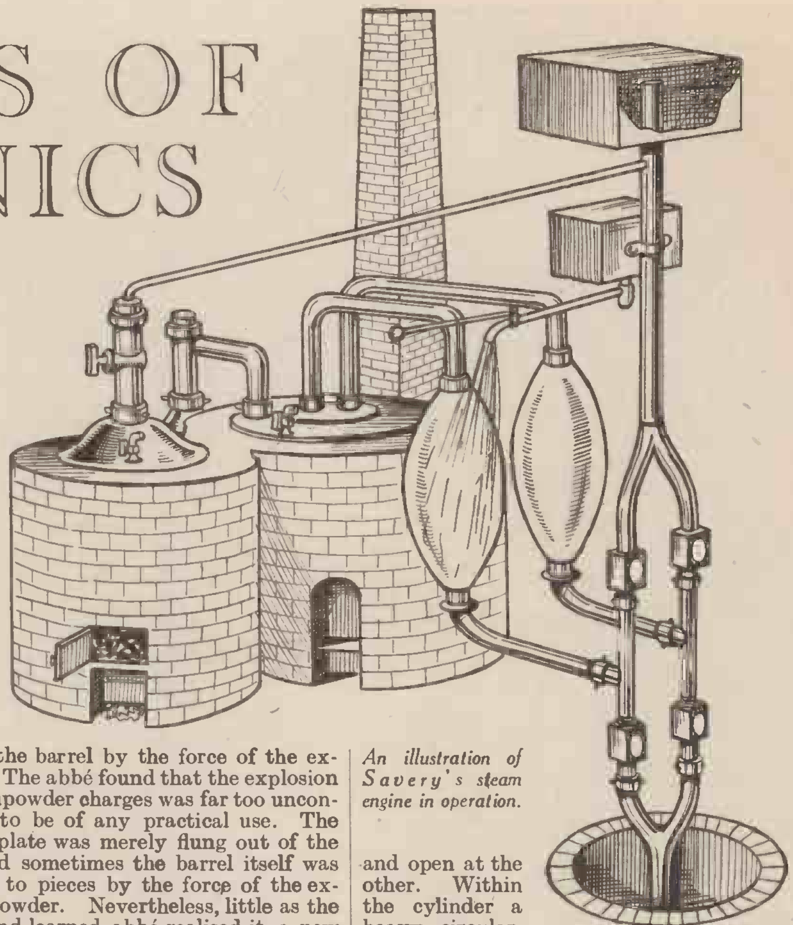
Fig. 8.—A useful bell indicator.

Fixing and Wiring the Transformer

The fixing and wiring of the transformer should not present any difficulties, but people seem rather afraid of these, and rather than have the work done properly, they connect up to a power plug through a length of flex, thus endangering both life and property. The simplest way of doing the work is to have a small plug wired up specially for the transformer, and then the latter can be removed for alterations to the circuit. Mount the transformer by the distribution board in, say, the pantry, so that it is well out of the way, and cannot be interfered with by children, and make high-tension leads as short as possible. A fuse should be included in each wire of the circuit, and the socket mounted a few inches above the transformer. It should be noted that all the wiring must comply with the regulations. The transformer is connected to the socket through a few inches of flex and a plug, which can be of the two-pin type. After completing the low-voltage side of the set, connections can be made to the transformer and the circuit can then be tested. Use the lowest voltage tapping which gives satisfactory results, and if the 3-volt taps are quite successful do not connect to the 8-volt tappings.

MASTERS OF MECHANICS

The Invention of the Piston and Cylinder



An illustration of Savery's steam engine in operation.

THE piston and the cylinder are articles which almost every individual possessing the slightest engineering turn of mind takes for granted. Yet the piston and the cylinder, in common with all other mechanical contrivances, had to be invented. Previous to their invention, attempts had been made to obtain useful power from steam, as we have seen in the previous article of this series. Such attempts, however, were not satisfactory. The crude engines of that period lacked a part that was vital. Until the necessity of having a movable piston oscillating within a cylinder had been realised by the early steam-engine inventors, progress in the construction of steam power machines was slow, painful and invariably disappointing. After the piston and the cylinder arrived, however, the steam engine made rapid strides both in constructional principles and in working efficiency.

The Abbé d'Hautefeuille

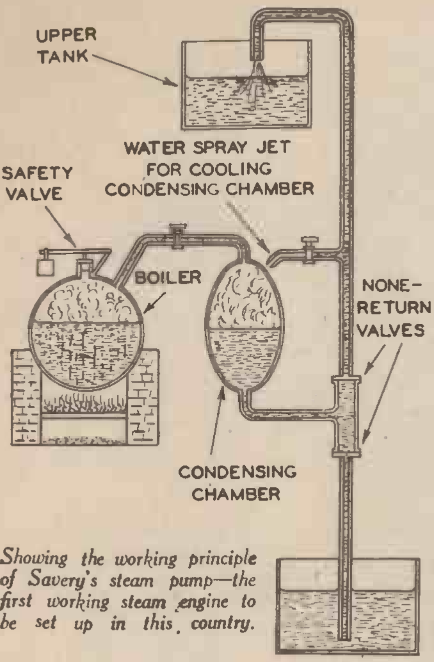
The honour of devising the first piston and cylinder has been given to more than one inventor. More probably than not, the very first individual to conceive the idea of a piston moving within a cylinder was the Abbé d'Hautefeuille, a mechanically-minded cleric who lived in France in the second half of the seventeenth century. In 1678 the Abbé d'Hautefeuille described some experiments which he had made in exploding charges of gunpowder in a barrel which was provided with a flat, circular plate capable of being thrust upwards in the barrel by the force of the explosion. The abbé found that the explosion of his gunpowder charges was far too uncontrollable to be of any practical use. The movable plate was merely flung out of the barrel and sometimes the barrel itself was shattered to pieces by the force of the exploding powder. Nevertheless, little as the worthy and learned abbé realised it, a new and mighty principle had been given to the world, a principle upon which was to be founded, in due course, the world's great power producers and, in fact, the entire civilisation of the future industrial age.

Christian Huyghens

The first individual to elaborate the crude piston and cylinder conception of the Abbé d'Hautefeuille was the celebrated Christian Huyghens, a Dutchman, who was born at the Hague on April 14th, 1629, and who afterwards became famous as an astronomer and a mechanician. Huyghens constructed that which may be regarded as the world's first internal-combustion engine. Huyghens' "gunpowder engine" comprised a metal cylinder, closed at one end and open at the other. Within the cylinder a heavy, circular, metal plate was free to move up and down, the plate being connected by means of a simple rope and pulley system to a heavy weight. A charge of gunpowder was exploded within the cylinder, the movable plate or piston being at the top of the cylinder. The combustion of the powder created a vacuum or a partial vacuum within the cylinder, whereupon the external atmospheric pressure drove the piston downwards into the cylinder, thus causing the weight to be lifted. A simple enough engine in all truth, and, if we are to believe Huyghens, it was fairly successful in actual practice.

As a serviceable method of obtaining mechanical power, however, Huyghens' "gunpowder engine" was entirely out of the question in view of the excessive slowness of its operating cycle, for after each descent of the piston a fresh

The ruined engine house of a 300-year-old Cornish tin mine. It was in ancient tin mines such as this that Savery's engines were applied.



Showing the working principle of Savery's steam pump—the first working steam engine to be set up in this country.

charge of gunpowder had to be placed in the cylinder and fired by hand. It occurred to Huyghens just before his death in 1695 that, instead of employing exploding gunpowder to produce a vacuum under the piston, steam might very well be used for the same purpose and, in addition, with much enhanced efficiency.

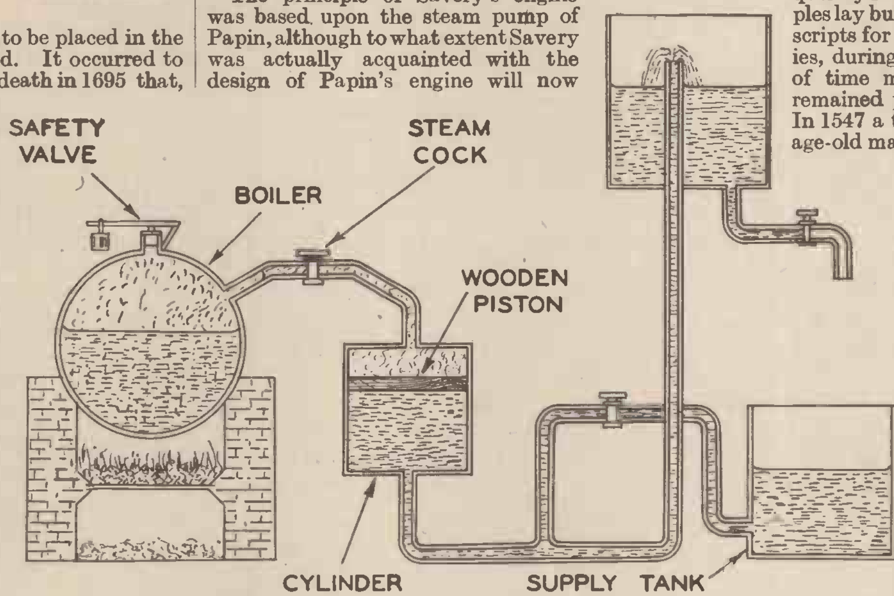
Dr. Denis Papin

The idea was put into practice by Dr. Denis Papin, a medical man born at Blois, in France, in 1647. Papin, about 1685, had experimented with various "gunpowder machines" and had fully realised their uselessness. To him is due the honour of first clearly realising that steam might be injected into the cylinder in order to raise the piston, and that afterwards the piston would descend under the external pressure of the atmosphere when the steam on the underside of the piston had condensed, and thus set up a partial vacuum within the cylinder. Papin attempted the construction of engines which were to operate on this principle, but he was not very successful. Papin was handicapped throughout his long and unsettled life, during the course of which he underwent political persecutions, by his lack of practical mechanical ability. He could conceive ingenious mechanical ideas, but he could seldom put them into practice. For all this, however, Papin invented the world's first steam safety valve. He elaborated a steam pump in which the steam, generated in a boiler, was caused to force downwards a wooden piston, and thus drove water out of a cylinder into an elevated vessel. The cylinder being emptied of water, the steam was turned off. A vacuum was produced in the cylinder by the condensation of the steam remaining therein. Atmospheric pressure on the supply tank caused water to re-enter the cylinder. Steam was once again admitted to the cylinder, and the sequence of operations recommenced. Here again, however, the working cycle of Papin's steam pump was slow, and was not adapted for practical service.

Thomas Savery

The next inventive mind to apply itself successfully to steam-engine design was that of Thomas Savery, who was born near Modbury, in Devon, about the year 1650. Very little is known of Savery's life-history, particularly during its earlier stages. For many years Savery was intimately associated with the Cornish mining industry. He was also a military engineer, becoming later on in life a captain of an engineer regiment. Savery was thoroughly well acquainted with the mechanics and physics of his day. Unlike the more philosophical Papin, Savery was an engineer to his finger tips. He could not only devise inventions, but he could also carry out their practical construction. The pumping engine which Savery designed and constructed was the first steam engine which was put to any lengthy and satisfactory use. Savery's engine ran for a relatively lengthy period in various Cornish tin mines, its object being to raise water from the mines.

The principle of Savery's engine was based upon the steam pump of Papin, although to what extent Savery was actually acquainted with the design of Papin's engine will now probably never be known. Savery's engine operated in virtue of its raising water to a height by the expansive force of steam, and by raising water from a low level by means of the utilisation of atmospheric pressure. Steam generated in a strong boiler was led into an enclosed vessel containing water.



An explanatory diagram of Papin's steam pump or water-raising engine.

