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PRACTICAL MECHANICS

EDITOR : F. J. CAMM

FEBRUARY: 1958

Contents

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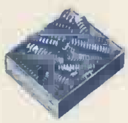

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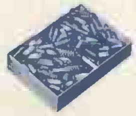

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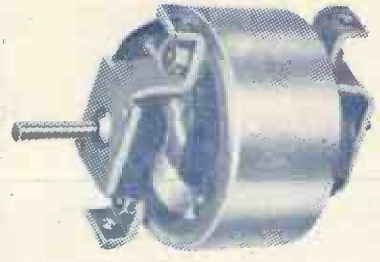

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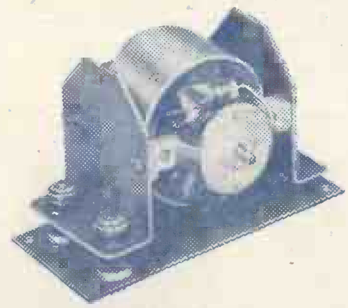

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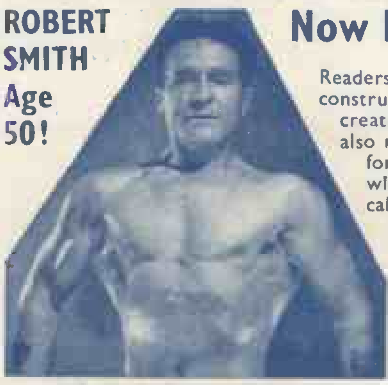

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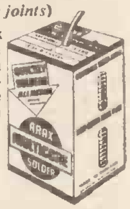

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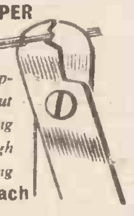

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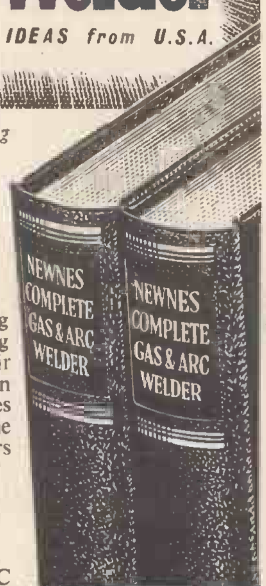

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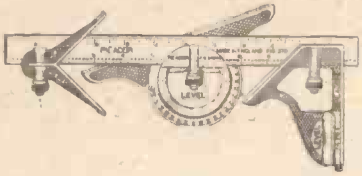

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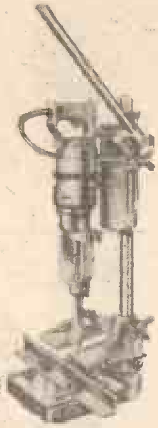

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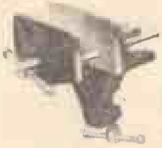

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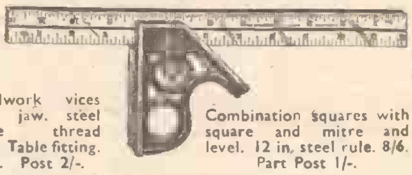

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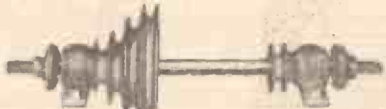

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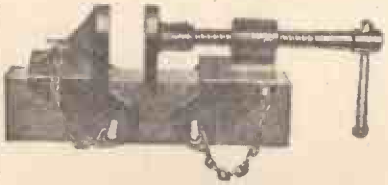

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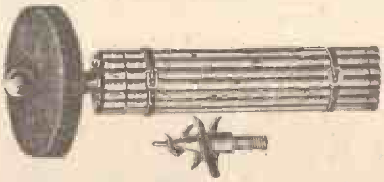