Details of the Engine

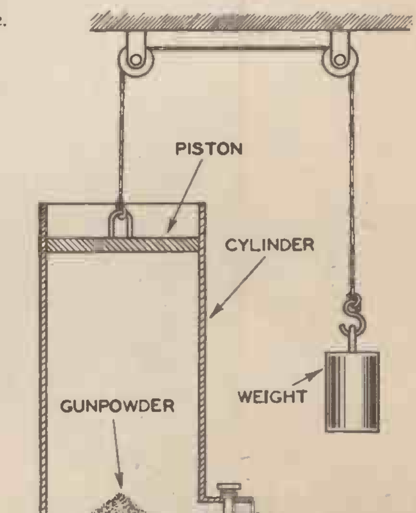
At first the entering steam condensed in this chamber, but after the condensation had ceased, the steam pressure drove the water downwards through an exit pipe and from thence into a vertical pipe which emptied itself into a high-level tank. After the water had been driven out of the condensing chamber, the steam supply was turned off. On the cooling down of the condensing chamber a partial vacuum was created within. The setting up of this vacuum resulted in water being forced upwards by atmospheric pressure from the low-level tank. It flowed through a non-return valve and thus entered the steam-condensing chamber, from which it was subsequently driven up into the elevated tank by the pressure of steam from the boiler.

Slow in Operation

At first, Savery's engine was slow in operation. Later, however, Savery speeded up the working cycle of his engine by providing for the rapid condensation of the steam in the condensing chamber by means of a jet of water which was allowed to spray on to or within the chamber from the upper tank. The practical working of Savery's engine necessitated the constant attendance of some individual who was trained to open the cocks for the admittance of steam and water to the condensing chamber at the requisite times, a difficulty which was only done away with in engines of the Newcomen type. With the working principles of this deservedly famous product of engineering genius the next article in this series will deal.

Hero's Steam Engine

Hero was the last mechanician and inventor of his age. His steam engine, the most interesting of all the mechanical devices which he describes, attracted little notice after his death. Indeed, it was quickly forgotten and its principles lay buried within his manuscripts for some sixteen centuries, during which long stretch of time mechanical invention remained practically dormant. In 1547 a translation of Hero's age-old manuscript was printed at Bologna, in Italy. This, the first book ever printed dealing purely with mechanical principles and inventions, attained great popularity. In a century it went through eight editions in different languages. The scientific era was beginning to dawn upon the world, and the legacy which Hero bequeathed to posterity at last began to bear fruit.



Huyghens' "gunpowder engine"—the world's first internal-combustion engine.

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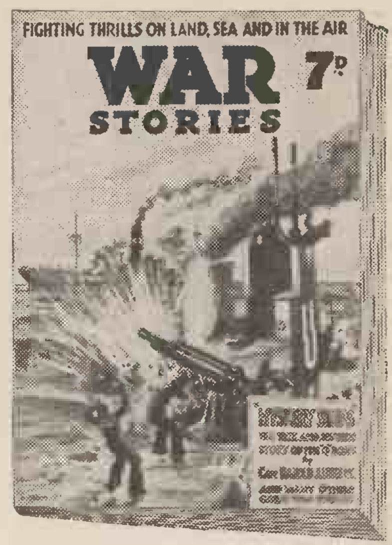

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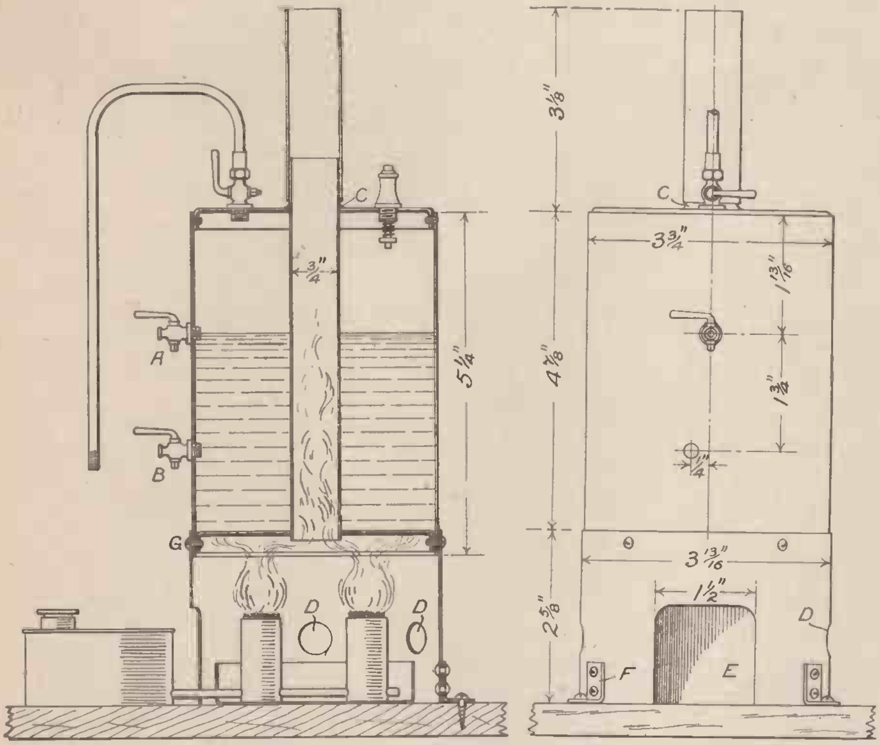
WORKING MODEL ENGINES

The Construction of a Simple Model Vertical Type Boiler is Described in This Third Article of the Series



Figs. 1 and 2.—Section and front elevation of a simple vertical type model steam boiler.

THE small boiler described below is suitable for supplying steam for driving the twin-cylinder engine dealt with in the previous issue. It will be seen with reference to Figs. 1 and 2 that the boiler is a vertical one with a central flue tube, this type being one of the easiest to make. A methylated spirit lamp with two $\frac{5}{8}$ in. wick tubes is used for heating the boiler.

Materials Required

To make the boiler the following material and fittings will be required, and it would be as well to obtain these from a model maker's supply stores before commencing work.

(*a*) $5\frac{1}{2}$ in. length of $3\frac{3}{4}$ in. outside diameter solid drawn brass tubing, No. 19 gauge in thickness (for boiler barrel).

(*b*) $2\frac{3}{4}$ in. length of $3\frac{3}{4}$ in. inside diameter brass tubing, about 21 gauge (for boiler support, or firebox).

(*c*) 6 in. length of light brass tubing $\frac{3}{4}$ in. outside diameter, and No. 21 gauge for the flue tube. (Part of the metal barrel of an old cycle pump would do for this.)

(*d*) 3 in. of brass tubing $\frac{3}{4}$ in. inside diameter (for chimney).

(*e*) 3 in. of brass tubing $\frac{5}{8}$ in. outside diameter (for wick tubes).

(*f*) 4 in. of $\frac{1}{8}$ in. diameter brass tubing (for spirit supply pipe).

(*g*) Two brass stampings for boiler ends.

(*h*) 10 in. of $\frac{1}{8}$ in. copper tubing (for steam pipe).

(*j*) Two test cocks, one union steam tap, and a spring safety valve.

Boiler Barrel

The first part to take in hand is the boiler barrel, and it will no doubt be found when the piece of tubing for this is obtained that the ends will require trueing up. As we have to reckon without a lathe, careful filing will have to be resorted to, but it will not be found a very difficult job if a little patience is exercised. To act as a guide for filing, scribe a line as near one end of the tube as possible. A thin, stiff piece of cardboard with a straight edge, wrapped round the tube, will form a guide for the scriber, and will enable the line to be

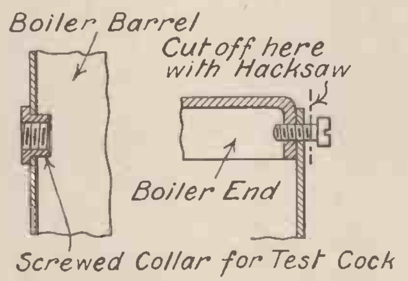


Fig. 3.—Details of screwed collar fitting for test cock, and method of screw-pinning the boiler end.

marked round sufficiently accurate for the purpose.

After marking one line, measure off a distance of $5\frac{1}{4}$ in. and scribe another line. File the two ends of the tube down to these lines, and test the squareness of the ends by applying the steel square at different positions round the tube, while the filing is being proceeded with.

After the tube is trued up satisfactorily, mark the positions of the holes for the two test cocks A and B to the dimensions given in Fig. 2. It does not matter what position these are placed round the tube so long as they are arranged $1\frac{3}{4}$ in. apart, and the top one is $1\frac{13}{16}$ in. from the top edge of the tube, as shown. To imitate the practice in large boilers, the bottom fitting can be arranged a little on one side, as depicted. The two holes can be tapped out to take the screwed ends, as shown in Fig. 1, or the holes can be enlarged, and the screwed bushes, which are usually supplied with the fittings, can be soldered into the barrel, as shown in Fig. 3.

Boiler Ends

The boiler ends can be taken in hand next, and these must be carefully filed round the edges to make them a good fit in the ends of the boiler barrel.

Take the top end first, and after cleaning the top with emery paper, locate the centre, and scribe a line through it right across the top face. On either side of the centre mark two points, each a distance of $1\frac{1}{8}$ in. from it, and drill two holes, as indicated in Fig. 4, of a diameter suitable for taking threads for the screwed ends of the steam tap and safety valve. Instead of tapping out threads for these fittings, screwed collars can be soldered into the boiler, as previously mentioned.

Now clamp the two boiler ends together by means of a small screw clamp and drill a $\frac{1}{8}$ in. hole through the centre of both in one operation. This hole must now be drilled with a larger drill and finally reamered out to be a good fit to the flue tube. Having done this, clean up the edges of the two boiler ends with emery paper, and also the inside of the barrel at both ends. Press the top end in place in the top of the barrel, and take care that the holes for the steam tap and safety valve are in their correct position relative to the test cocks. Allow the end to project about $\frac{1}{16}$ in., as shown in the drawings, and apply a little solder in two or three places round the joint to hold the end securely while the holes for the screwed pins are drilled. These holes—of which there are six, spaced at equal distances round the barrel—should be drilled $\frac{1}{16}$ in. diameter, and tapped out to

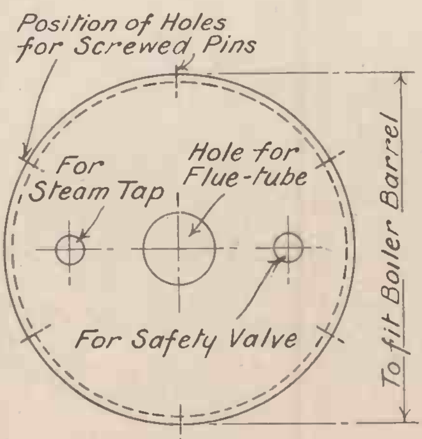


Fig. 4.—Showing the setting out of the top boiler end.

take $\frac{3}{32}$ in. diameter brass screws. After being screwed in, the heads of the screws may be cut off with a hacksaw, as in Fig. 3, and the ends filed flush with the boiler barrel. The bottom end can now be treated in the same way, the flange in this case being placed outwards, as shown in Fig. 1. About $\frac{1}{16}$ in. of the boiler shell should project beyond the edge of the flange to assist the solder to run where required.

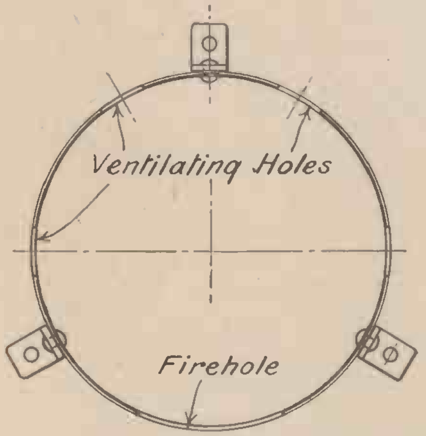


Fig. 5.—Details of the firebox, or boiler support.

Soldering the Joints

To solder the joints apply some flux and hold the end of the boiler over a gas flame, at the same time giving the barrel a few turns to get it evenly heated. With a thin stick of wood, coax the flux all round the joint, so that it runs between the flange of boiler end and the barrel. When this is done, the soldering iron, which should have been previously placed in the gas flame to get hot, can be applied, the solder being made to run or "sweat" well into the joint. More care must be taken with the top joint, as the solder here will not be covered with water when the boiler is in use. After both ends are soldered in satisfactorily, remove any superfluous solder with an old, coarse-cut file, and rub down afterwards with fine emery paper.

Now take the flue tube and, after filing the ends square, press it in place through the holes made for it in the boiler ends. See that the latter, and the outside of the tube, are well cleaned where the joints are to be made, and then adjust the tube so that it projects about $\frac{1}{8}$ in. at the bottom. The joints can now be well soldered, the top one being rubbed down afterwards with coarse and fine emery paper, so as to leave a neat fillet of solder round the flue tube, as indicated at C, Figs. 1 and 2. The chimney, which should be a fairly tight fit on the flue tube, has simply to have the ends squared up with a file.

Boiler Support

The boiler support, or firebox, can be taken in hand next. Scribe a line round the piece of tube $\frac{7}{8}$ in. from one edge and mark the positions of the four ventilating holes D and the firehole E. The latter can be cut out and filed to shape, after the ventilating holes are drilled, which are $\frac{1}{4}$ in. diameter, and spaced as indicated in Fig. 5. The three feet F can be shaped from strips of sheet brass $1\frac{1}{4}$ in. by $\frac{3}{8}$ in. wide, after the holes for the rivets and screws have been drilled. Those to take the screws for fixing to the wooden base can be drilled $\frac{3}{32}$ in., the other two holes being drilled for $\frac{3}{32}$ in. rivets for fixing to the firebox side, as shown. The firebox is fixed to the boiler by four $\frac{3}{32}$ in. screws, as at G, which must be so arranged that they do not screw into the boiler flange in the same place as the screw pins. Before drilling and tapping the four holes, apply a little solder here and there round the joint on the inside of the firebox to prevent it shifting. Previous to applying the solder, see that the boiler stands quite upright, and also that the firehole is arranged immediately beneath the test cocks, as shown in Fig. 2.

The Spirit Lamp

Details of the spirit lamp are given in Fig. 6. The spirit reservoir can be made from a round tin about $2\frac{1}{4}$ in. diameter and $1\frac{1}{8}$ in. deep. Cut a circular piece of tin-plate for the top, and drill a hole in this for the filler, which is a short piece of $\frac{1}{2}$ in. brass tube soldered in position. The cap consists of another short piece of tubing, H, to which a disc of thin sheet brass is soldered. Drill a $\frac{1}{16}$ in. hole in the middle of the disc to act as a vent hole. Cut the two wick tubes to a length of $1\frac{1}{4}$ in. and file the ends square. At a distance of $\frac{1}{8}$ in. from the lower ends of each piece of tubing drill a $\frac{1}{8}$ in. hole through for the supply pipe. At the points indicated along this pipe make round nicks on each side of the pipe with a round file. These nicks should be at least $\frac{1}{16}$ in. diameter, and should be arranged sideways of the pipe in relation to the wick tubes. Slip the wick tubes on the pipe, in the position shown in Fig. 6, and solder them in place. Brass discs, K, K, can now be soldered in the lower ends of the tubes, and at the same time a short piece of brass rod, M, can be soldered in the end of the tube.

The lid of a small tin box of suitable size can be made to answer for the drip tray, N, or failing that, one can easily be bent to the required shape from a piece of tinplate. A $\frac{1}{8}$ in. hole is drilled in one end for the supply pipe to pass through. Drill a $\frac{1}{8}$ in. hole near the bottom of the reservoir, push the end of the supply pipe through and solder the joint. Also solder the end of the pipe to the bottom of the reservoir, on the inside, and then solder on the top of the reservoir.

With regard to the wicks, about the best material to use for these is known as asbestos yarn, and the wick tubes should be filled with this, allowing about $\frac{1}{8}$ in. to project. If asbestos yarn is not available, cotton yarn could be used.

Finally, just a word or two of caution. Do not let the water get below the level of the lower test cock while the lamp is alight under the boiler, and never leave it unattended without first withdrawing the lamp and blowing out the flames.

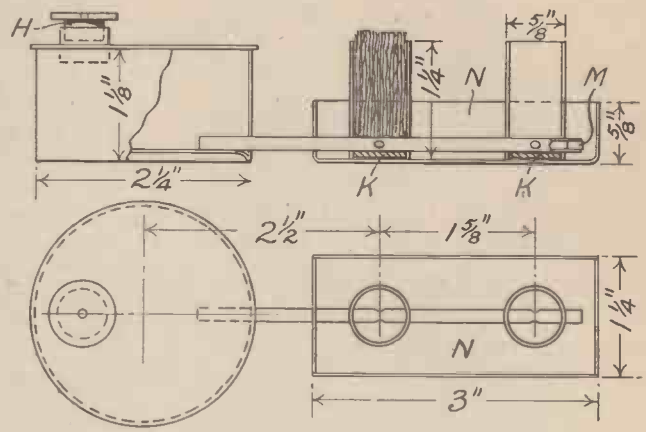


Fig. 6.—Part sectional elevation, and plan of spirit lamp.

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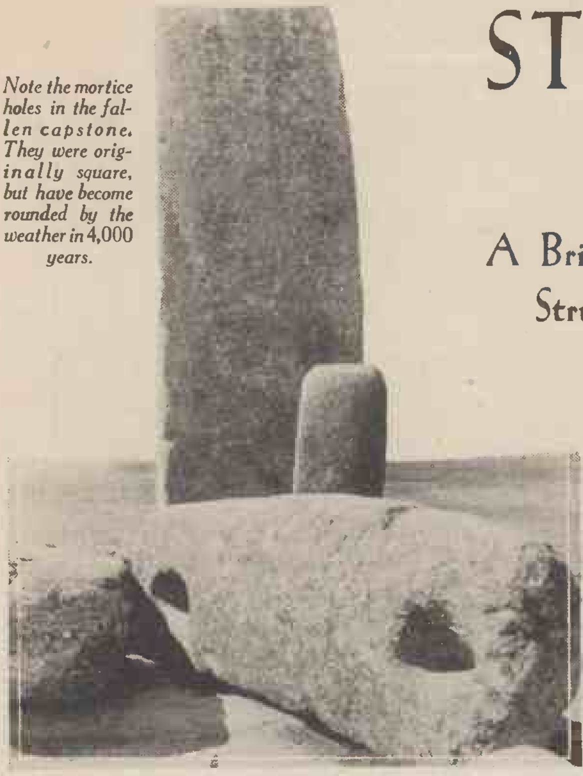
STONE-AGE MECHANICS

A Brief Description of Some of the Remarkable Structures Built Thousands of Years Ago



Note the mortice holes in the fallen capstone. They were originally square, but have become rounded by the weather in 4,000 years.

The magnificent Lanyon Quoit near Penzance was originally so tall that a man on horseback could ride under the capstone, which is believed to weigh fifteen tons.

IT is an amazing fact that the world's mightiest buildings had all been erected two thousand years ago, and some of them were already very old. The Great Hall of the Temple of Karnack (Egypt) is large enough to contain every cathedral in England, and the Great Pyramid is immeasurably the largest building ever erected. It covers 13 acres, and if (as seems probable) it is solid, it contains 85,000,000 cu. ft. of stone. A hundred-thousand men took twenty years to build it, after toiling for ten years to make the road by which the stones were brought to it from the Nile.

Even more remarkable than the gigantic scale of these ancient temples and monuments, is the stupendous size of individual blocks of stone. How could they have been quarried, transported for long distances, and finally placed in position before the age of machinery? Most of the outer stones in the Great Pyramid are 30 ft. long, and some are larger still, while other examples can be found which are far greater. The wonderful Temple of Diana, at Ephesus, had 127 mighty pillars, each hewn from a single block of marble, and the columns were each 60 ft. long and 7 ft. in diameter, while there are stones in the Temple of Baalbeek measuring 60 × 12 × 9 ft.

The great statues hewn by the Egyptians are greater still. The two Colossi at Thebes, which are sitting statues hewn from a single block of granite, are each 47 ft. high and weigh 847 tons, while in all cases the original block as hewn from the quarry must have been both larger and heavier than the finished statue.

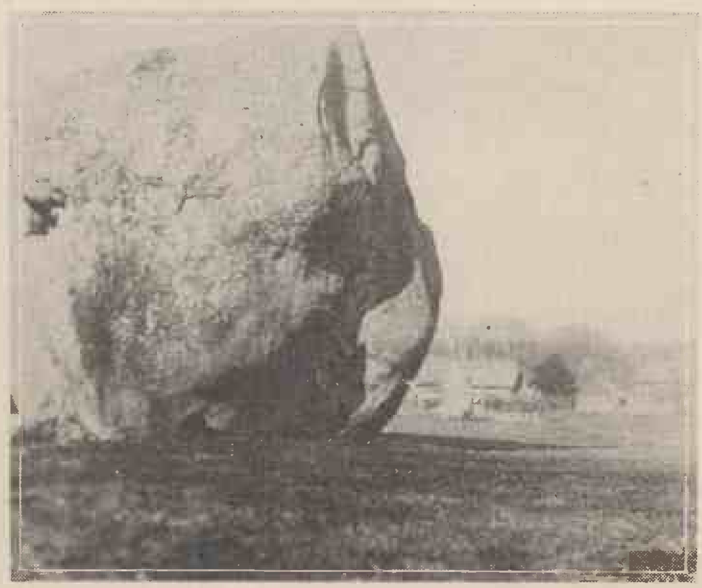
The Rameses Statue at Thebes

This statue is hewn from a 60-ft. block and weighs 847 tons, while another statue at Tanis is 125 ft. high and weighs 1,200 tons, and all these were transported from quarries hundreds of miles away.

Although not a building, the Great Wall of China must also be mentioned. Built about 214 B.C., it is the most stupendous constructional achievement on earth. Its length is 2,550 miles, crossing over chains of mountains and reaching an altitude of over 5,000 ft. It is about 50 ft. high, and so thick that the top is now used as a motor road, with room for three cars abreast.

These are astonishing feats, but they are the work of highly-civilised and organised peoples; and in our own country we have many remarkable examples of Stone-Age engineering, performed by primitive, uncivilised races, who could neither read nor write, and whose very names are unknown to us. And yet these untutored savages, (for so we regard them) could build great tombs and temples, and transport for long distances and set up enormous blocks of stone, to remove which would be quite a problem for modern engineers armed with all the mechanical resources of the age.

Their earthworks were simply stupendous. Silbury Hill, near Marlborough in Wiltshire, is the largest man-made mound in Europe. It covers an area of 5 acres, is over 130 ft. high, and 1,660 ft. in circumference at the base. The circle of huge stones which formerly surrounded it has now disappeared.



This gigantic stone at Avebury resembles a small haystack and weighs over sixty tons.

Even more remarkable is Maiden Castle, near Dorchester. It is a fortified town having a triple rampart of ditches and ramparts 60 ft. high and astonishingly steep. The outside of the ramparts is 2 miles in circuit, and in places there are five lines of defences.

There are also

ancient ramparts which run for many miles across country, such as the Wansdyke, and the (later) Offa's Dyke, which runs from the mouth of the Dee to the Severn, and cuts off Wales from England.

Stonehenge

The most remarkable of our stone circles are Stonehenge and Avebury, both in Wiltshire. The former is 3,500 to 4,000 years old, and the latter is at least a thousand years older still.

Avebury originally consisted of 600 huge stones, and was the greatest megalithic monument in the whole world; but it has suffered shamefully from vandalism, hundreds of the stones having been broken up and used to build cottages and even pigsties.

The original design consisted of two large, and one smaller circle, and two vast avenues. The best part now remaining is the circle near the village, which has 18 stones remaining out of 100. The largest of these now standing is *sixty tons* in weight, but many of those which have been destroyed were far greater, and one probably scaled 100 tons.