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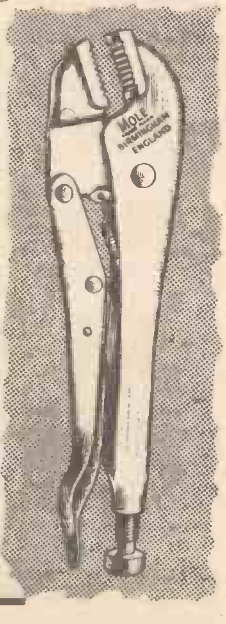

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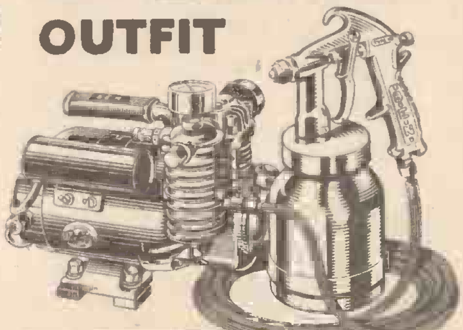

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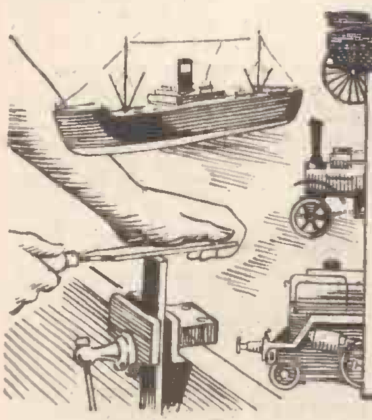

Practical Mechanics

Vol. XXV No. 288 FEBRUARY, 1958

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FAIR COMMENT

THE SATELLITE ERA

THE launching of the two Russian satellites has made the public space conscious and given it an interest in astronomical and astronautical matters far more intense than ever before. The mystery of space had been taken for granted. The public vaguely knew that there were planets and satellites and galaxies of stars in the firmament. This mysterious cosmos is beyond the understanding of most and therefore ignored by most. I wonder how many people have realised the full significance of the new satellite era inaugurated by the two launchings? If it is found, for example, that some of the other planets are inhabited, the whole of our scientific concept as well as our religious beliefs must undergo a radical metamorphosis. Have you ever pondered over the fact that space is limitless—you cannot come to the end of it? This great scientific achievement presages changes in our beliefs, both psychological and metaphysical.

Religions have always dealt with the intangible and the immaterial. Astronomers have plotted the Universe, the location, the orbits and the times of the appearance of large numbers of heavenly bodies. We have regarded the Earth as the centre of the universe, although it is not a self-contained planet and is dependent on the sun for its existence. It was Copernicus and those before him who promoted this belief. The theology of to-day, as it was then, is that man is God's chosen being and the ultimate creation. Because we have no knowledge of mankind elsewhere it is now our belief irrespective of our religions that the Earth was divinely chosen for human habitation. Galileo and Copernicus declared that it was the sun that was the centre of the universe and they were considered as heretics because of those beliefs. Bruno developed those beliefs as his writings show. Galileo found a new companionship with the distant worlds. Bruno said, "What, Is a feeble human creature the only object worthy of the care of God? No, the Earth is but a planet. The rank she holds among the stars is but by usurpation; it is time to de-throne her. The ruler of our Earth is not man but the sun. The life which breathes in common through the universe. Only one bereft of his reason could believe that those infinite spaces tenanted by vast bodies are provided only to give us light." Because of these thoughts, the church burned Bruno at the stake.

The importance of space travel transcends its immediate potential military advantage. It must have great political significance. Nations may no longer be bounded upon the surface of the Earth. Nor may be restricted in area. Our Earth may no longer consist of peoples dependent for their existence on imports and exports. Above our heads lie vast new empires rich in natural resources.