Stonehenge is smaller, but more interesting, as the stones here are *squared* and *mortised* together, thus forming trilithons (Π), consisting of two uprights, with a lintel on top. The two longest uprights are 29 ft. and 25 ft. in length, but the longer was sunk 8 ft. into the ground, and the shorter only 4 ft. The largest stone weighs about 35 tons.

The most remarkable feature about Stonehenge is the puzzle of the forty-five "foreign" stones, of blue or igneous rock. The nearest similar rocks are said to be in Pembrokeshire, and they must in any case have been transported a great distance.

"*How*" is the puzzle. It is just possible that they may have been ice-borne during the glacial age, and deposited somewhere on the plains, but it is by no means impossible that they were rafted round by sea and brought up the river. Certainly there is a large stone in the bottom of the River Avon, some 4 miles away, which gives one furiously to think; and tradition states that their landing-stage was on the river at West Amesbury.

So far as the "Grey Wethers," which form the majority of the stones in our megalithic monuments, are concerned, these are liable to be found in down country, probably having been ice-borne, but in any case they must have been moved considerable distances to form our numerous stone circles.

How, then, could primitive peoples drag these great boulders, weighing 20 to 60 tons, and finally set them up on end?

How the Boulders were Moved

Although they have left no records, it is easy to surmise how it was done, because the Egyptians and Assyrians have told us all about it. In ancient bas-reliefs and paintings, they have recorded the methods of quarrying, transporting, and setting up the stones and statues which they handled. In the quarries of Syene we can see to this day the rows of holes which were bored in the rock prior to splitting off huge stone blocks. Wooden wedges were then driven in, and afterwards soaked with water. This caused them to swell and split the hard rock. Both drills and saws were used, and there is an iron saw in the British Museum, which was used for this purpose in Nimrod.

A great trilithon.

Some Stonehenge trilithons. The "foreign" stones—brought from Pembrokeshire—are the small upright pillars on the front of the trilithons.

Moving the blocks was a most spectacular affair. There is a painting in an Egyptian tomb 3,600 years old which shows how a huge statue was transported, and a long inscription gives full details. In the painting, 172 men in four double rows are pulling on ropes, and others urge it from behind with levers. The leader stands on the statue, and beats time so that all haul together with short jerky movements. In some other pictures the leader blows a trumpet as the signal to pull. The statue was mounted on a wooden sledge, and a man was constantly employed pouring oil under the runners to reduce the friction. The Assyrians used wooden rollers under their loads, but the Egyptians plain sledges only. It is likely that many more men were employed pulling than are shown in the painting, and they probably used many ropes of twisted fibre, or even raw hide. The system of pulling in a *series of jerks* makes it possible to move masses which could never be drawn along continuously, as then the inertia of a moving mass would come into play.

The Men-a-Tol in Cornwall has been hewn out by stone axes.

Upright Stones

Still more interesting is the method of erecting great stones in an upright position. Let us suppose one of the huge stones at Stonehenge has been placed in position, ready for elevation. A hole is dug near the foot of the stone having three vertical

(*Continued on page* 50)

STONE AGE MECHANICS

(Continued from page 49)

and one sloping side. The other end of the stone was slowly raised by levers and packed by timber or smaller stones as it rose, until the foot could slide down the sloping rim into the pit, and it was then hoisted into an upright position by gangs of men pulling on ropes of fibre or hide. When upright it would be packed tight with small stones. It is considered highly probable that the trilithons were joined up when lying flat on the ground, and were raised slowly into position as one unit. Certainly the dovetail joint would hold the lintel in position during erection, and it would otherwise be unnecessary, as numerous dolmens have their cover stone simply placed on the top of the uprights; they are never mortised.

But these are not lofty, and the cover stones were probably slid up an earth slope till they reached the top, and when they were securely in position the earth was dug away.

Even so, it was a remarkable feat. The cover stone of the well-known "Kits Coty House," near Rochester, weighs about 10 tons, and the much finer Lanyon Quoit, near Penzance, has a cover stone which perhaps weighs 15 tons, and it was originally so lofty that there are records of a man on horseback riding under the capstone!

Shaping the Stones

There remains the problem of shaping the stones. Recent excavations have disclosed many of the tools used by these builders of 4,000 years ago. There were numerous flint axes of various shapes, all much blunted by wear. There were also quartzite hammer stones weighing up to 6 lb., and a number of quartzite mauls with well-defined faces, and traces of a waist as if to hold a rope. These weighed anything from 37 up to 64 lb. and closely resemble the great stone mauls used in Japan up to fairly recent times. It is an interesting fact that in the evolution of mankind, we find the same tools and methods in use at various periods among widely differing races of men all over the globe.

We cannot leave the question of *shaped* stones, however, without a brief reference to the wonderful Men-a-Tol, near Lanyon Farm, and about six miles from Penzance, in Cornwall. The monument consists of two upright stones, standing on each side of a remarkable shaped stone like a gigantic letter O, but large enough for a man to crawl through.

The stone is at least 6 in. in thickness, and it was a great achievement to cut it out with stone axes.

The earthworks also were constructed with the most primitive tools. All the workers had were picks made from deer horns, and primitive shovels made from the shoulder blades of sheep or other small animals. The earth was carried to the top of great mounds in wicker baskets, and piled up to form miniature mountains.

It is likely enough that this toilsome task was the work of slaves or prisoners of war, for there is abundant evidence that most of the great monuments of antiquity were raised by the ruthless use of slave labour. It is said that more than a hundred thousand miserable wretches perished in building the Great Wall of China, and a sick or lazy worker was flung into the central mass of the wall, so that his corpse would become a part of it, and the terror of his fate would urge on the others to still greater efforts. There is little doubt that similar cruelty marked the erection of the Great Pyramid of Egypt, and many other structures whose size and beauty delight us to-day.

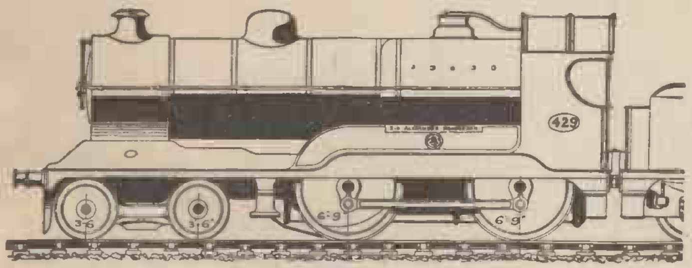


Fig. 7.—A G.C.R. (L.N.E.R.) "Director" class.

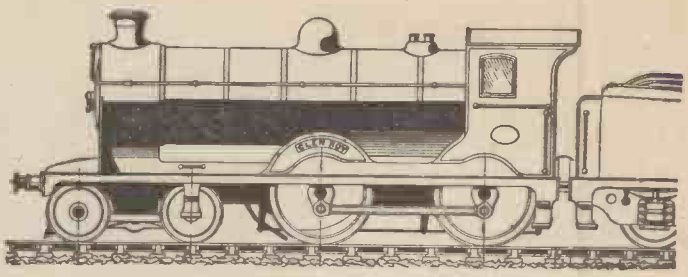


Fig. 8.—A "Glen Roy" type North British engine.

MODEL RAILWAY CONSTRUCTION FOR BEGINNERS

(Concluded from page 519 of the August issue)

Ash Pan.—A box- or hopper-shaped arrangement not often used except in large models placed underneath the fire bars. On full-size locomotives it retains ash and cinders, but on even large models its chief use is to make provision for dampers.

Axle.—The steel shaft upon which a pair of wheels are fixed. Two portions of an axle are formed into journals, which fit and revolve in axle boxes.

Blow-off Cocks.—Small cocks or valves fitted one at each end of a cylinder to allow of the discharge of water which may accumulate in the cylinder through the condensation of steam.

Boiler.—A more correct term for this would be "steam generator." It is the large portion of the engine which contains the water made to surround the fire and flue tubes (see Fig. 4). In it the water is converted into steam and conveyed as and when required to the cylinders. In the Smithies type water-tube boiler (Fig. 4) the whole of the steam generator, consisting of a boiler shell and bent water tubes, is totally enclosed in an outer casing, which casing is filled by the flames from the fire.

Brakes.—Few small models are fitted with brakes, larger ones frequently have complete brake rigging operated by a steam cylinder, whilst some are provided with a hand brake. Engines for 15 in. gauge and upwards often have either air or vacuum brakes, somewhat resembling full-size practice.

Blast.—A violent emission of steam from the exhaust pipe directed up the chimney and inducing a rapid passage of air through the fire and flue tubes.

Coupled Wheels.—Wheels of the same diameter as the driving wheels, and which are connected thereto by means of additional rods called coupling rods.

Cut-off.—The expression refers to the cutting-off of the steam at the end of the admission period to the cylinder by the valve. In full gear, that is to say, when the valve gear is set to give the maximum travel to the valve, cut-off in the cylinder takes place usually at about 75 per cent. of the stroke, that is to say, in a 2-in. stroke cylinder cut-off would take place when the piston has travelled 1½ in.

Below are Given Useful Hints on Model Railway Design and Construction Which Will be Found Extremely Helpful to Those Readers Desirous of Taking up this Fascinating Hobby

Cylinder.—A symmetrical tube closed at both ends with the exception of the apertures through which steam is admitted and emitted. Within such a tube a steam-tight piston moves from one end to the other and back again, with a reciprocating motion, the purpose of which is to revolve, through the medium of rods, the wheels of the engine. (See Figs. 12, and 13.)

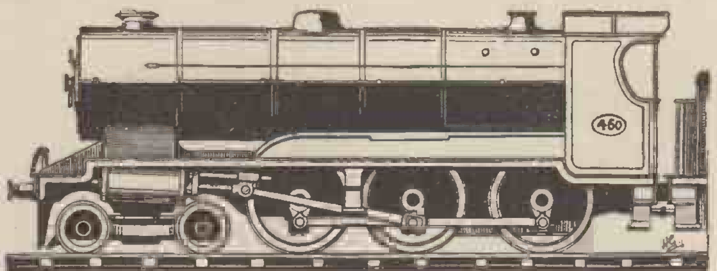


Fig. 9.—The 4-6-0 type wheel arrangement.

Damper.—An arrangement of one or more louvres fixed to or forming part of the ash pan and used by opening or closing them to regulate the amount of air passing to the fire.

Dome.—A cavity or projection upwards on the top of a boiler, the object of which is to provide a point as high above the water level as taken through the steam pipe. The taking of steam from the high point reduces, so it is claimed, the possibility of priming, that is, of water entering the steam pipe. Some engineers have demonstrated, and some still contend that domes are unnecessary and that priming can be avoided by other equally or more efficient means. It is fairly certain that on big, modern, high-pitched boilers the extremely shallow domes in use cannot be very effective.

Driving Wheels.—The pair of wheels directly driven by the connecting rods, which are moved by the reciprocating action of the pistons.

Eccentric.—The revolving disc or sheave set out of centre with the shaft on which it is mounted and which may be likened to a very much enlarged crank pin used in locomotive work to impart motion to the slide valve. (See *E* in Fig. 13.)

Expansion.—The cylinder, up to the point of cut-off by the valve, is filled with steam at, or some amount below, boiler pressure. After cut-off, steam is locked in the cylinder, but continues to do useful work by virtue of its expansive properties. The period from cut-off to exhaust is known as expansion.

Exhaust.—The steam after it has done its work in the cylinder.

Expansion Link.—A slotted link (*L*, Fig. 12) made to vibrate about a point situated at its centre and actuated usually from the driving axle. The connection to the slide valve is taken at the will of the driver by means of his reversing lever (Figs. 12 and 13) from a point either above or below the centre of the link, according to the direction in which he wishes the engine to move.

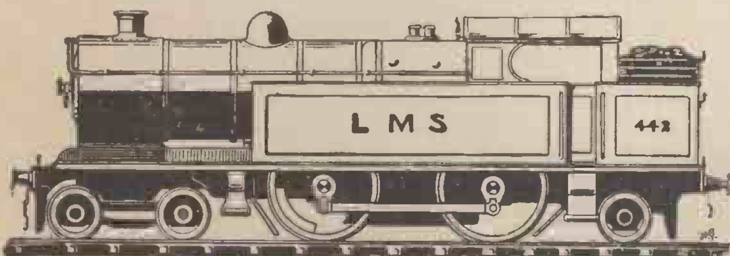


Fig. 10.—The 4-4-2 type tank.

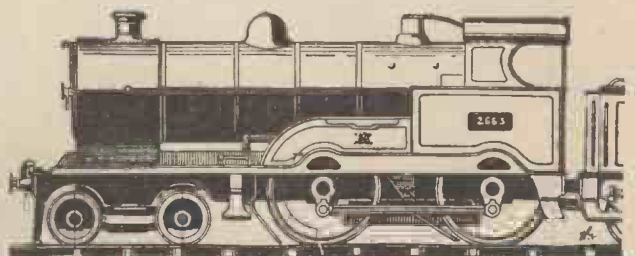


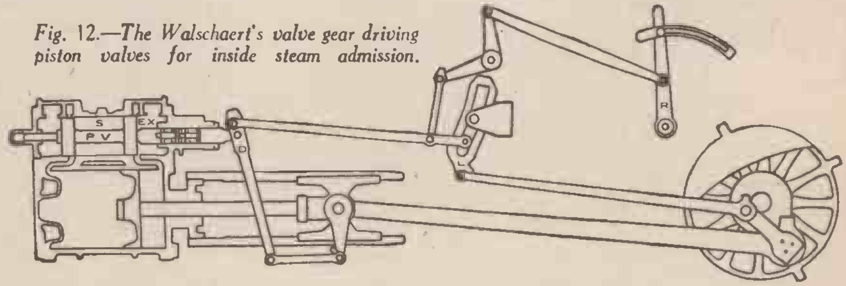
Fig. 11.—The 4-4-0 type.

Fire.—In model locomotives coal, charcoal, or wood, or a mixture of all three, or vaporised or atomised paraffin, or else, in small boilers, methylated spirit.

Fuel.—See Fire.

Gear.—This word either refers to the relative attitudes of the wheels, valves, and reversing lever or to various rods, links, etc., which constitute the operating mechanism for driving the valve. In the first sense of the term the engine is said to be in forward gear, in mid gear, or backward gear, according to the position of the reversing lever and the main connection to the valve in the expansion link. In both of the models shown in Figs. 12 and 13 the engine is set in forward gear.

Fig. 12.—The Walschaert's valve gear driving piston valves for inside steam admission.



Gauge.—An instrument for determining the pressure of vacuum. Also a term applied to the width between the rails of the track.

Model Rail Gauges.—Gauge No. 00 ($\frac{5}{8}$ in.). Distance between the tracks is $\frac{5}{8}$ in. (16 mm.) and the scale of the model is 4 mm. to the foot. This size was first brought out as a toy, and has now been developed for serious workers. The advantage is that a system as complete as No. 0 ($1\frac{1}{4}$-in. gauge) can be packed into half the space.

Gauge No. 0 ($1\frac{1}{4}$ in.). This is the most popular model railway gauge at the moment. It suits the amateur who uses clockwork or electric locomotives, and where the interest is mainly in the operation of a steam locomotive this gauge is the smallest that can be used.

Gauge No. 1 ($1\frac{3}{4}$ in.). A very handy gauge, especially for the home worker, who makes his own engines and wishes to introduce the maximum amount of detail into all parts of both the rolling stock and the "way and the works."

Gauge No. 2 ($2\frac{1}{2}$ in.). This is a model locomotive builder's gauge. The scale is just over $\frac{1}{2}$ in. to the foot and quite powerful engines are possible on it. A well-designed $2\frac{1}{2}$-in. gauge engine will pull an adult, and burn solid fuel like a full-size locomotive.

Injector.—A piece of apparatus into which steam and water enter and mix, the effect of which, through the condensation of the steam, is to impart sufficient velocity to the water to compel it to enter the boiler against the pressure within the boiler.

Lap.—This is the amount by which the length of a slide valve exceeds the distance between outside or inside, as the case may be, edges of the steam ports leading to a cylinder. In the case of inside admission the lap will be on the inside edges of the piston valve, and with outside admission will be on the outside edges of the valve. The object of providing lap is to cut off steam in the cylinder before the piston has reached the end of its stroke. The effect of this is to compel the steam locked up in the cylinder to continue to do useful work by virtue of its expansive properties. (See Expansion Link.)

Lead.—This is provided for, not in the valve itself, but in the proportion and arrangement of the gear which drives it. In Stephenson's link motion (Fig. 13) it is arranged by advancing the position of the eccentric sheave upon the axle, and in another well-known gear, the Walschaert's (Fig. 12), by introducing the lever between the cross-head and the valve spindle, which causes the valve to have an additional motion.

Lubricator.—On models it is essential that the valves and pistons should be constantly oiled by being fed with minute quantities of oil. The Roscoe or displacement type of lubricator best effects this. Its action depends upon the condensation of steam in a closed vessel filled with oil. A pipe conducts the steam from the valve chests to the top of this vessel: as the steam is conducted it falls to the bottom in the form of water. The oil is thus compelled to pass through the same pipe as that through which steam entered, and so goes to the valve chests, from whence it is carried through the ports, by the rush of steam, to the pistons.

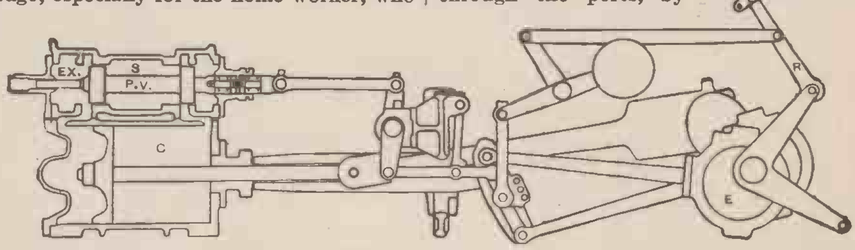
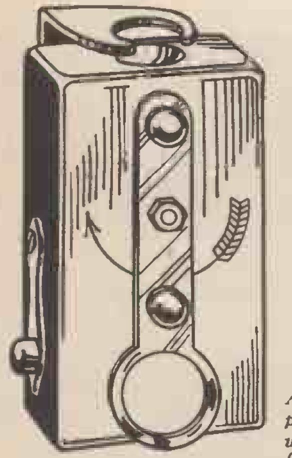


Fig. 13.—An instructional model of Stephenson's gear with inside admission piston valve.

Slide Valve.—This is of two types, the old-fashioned flat or D valve, which provided for outside admission, and the more modern piston valve (shown in Figs. 12 and 13), which usually arranges for inside admission. The piston valve really consists of two pistons connected together on one stem, the space between them being filled with boiler steam, and the space at either end leading to the blast pipe.

AN A.B.C. OF PHOTOGRAPHY

The Concluding Article of this Series. Previous Articles have appeared in the May, June, and July issues of "Practical Mechanics."



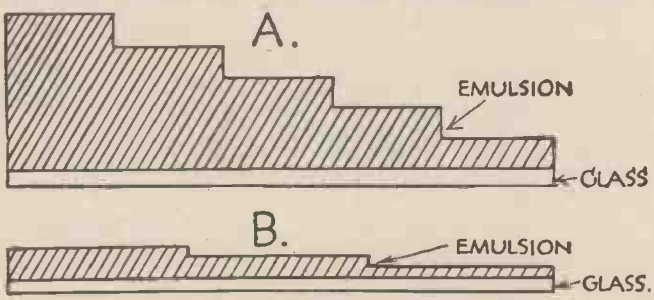
A novel self-portrait device which can be fitted to the end of an antinous release and operates the shutter after a short time, so that the user may include himself in a group or scene.

Retouching Medium

A MIXTURE of turpentine and gum which is painted on a negative in order that the pencil or brush may take a hold on the surface.

Roller-Blind Shutter

A length of strong opaque material, such as linen, attached at one end to a roller which contains a spring. The lower edge of the blind is pulled down and engages in a catch, to be released when a trigger is operated. Usually this is carried out by means of a pneumatic device, such as a rubber bulb, and small pressure plate. When the catch is released the blind flies up in exactly the same manner as the domestic window blind. One form of this shutter has the blind in two sections, the sections being adjustable one from the other. Exposure in this case is controlled by varying the width of the slot, the speed with which the blind travels being constant. A narrow slot is used for high speeds, and *vice versâ*. This type of shutter is used for the highest speeds.



This diagram shows why a slow-speed plate (thick emulsion) can give better graduations of tone than a fast (thin emulsion) plate. The thick emulsion produces various densities having greater differences than can be obtained on a thin emulsion, where the greatest thickness is a very little greater than the minimum.

Roll Film

A sensitive film affixed at each end to a strip of light proof material and rolled round a spool. The paper bears indications of the sections where pictures may be taken in order to accommodate the correct number on the strip, and these indications are viewed through a small window in the back of the camera.

Shutter

The mechanism which operates in front of the camera to permit the light to pass through to the sensitive surface. The simplest shutter consists of a metal plate with a hole in it, and it is pulled down by the operation of the release and returned to its original position by the action of a spring. See also Roller Blind Shutter and Focal Plane Shutter.

Sodium Sulphite

Clean, waxy-looking crystals with no white powder covering them. Turns to a powder when exposed to the air, and should therefore only be used in the clean crystal form. Hot water should not be used when preparing solution. Should be kept in dry form and not as a solution.

Sodium Sulphide

Large greenish crystals, smelling very offensively. Rapidly absorbs moisture from the atmosphere, and should therefore be kept in well-corked bottle.

Speed

The emulsion coating a film or plate is rated according to its sensitivity. The most common method of referring to this sensitivity is to give it an H. and D. number. At the present time plates are obtainable having an H. D. number of 850 or more. The speed of the normal roll film is between 400 and 500 H. and D. Colour plates are much slower. Cinema films are much faster. For general photographic work a speed of 500 is most convenient. Generally speaking, the faster the speed, the thinner emulsion, and consequently the less the degree of graduation which is obtainable in the finished picture. This is explained in the accompanying sketch. The slow speed (or thick) emulsion will enable various thicknesses of material to be left when the picture is fully developed and fixed, as shown at A. On the other hand, the fast or thin emulsion will only permit of very few steps or degrees of density. Special plates are obtainable, or course, where this does not apply.

Stop

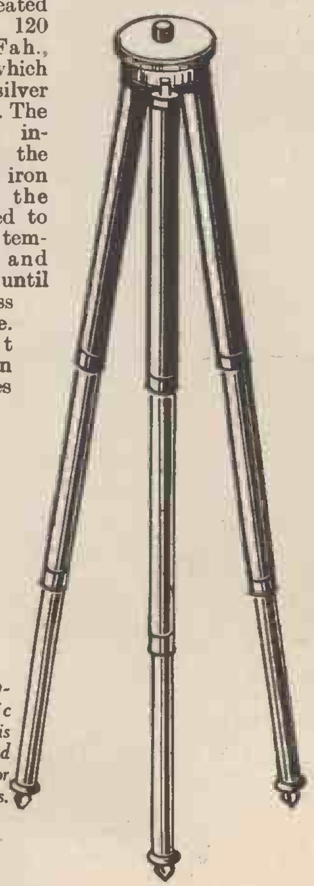
The term applied to the hole through which the light passes in front of the camera. In some cases the stop is situated in front of the lens. In other cases it is behind the lens or even between the separate components of a compound lens.—See also Diaphragm.

Tank

A piece of apparatus in which plates or films are developed. A metal container holds the developing solution and the negatives are immersed in this for a time. The developer is drained off, the negative rinsed, and fixation completed in the tank. A special type of apparatus is obtainable in order that these processes may be carried out in daylight.—See Daylight Tank.