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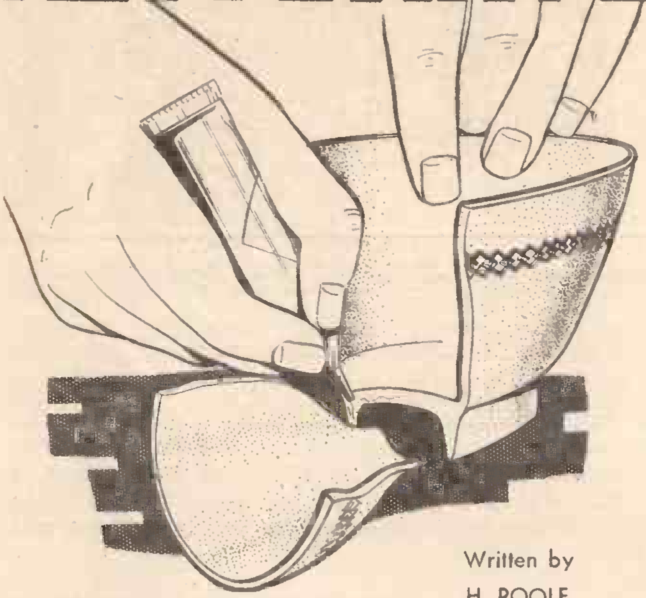
THE great Practical Householder Exhibition sponsored by our companion journal opens at the Empress Hall, Earls Court, London, on February 19th and closes on March 1st. It will be open every day from 11 a.m. until 9.30 p.m. on weekdays and 10 a.m. to 10 p.m. on Saturdays. The entrance fee is 2s. 6d. Nearly 100 manufacturers will display their goods and give advice and demonstrations. Every "do-it-yourself" enthusiast should visit this magnificent show. —F. J. C.

REPAIRING POTTERY



No. 1.—Some Hints on the Materials and Methods Used

Written by
H. POOLE

This Article is Published in Response to Requests from Readers

TODAY, pottery is expensive to buy and it has become "good policy" to repair whenever possible not only items of decorative or antique value, but also the many ceramic articles in everyday use. A pottery object which has been dropped and smashed into a hundred or more pieces is beyond redemption unless it is of extreme value, when it can be sent to an expert for "invisible mending," but less serious damage can be repaired at home. Pottery may develop cracks, become badly chipped, have large pieces knocked out and suffer other and varying types of injuries. Sometimes a cup or bowl will be broken cleanly into two halves or a vase may have a hole knocked in its side. A decorative pottery figure may be unfortunate enough to have one of its arms or legs knocked off. The more humble domestic teapot may suffer spout fracture or some similar trouble.

All these everyday injuries can, provided they are not too extensive, generally be remedied by one process or another of what we may term "ceramic surgery," whereby pottery pieces are carefully prepared and cemented together, bits are wired or riveted on, missing pieces are skilfully filled in with a sort of artificial porcelain, surface defects are painted over and other injuries made good.

Fig. 1 shows an Italian jug which was accidentally damaged. Fig. 2 shows the jug after it was repaired.

Mending a Plate

The easiest task in the art of pottery surgery is to mend a plate, a cup or dish which has been broken cleanly in two. First the two pieces should be very carefully washed in soap and water, great care being taken to avoid all grease contamination. When the pieces are quite dry (and not before) they should be fitted together to make sure they will join up properly when cemented together. This having been done, the contacting surfaces are lightly smeared with a very thin film of cellulose cement. The cement is rubbed into the contacting surfaces with the finger tip and it is then left to dry—preferably overnight. This provides each surface with an effective keying layer.

To join up the pieces, give the prepared surfaces a light smearing over with cellulose cement, then fit them together and hold them under slight but effective pressure for a few hours. In applying this necessary pressure be very careful to see that the two pieces are not pushed out of position. Often enough a strong elastic band round the two pieces is all that is required. A very light press may sometimes be used instead and with care the two pieces forming the complete article may be merely wrapped round with damp string. Moisture will cause the string to contract when it dries out and thus tighten up, thereby keeping a firm pressure. Fig. 3 shows a rough method of lengthening the life of a plate. A strong piece of calico has been cemented over a bad crack. Subsequently several coats of paint are laid over the fabric.