Toning

The process of changing the colour of a print by chemical means. In some cases a stain is used and the print is stained all over. This arrangement is used in such subjects as fireside portraits, etc. The usual bromide enlargement in its ordinary condition is black and white, but many prefer a sepia tone, and this is obtained by means of a toning bath. The simplest method for toning gaslight or bromide prints to a warm sepia is to bleach the print in a ferricyanide and bromide bath and afterwards redevelop in a sodium sulphide bath. The formula will vary according to the paper. The hot hypo and alum process consists of a bath of hypo containing alum which is heated to about 120 degrees Fah., and in which nitrate of silver is dissolved. The prints are inserted in the bath in an iron dish and the whole raised to the above temperature and kept there until the process is complete. A slight reduction usually takes place.



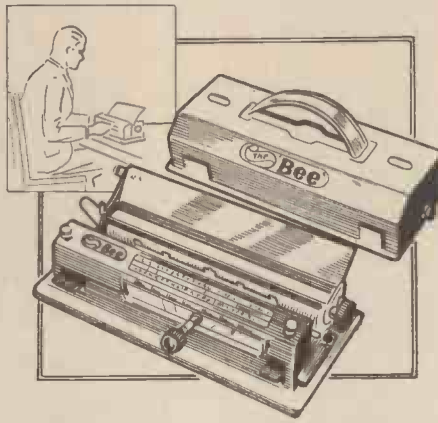
A tripod having telescopic legs, which is both rigid and adjustable for various heights.

The LATEST Novelties

The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS 8-11, Southampton St., Strand, W.C. 2. Quote number at end of paragraph.

An Ingenious Typewriter

WEIGHING only 4 lb. and measuring only 11 in. × 5 in. × 3 in., this little machine is really portable and amazingly efficient in operation, the results being indistinguishable from that of an expensive three- or four-bank machine. Although very simple and

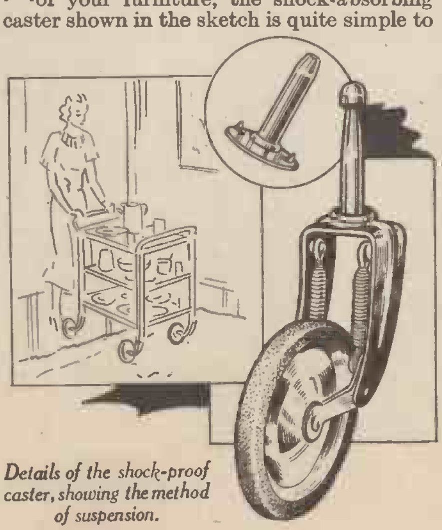


A midget portable typewriter which measures 11 in. × 5 in. × 3 in. and weighs only 4 lb.

compact, it bristles with noteworthy features, such as a margin setter, paper release, line space adjustment, automatic ribbon feed, back space lever, and a simple device by which the ribbons may be changed in a few moments. The type faces include capitals, figures, punctuation marks, and all the usual symbols and fractions, and clear carbon copies are obtainable. A good average speed is possible by even a novice after a few minutes' practice. Cleaning and maintenance are greatly simplified by the fact that all moving parts are quickly detachable. The price is £4 4*s.* carriage paid in the British Isles. [147.]

Shock-absorbing Casters

APART from improving the appearance of your furniture, the shock-absorbing caster shown in the sketch is quite simple to

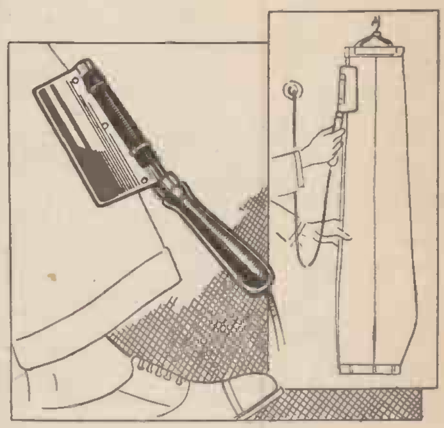


Details of the shock-proof caster, showing the method of suspension.

fix. Known as the "Flexells" caster, they are obtainable in two sizes, namely, 3-in. and 4-in. wheel diameters respectively. If when fitted to a dinner wagon the casters meet a sudden change in level from floor to carpet, the whole shock is taken by two springs (fitted in each caster), which expand, thus preserving the uniform level of the wagon. When travelling on a level surface, the springs are slightly expanded to allow for the load carried, while the rubber-tyred wheels, running on special bearings, ensure smooth and noiseless movement. It is possible to obtain oxidised, copper, or nickel-plated casters, the 3-in. casters costing 10*s.* 6*d.* per set of four, including sockets, and 4-in. casters 13*s.* 2*d.* post free. [148.]

An Electric Clothes Press

DISTINCTLY novel and extremely serviceable, this press prompts one to ask, "Why wasn't it thought of before?" By



An electric clothes press.

simply plugging in to a convenient power point and allowing about three minutes for the elements to warm up, the presser is ready for use. The inset sketch shows the best method for creasing trousers, and should one be caught in a shower, it is but a few minutes' work to put a knife-edge crease down the front edge of the trousers. It will be found equally useful for coats, ties, and pleated skirts and may be obtained for 12*s.* 6*d.* carriage paid. [149.]

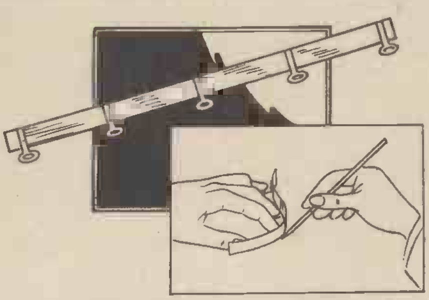
New Style Shaving

THE revolutionary shaving device, illustrated, removes the hair from the face comfortably and closely and as no lather is required it may be used wherever an electric point is handy. The shearing head consists of two slotted plates, the outer one being stationary and the inner one moving rapidly backward and forward, actuated by the motor which is housed in the handle of the shaver. It is almost impossible to cut oneself when using this dry shaver, and as no new blades are required, a great saving is effected. It costs £4 19*s.* post free. [150.]

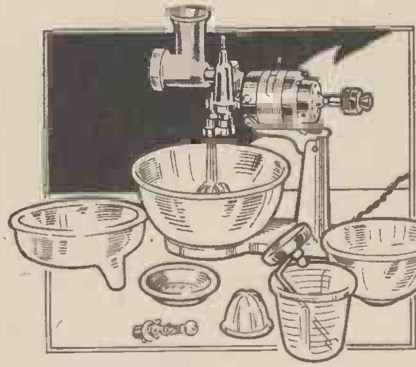
An ingenious electric shaving device.

An Adjustable Drawing Curve

EVERY draughtsman has come up against the "snag" when using French curves to find one which just fits that awkward curve on the drawing. The adjustable curve illustrated will be found useful for overcoming these "snags," for as will be seen from the sketch, it may be adjusted to fit the most awkward of curves. It consists of a thin strip of flexible steel fitted with metal tabs which may be held in position by the fingers or with drawing-pins. The 12-in. curve costs 2*s.* 4*d.*, and one 18 in. long costs 2*s.* 11*d.* [151.]



An adjustable drawing curve that will be appreciated by most draughtsmen.



A universal kitchen motor that can be put to a number of labour-saving tasks.

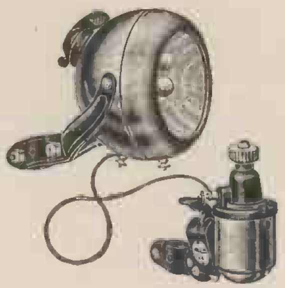
An Ingenious Kitchen Appliance

RECENTLY placed on the market, the universal kitchen motor, illustrated on this page, performs an amazing number of operations. It may be used as a beater, tin-opener, food chopper, knife sharpener, juice extractor, or drink mixer, and is supplied complete with mixing bowls and graduated measure for £6 19*s.* 6*d.* carriage paid. The motor is air-cooled and is fitted with double worm-gear drive and has three controlled speed variations. All the attachments may be quickly interchanged and are held positively in position. Finished in ivory enamel and chromium it is thus very easy to keep clean. [152.]

A Review of the Latest Devices for the Amateur Mechanic. The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.

A De-luxe Headlamp for Cyclists

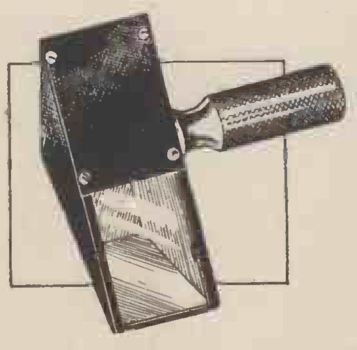
ATTRACTIVELY designed, and easily attached to the handlebars or frame of a bicycle, the "Wilco" de-luxe lighting set shown herewith will appeal to all cyclists. The lamp, which is chromium plated, is fitted with a control switch for regulating the light. The special silvered patented reflector increases the intensity of the light, making it extremely powerful. Two special quality bulbs are supplied correctly focused and are controlled by a neat switch on the lamp which will operate either bulbs from the dynamo. The centre bulb gives a penetrating beam straight ahead, whilst the top bulb gives a broader light slightly dipped. The fixing bracket holds the lamp rigid, making it practically thief-proof. The set complete costs 21*s.* [138.]



The "Wilco" de-luxe lighting set for cyclists.

A Useful Apomecometer

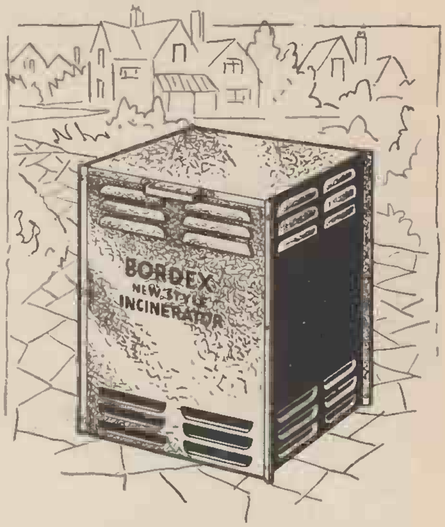
A SIMPLE and convenient device for approximately gauging the height of trees, buildings, etc., this instrument is similar to an optical square, but reflects at 45 degrees instead of at right angles. To use the instrument, a sight is taken on to a spot near the foot of the object to be measured, level with the observer's eye; then by walking backward or forward the position is ascertained where the top of the tree is seen by reflection in the apomecometer simultaneously with the spot on the tree. The height of the object is then equal to the distance of the observer from it, plus the height of the sighting spot above the ground. The cost is £1 10*s.*, post free. [139.]



A useful device for approximately gauging the height of trees, buildings, etc.

A New-style Incinerator

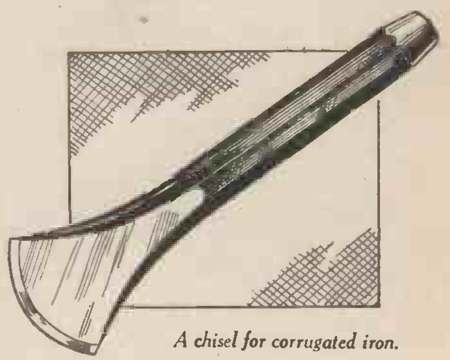
MADE from heavy bright galvanised metal, the incinerator shown lights quickly, and burns wet as well as dry rubbish continuously. If used as instructed, it will outlast the ordinary type. Sparks and ash are not blown about—an immense boon—and the ash, not having the valuable potash evaporated in flames, forms one of the most valuable fertilisers, indispensable for flowers and fruit. The entire height is all working capacity—4 in. for ash, the remainder for rubbish. Lightly drop in fairly dry rubbish, and when this has ignited, wet rubbish will smoulder into ash with practically no attention. All parts of the incinerator are renewable separately, and it is sold in two sizes. In heavy metal measuring 24 in. × 17 in. × 22½ in. in extreme size, it costs 10*s.* 6*d.*, and in very heavy metal 30 in. × 17 in. × 22½ in. costs 16*s.* 9*d.* [140.]