Fig. 1.—The damaged Italian jug.

Do not use any type of animal glue for pottery cementing. It is messy stuff for this job. It stains—often indelibly. Its holding powers are not very great in these circumstances and, worst of all, it is not waterproof. A casein glue can be used, but generally it is more trouble in these instances than it is worth. Ordinary cellulose cement is the best. It can be purchased in tubes almost anywhere and a little of it goes a long way when used in the manner described above.

Home-made Cement

If you wish to make this cement yourself you can do so by dissolving clear scrap celluloid in a mixture (about equal parts) of amyl or butyl acetate and acetone. Alternatively, you can dissolve the celluloid in the liquid which is known as "Cellusolve," this being a clear water-white liquid of high solvent powers.

The solution of the celluloid must not be made by heating the solvents. Cut the celluloid up into thin shreds. Place it in a bottle and half fill the bottle with the solvent. Cork the bottle and leave it to stand overnight. During the next day shake the bottle frequently. The celluloid will dissolve to a thickish liquid. For cementing purposes the solution should be about as thick as glycerine, if not a little thicker.

There are two other cements which can be used for pottery repairs, the first consisting of a simple solution of clear Perspex in trichlorethylene. This is made up in just the same way as above, and it forms a thick, almost rubbery solution.

The other cement is Canada balsam, long the favourite of microscopists and all optical workers. Canada balsam is a natural crystal resin. It is soluble in benzene, chloroform, naphtha and other liquids. It forms a highly viscous solution which will stick glass, pottery and other smooth objects. Its joints are strong, but it has the disadvantage of taking about a month to set and to harden, during the whole of which time the contacted fragments must be under continual pressure in a warm atmosphere.

All the above cements are waterproof and have good adhesive strengths, even when used on an edge-to-edge joint. They are also non-poisonous after setting.

Fig. 2.—The Italian jug after repair.

Treating a Crack

Sometimes an ominous crack may develop in a piece of china or pottery. Even if such an article does not come to pieces within a few days, the crack will grow, gather dirt, and become unsightly. The best way to deal with this occurrence is with the tip of the little finger work a little precipitated chalk, or, better still, magnesium carbonate (which is "the whitest thing on earth") into the crack, and afterwards, with the same finger-tip, work some of the clear cellulose cement along the line of the crack. Most of the cement will remain on the surface, but a little of it will seep down into the crack and will seal up the white filling which you have placed therein.

Decorative china and other ceramic articles which become cleanly fractured are usually riveted together in addition to being cemented up. The rivets give additional strength, and being fitted at the back of the plate or dish they do not show. A good example of pottery riveting will be seen in Fig. 4. In this particular instance the rivets were put in about 30 years ago and have lasted ever since. The front of the plate is shown in Fig. 5.

The cement used, in addition to the rivets, was a natural one. Its formula sounds rather extravagant, its composition comprising 1oz. finely grated cheese, ½oz. finely powdered quicklime, these two ingredients being made into a paste with white of an egg. There is no doubt that this composition would be effective, since it combines in the one formula albumen and casein, together with lime, which induces a setting and hardening action, but as you will see from the photographs, the actual cementing was badly done—most probably owing to the thickness of the cement—leaving an objectionable and dirt-gathering line between the joined-up pieces.

Fig. 3. — Lengthening the life of a plate by cementing a piece of calico over a bad crack.

Riveting Pottery

Expert china repairers use a diamond-tipped drill for making rivet holes in pottery. With care, however, the necessary rivet holes can be drilled with a small Archimedian drill, using a very fine tip. Again, a small three-cornered file can be hardened by heating it in a fire to red heat and then by plunging it in cold water. The file is then ground to a fine point on a grindstone. Such an article is of great use for making a tiny scratch on the pot-surface for the purpose of starting the drill but, with great care, the file point itself can be used as a drill. In this instance much care is necessary to guard against undue hand pressure, which would only result in an irregular hole being made and its edges splintering, or the article breaking altogether.