A useful accessory for the garden is the new-style incinerator shown.

A Chisel for Corrugated Iron

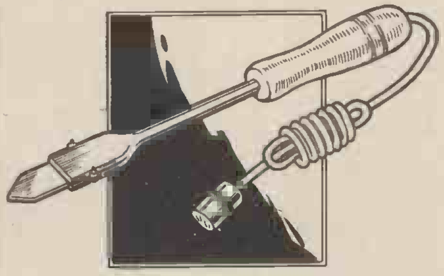
HAVING to cut corrugated iron with an ordinary chisel is a form of punishment which has to be experienced before the full subtleties of the torture can be appreciated. Costing only 1*s.* 6*d.*, the special chisel illustrated on this page (designed by some humane person) will soon pay for itself in time and temper. [141.]



A chisel for corrugated iron.

An Inexpensive Soldering Iron

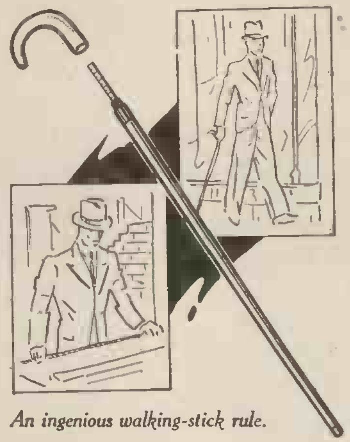
COSTING only 1*s.* 9*d.* post free, the electric soldering iron (see facing page) is an amazingly sturdy job and will prove a great time- and temper-saver when wiring up the radio receiver and also for use on those hundred and one jobs for which a soldering iron is essential. It is supplied with a substantial copper bit, a useful length of strong flex, and an adapter. [142.]



This cheap electric soldering iron sells at the extremely low price of 1s. 9d.

A Walking-stick Rule

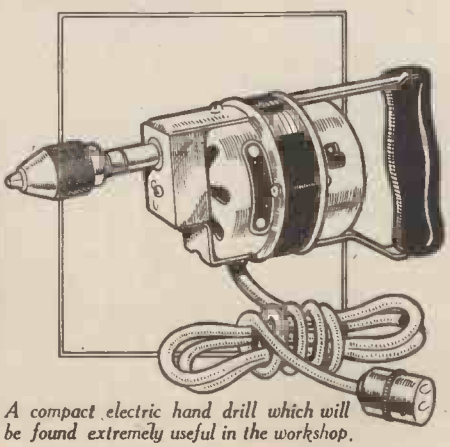
As will be seen from the inset sketches, this walking-stick serves a dual purpose. Whilst it may be used as and outwardly looks like a normal stick, it has the added advantage of containing a stout folding 5-ft. measuring rod that is held in position by the crook, which screws firmly down on to the barrel. Two styles are available: one made from root bamboo at £1 16*s*., and one at £2 12*s*. 6*d*. which is malacca cane, fitted with a horn handle and a silver band. Both prices are carriage paid. [143.]



An ingenious walking-stick rule.

A Compact Electric Hand Drill

Costing only 24*s*. 6*d*., the electric hand drill illustrated on this page will be found to be a great time-saver in the home workshop. The robustly constructed motor, which is fan cooled, is operated from A.C. mains and consumes approximately 1 ampere. The switch, as will be seen from the sketch, is conveniently mounted on the body of the motor and the chuck holds drills up to $\frac{1}{4}$ in. diameter. The drill is supplied complete with 9 ft. of stout rubber-covered cable. [144.]



A compact electric hand drill which will be found extremely useful in the workshop.

Hints About Hobbies

Practical Ideas Contributed By Readers

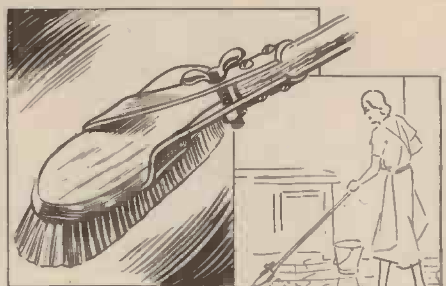
THAT HINT OF YOURS

Every reader of PRACTICAL MECHANICS must have originated some little dodge which would be of interest to other readers. Why not pass it on to us? For every item published on this page we will pay 5s. Address your envelope to "Hint," PRACTICAL MECHANICS, George Newnes Ltd., 8-11 Southampton Street, W.C.2. Put your name and address on every item. Please note that every hint sent in must be original.

A Scrubbing Device

ALL the worry and backache can be taken out of scrubbing with the aid of this simple little device, which will hold any type of flat-top scrubbing brush.

Two pieces of flat iron are drilled to take a wing bolt and hammered into the shape shown in the sketch. They are fixed to an ordinary broom handle which can be cut to any desired length.



A simple gadget to facilitate the scrubbing of floors.

The scrubbing brush is placed between the jaws and tightly clamped by means of the wing nut and bolt.

What does the Clock Say?

WHY do we always think of the ticking of a watch as "tick, tick," but regard that of a clock as "tick, tock"? Is there an actual distinction between the alternate sounds, or is it due purely to our imagination?

It seems to be the general opinion of uninformed people that it is merely a matter of chance whether the left beat of the pendulum clock is accompanied by the "tick" and the right beat by the "tock" or vice versa. This matter, however, is not left to chance, but the "tick" always marks the moment when the pendulum reaches the extreme point from its perpendicular on its right beat, and the "tock" similarly marks the extreme point on the left swing. This is true with pendulums of all lengths.

The reason for this is that the anchor of the escapement mechanism is above the rotating escapement wheel and in the same plane, the conditions under which its arms strike the cogs of the wheel are not the same for both arms. One of the arms of the anchor strikes the wheel cogs moving upward in a direction opposed to that of the anchor, while the other anchor arm strikes against the cogs when the wheel is moving down.

Constructional details for making a handy scoop.

The result of the unequal conditions under which the two arms engage the cogs of the wheel, is the natural production of a difference in the sounds produced by the contact of the parts.—F. C. L. (London).

A Handy Scoop

THIS scoop is made from a wooden "darner," a piece of cardboard, and a piece of spring metal such as is found round jars of shrimp paste, etc.

The cardboard is cut into a semi-circular shape and can be made to hold a certain known quantity.—T. S. (E.C.1).

USEFUL TEMPERATURE GUIDE.

CENTIGRADE	FAHRENHEIT	
3500	6330	Carbon vapourises, also temperature of -
3000	5400	Temp. attained by Thermit (electric arc
2800	5072	Temperature of Oxy-Hydrogen flame
2500	4532	Osmium melts
2275	4037	Iridium melts
2231	4000	Temperature attained by Bessemer furnace
1710	3080	Platinum melts
1530	2731	Wrought iron melts
1400	2552	White heat
1371	2500	Steel melts
1200	2192	Orange-red heat
1100	2012	Copper melts
1063	1981	Pure gold melts
1050	1922	Cast iron (lowest) melts
970	1778	Silver melts
700	1292	Dull-red heat
625	1157	Aluminium melts
405	762	(about) coal ignites
357	674	Mercury boils
316	600	Lead melts
288	550	Gunpowder ignites
215	420	Tin melts
109	228	Sulphur melts
100	212	Water boils
79	174	Alcohol boils
65	149	Fusible alloy melts
61	142	Beeswax melts
46	114	Paraffin melts
44	111	Phosphorus melts
36.8	98.4	Normal temperature of human body
17	62	Mean temperature of sea
10	50	Mean temperature of air
0	32	Water freezes
-20	-4	Mixture salts and ice
-38.8	-34.3	Mercury freezes
-55	-68	Greatest natural cold on Earth
-191	-312	Air liquifies under normal pressure
-252	-422	Hydrogen liquifies
-257	-432	Hydrogen freezes
-260	-436	Greatest artifical cold on Earth
-278	-459	Absolute zero

The chart shown above is one which will undoubtedly prove of great convenience to anyone interested in chemistry or physics. Cut it out and paste it in your notebook, or on a card.

BOOKS worth READING

"Britain's Fighting Fleets," by A. Guy Verco. 164 pp., with numerous half-tone illustrations. Percival Marshall & Co., Ltd., 2/6.

THIS well-produced little book tells, in interesting fashion, the story of the development of the British Navy from 1890 to 1935. The descriptions are divided into eleven chapters, which cover warships, dreadnoughts, cruisers, destroyers, submarines, aircraft carriers, etc. There is also an appendix which gives details of British naval guns and the names of small craft.

The book is beautifully illustrated throughout by reproductions of photographs by R. Perkins; these have reproduced remarkably well due to the good-quality paper on which the book is printed. This publication should meet with warm approval at this critical time.

"Profitable Photography," by William Stewart. Price 2/6. Published by Sir Isaac Pitman & Sons, Ltd.

THIS is an admirable little book for the photographic novice anxious to turn amateur efforts into profit-making ventures. The author, who has had wide experience in commercial photography, is at pains to show that expensive apparatus is unnecessary for the taking of a good photograph, and that careful grouping, focusing, and touching-up can render any portrait or snapshot saleable. He details various markets and media, stressing the simplicity of gas-light photography.

"Central Heating and Hot-water Supply." By J. W. Cowan, A.M.I.H.V.E., 131 pp. with line illustrations. Percival Marshall & Co., Ltd., 3/6.

FOR the student in building and heating this publication provides an excellent grounding. It is comparatively elementary in character, and explains the principles of the subject and the natural laws upon which the success of hot-water supply systems operate. The object of the book is to prepare the reader for more advanced studies, and in this it is particularly successful. The principles underlying the circulation of hot water through pipes due to expansion, and the practical details of complete hot-water systems, are fully treated. In addition, methods of heat transmission are described, and information is given with regard to expansion and water tanks, hot-water cylinders, elementary calculation of capacities of heating systems, etc. Throughout the book is interestingly written, and is well indexed for reference purposes.

POSTAGE STAMPS OF THE WORLD

MESSRS. Whitfield King & Co., Ipswich, the well-known stamp dealers, have recently produced their 1936 edition of the Standard Catalogue of the Postage Stamps of the World. This work of reference for stamp collectors is now in its thirty-fifth year of publication. Containing over 6,700 illustrations, it also introduces a number of improvements, which, together with some statistical information concerning the world's postage stamps, will be found in the preface. The price of the 1936 edition is 5/-.

Practical Mechanics Replies to Queries and Enquiries

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page iii of cover. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8-11 Southampton Street, Strand, London, W.C.2.

THE MANUFACTURE OF GLASS

"I AM carrying out some experiments with glass. Could you tell me what type of furnace would be necessary to produce about 10 or 14 lb. of glass, that is if it is possible to buy or make a furnace to produce so small an amount? In the mixing of the constituents, what is the proportion of the sand, soda, and lime, and in the case of water-glass, the proportion of sand and soda? At what temperature do the materials fuse to form glass, and would the same heat be necessary to remelt old glass?" (L. C. H., Coventry.)

IT is thought that you will experience difficulty with your glass-making experiments, since this is a task which cannot very well be carried out on a small scale. About the cheapest form of furnace which you can make for home use consists of a large earthenware crucible, which can be obtained from any firm of laboratory suppliers, or, failing this, a flower-pot, with the bottom hole filled up with clay. This is loosely packed with the glass-producing mixture and heated either in a bright-red domestic fire, or by means of several blow-lamps. It would, of course, be possible to purchase a gas-fed muffle-furnace from a firm of laboratory suppliers, such as Messrs. James Woolley, Sons & Co., Ltd., Victoria Bridge, Manchester, but such a furnace would be costly.

The ingredients for making glass depend upon the type of glass required. There are many hundreds of different glasses and, therefore, it is only possible for us to give you the proportions of a mixture for the preparation of common bottle glass. This results from the heating of the following mixture:

Sand	60 parts (by weight)
Lime	6 ,, ,,
Soda	20 ,, ,,
Nitrate of soda	5 ,, ,,

A little broken glass may be added to the above mixture if desired. For the preparation of water-glass (sodium silicate), the following mixture will suffice:

Sand	20 parts (by weight)
Caustic Soda	15 ,, ,,

In the case of ordinary glass, the mixture must be heated to bright redness, and at this temperature old glass will remelt. For the preparation of water-glass, a considerably lower temperature is sufficient, the mixture, after having cooled down, being boiled with water in order to extract the soluble sodium silicate or water-glass.

THE INFLUENCE OF RAYS

"WHAT usual chemicals become luminous when subjected to the influence of X-rays, ultra-violet rays, and infra-red rays respectively?" (A. E. M., Folkestone.)

THE following substances become luminous when subjected to the action of X-rays:

Barium platinocyanide, potassium platinocyanide, magnesium platinocyanide, calcium tungstate, calcium fluoride (fluorspar), calcium sulphate, zinc sulphate, zinc sulphide, potassium-uranium sulphate, barium sulphate, barium sulphide, chlorophyll, many varieties of glass, quinine sulphate, mica, potassium acetate, strontium sulphate, strontium sulphide, uranium fluoride, and uranium sulphate. Of these, the best are calcium tungstate or barium platinocyanide.

The following materials are self-luminous under the influence of ultra-violet rays, their luminescence being known as "fluorescence":

Quinine sulphate (acid or alkaline solution of), solution of æsculin, solution of fluorescein, many varieties of mineral oil, and solutions of uranium salts. Of these, solutions of quinine sulphate and æsculin give the brightest fluorescence.

No chemicals evolve light under the influence of infra-red rays, since the rays do not contain sufficient energy for this purpose. A surface painted with thallium iodide, however, possesses a selective reflecting power on infra-red rays. Also, a thin sheet of ebonite will transmit infra-red rays, whilst remaining perfectly opaque to ordinary light rays.

STARTING A LEAF COLLECTION

"I WISH to make a collection of skeletons of leaves of trees and plants. Please could you inform me how to make, preserve, and mount them?" (K. D., North Finchley.)

SKELETONISING leaves is not usually a difficult task, although it is tedious and calls for much patience. A good method consists in soaking the leaves in clean soft water for three months, during which time the fleshy matter of the leaf rots away, leaving the leaf skeleton. This process, however, is too lengthy for most individuals. It may be speeded up as follows:

Dissolve 2 oz. of washing soda in a pint of water, and to this solution add 2 oz. of slaked lime. Boil the solution for about ten minutes. Allow it to cool and then decant or filter the clear liquid after the residue of lime has settled to the bottom of the vessel. Place the clear liquid into a clean saucepan (preferably an enamelled one), immerse in the liquid the leaves to be skeletonised and carefully raise the temperature of the liquid to just below boiling-point. Allow the liquid to be thus heated for an hour. Afterwards let the liquid cool down. It will be found that on taking the leaves up one by one, the cellular matter can be rubbed away between the fingers, leaving the skeletons behind. A better method still is to use a soft brush for the removal of the cellular or fleshy portion of the leaves after the boiling process, since there will be less danger of the delicate skeletons becoming damaged. Usually, by this process, the leaf skeletons are brown in colour. If they are required to be perfectly white, they should be immersed in a weak solution of hydrogen peroxide or chloride of lime for a quarter of an hour and then dried in sunlight. This bleaching process can be repeated if necessary.

Leaves for skeletonising should be gathered just before the leaf begins to fall. August and September are the best months for gathering. With care, however, most leaves can be skeletonised successfully at all stages of their growth, except, perhaps, their very earliest stages.

For mounting, the best method is to fasten the skeletonised leaves down to black paper by means of a tiny globule of seccotine or some other liquid glue placed under the thicker portion of the skeletonised structure. Alternatively, the skeletonised leaves can be stored separately in little envelopes made of transparent paper or cellophane (*i.e.* the transparent wrappings of chocolate boxes, cigarette packets, etc.), a number of the leaves being placed between the leaves of a book or in a press.

CHEMICALLY TREATED CLOTH

"IN your April issue you have two articles on "Plastic Ware." On page 328 you mention 'If the original resin is hot-rolled on to cotton fabric, brightly coloured transparent materials are produced which are indistinguishable from oiled silk.' Now, on page 297 you mention 'Leukon' as being unaffected by 40 per cent. sulphuric acid and also alkalis. Is it possible to obtain a cloth so treated, that it will withstand sulphur fumes for a considerable time? What would be the approximate price per yard out here in Australia? Would the makers forward a small sample to above address? The purpose for which I require the article, is to cover goods to be sulphured, so that the treated cloth or canvas would have to be almost airtight to withstand hard usage. If the article were suitable and reasonably priced I would require fairly large quantities. If the above cloth is not obtainable could you suggest a way to treat canvas to prevent rotting by sulphur fumes? (A. L. M., Australia.)

IT is not possible for an amateur to manufacture cloth impregnated with plastic resins, for the reason that articles of this nature require specially heavy presses. "Leukon" is a transparent synthetic resin, which has been recently produced by Imperial Chemical Industries, Ltd., Millbank, London, S.W.1, from which company you can obtain all particulars. It has not, up to the present, been produced in cloth-impregnated form.

You can readily make fabric impervious to sulphur fumes by soaking it in boiled linseed oil for 24 hours, and then by hanging it out in contact with the air for a few days. Cloth so treated, however, is apt to remain sticky afterwards. If this characteristic is objected to, immerse the material in a bath of molten wax (paraffin wax for preference). When the material has become thoroughly impregnated with the wax, remove it from the wax bath and hang it up to drain, or, better still, pass it through a roller.

Another way to prevent canvas rotting, is to soak it in paraffin (or petrol) containing 10–15 per cent. (by volume) of creosote. Cloth soaked in alum solution is, also, rendered fairly impervious to sulphur fumes. Messrs. M. Barr & Co., Ltd., 83 Hutchinson Street, Glasgow; and Messrs. Macbean & Co., Ltd., Wellington Mills, 103 Mary Street, Port Dundas, Glasgow, are manufacturers of oiled and other resistant cloths.

REPLIES in BRIEF

E. H. (Beckenham).—A 3-in.-centre lathe should be driven at a minimum speed of 1,000 revolutions per minute. A ½-h.p. motor should be sufficient.

D. J. G. (Cork).—A suitable formula for a waterproof cement is as follows: dissolve celluloid chippings in amyl acetate, taking care to keep the mixture tightly corked. It is highly inflammable and dries rapidly.

R. V. P. (Guildford).—The only firm we know supplying moulds for toy figures is Toy Moulds Ltd., 7 Jamaica Row, London, E.C. A dictionary of chemistry terms may be obtained from Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C.2. The maker of the "Adept" lathe is Mr. F. W. Portass, 83A Sellers Street, Sheffield.

S. D. (Cork).—It will certainly not be possible to make the petrol engine without a lathe; accurate workmanship and fit are necessary. The address of Messrs. F. J. Hallam is: Hamworthy, Poole, Dorset. The Brown Junior engine is obtainable from Messrs. Stewart Turner & Co., Ltd., Henley-on-Thames.

A. W. C. (Cinderford).—There is no known method of divining the depth at which water may be found. Many people claim to be able to divine the location of water, but none its depth.

D. A. L. (Bude).—It is not possible to operate an arc from a flash-lamp. You are expecting the impossible. You give no details of your apparatus—we need to know the make, etc.

J. R. B. (Sheffield).—Sorry we do not publish plans for making such a motor. You may be able to obtain these from Messrs. Percival Marshall & Co., Ltd., 13/16 Fisher Street, Southampton Row, W.C.1.

J. B. C. (Bexhill).—We cannot trace a positive known as "pynokriptone." Pinacryptol, however, can be obtained through any chemist.

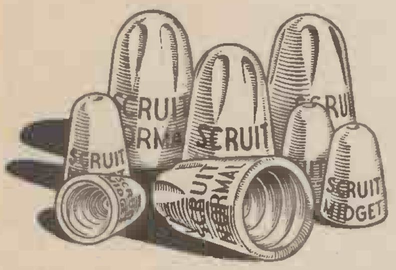
J. D. (Bolton).—The parts required for the 15-c.c. petrol engine are obtainable from Messrs. A. E. Jones, Ltd., 97 New Oxford Street, London, W.C.1.

H. M. M. (Glasgow).—If you will send us a stamped addressed envelope we shall be pleased to put you in touch with our contributor, who will give you all details regarding the Bathysphere.

W. A. D. (Southampton).—We do not know of any cure for diabetes other than the compound made from sheep's sweetbreads, known, we believe, as insulin. You did not enclose a stamp for reply.

The "Scruit" Connector

A One-piece Wiring Connector that Will Make an Efficient Wire Joint that is Fire and Moisture Proof

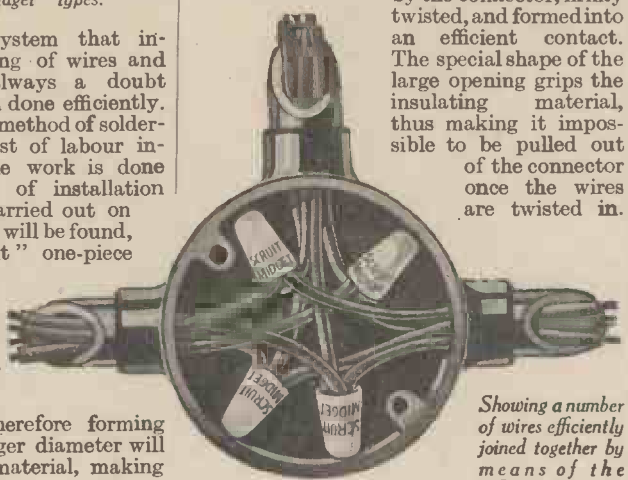


A group of "Scruit" connectors showing the "Normal" and the "Midget" types.

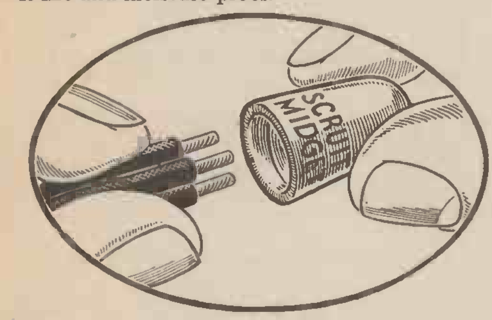
WITH any wiring system that introduces the jointing of wires and cables there is always a doubt whether the work has been done efficiently. We cannot consider the old method of soldering and taping, as the cost of labour increases immediately if the work is done efficiently, and the cost of installation becomes greater than if carried out on the loop wiring method. It will be found, however, that the "scruit" one-piece wiring connector shown on this page will prove ideal for securing a highly insulated joint, as it effectively twists the wires together, at the same time cutting an external thread on the copper conductor and therefore forming itself into a nut. The larger diameter will thus grip the insulating material, making it fire and moisture proof.

The Connector Described

The connector, which is manufactured by J. M. Blair, Audrey House, Ely Place, E.C.1, consists of one piece of high-grade porcelain, the internal construction of which being its special feature. It has two internal threads with different tapers, the first or outer thread having a wide opening which narrows and has a "shark's"-tooth thread, and the inner screw has a rounded female thread with a slight taper towards the apex. The purpose of this special construction ensures that the wires are gripped by the connector, firmly twisted, and formed into an efficient contact. The special shape of the large opening grips the insulating material, thus making it impossible to be pulled out of the connector once the wires are twisted in.



Showing a number of wires efficiently joined together by means of the "Scruit" connector.



The method of inserting the ends of the wire into the connector.

The Five Types

In the "Scruit Normal" all surfaces are glazed and the exterior is ribbed for better twisting, whilst the "Midget" is glazed inside and finished rough outside. The connector makes a universal joint, and can be used for a large number of combinations of wires, the large connectors being suitable for wires up to three 7/20 S.W.G. and the small connectors to three 3/26 S.W.G. When the instructions that are supplied with each box have been carefully followed, a joint equal to a soldered joint can be formed.

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