Generally the drilling can be done dry, but if a lubricant is necessary use turpentine, but genuine turpentine only.

When drilling a china plate, dish or saucer from its underside, take care not to let the drill go right through. It is sufficient to stop when the drill is about three-quarters way through. This will prevent unsightly protrusions of the rivet ends on the "face" of the plate or dish.

Having made all the necessary rivet holes, pack them loosely with a suitable rivet cement and push down the rivets, which are ordinary U-shaped pieces of wire—either iron or copper—the latter being better.

Sometimes when a dish, plate or other vessel, ornamental or otherwise, is riveted up, some of its parts may be missing. Such gaps, however, provided they are not too extensive, can usually be filled in by the process to be described in the second and concluding part of this article, which will appear next month.

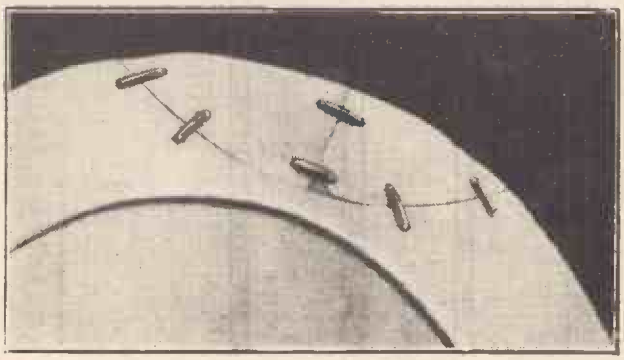


Fig. 4.—Repair by riveting.

Missing Handles and Spouts

When a handle is knocked off a jug or when a spout comes apart from its teapot, the extent and the success of a possible repair must be governed by the extent of the damage. With care a handle may be riveted to a jug or other container, but in this case it is always advisable for the rivets to go right through the walls of the vessel, so as to give maximum strength. It is usually possible to rivet a spout to a teapot, the edges being joined up in the usual manner and two or three rivets being inserted in the sides of the spout. In this case the rivet holes should not go right through the spout, owing to the difficulty of cementing them up afterwards and of making them liquid-tight. Additional strength could be given to this assembly of the spout by tightly binding the outside with fine wire and carefully painting over the wire turns with a suitable cellulose paint.

Fig. 5.—The repaired plate shown in Fig. 4.

"Crazed" Crockery

Many readers will have noticed that pottery articles, although they manage to remain whole and unbroken, gradually become "dirty" or at least discoloured. Very little can be done about this. The whole effect is due to a surface "crazing" of the pottery, the enamel, owing to its brittleness, breaking up into an immense number of small pieces.

Each small piece of surface crazing is bounded by three or four cracks, down into which gradually seep some of the dirt, dust and grease which the surface of the plate or dish necessarily collects. When the pot is washed, some of this surface dirt is removed, but a little of it is drawn down into the cracks and retained (see Fig. 6).

(*To be concluded*)

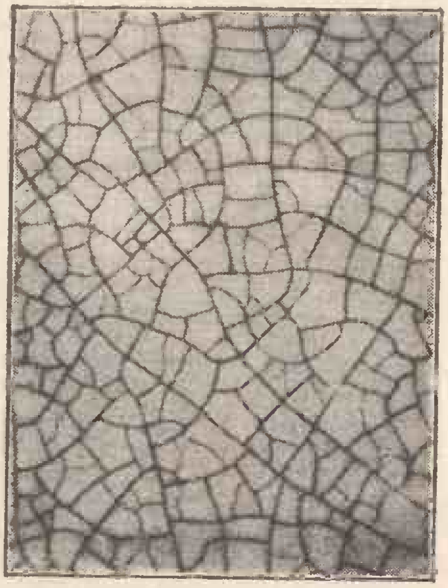


Fig. 6.—A close up of "surface crazing."

A STILL PROJECTOR STAND
INCORPORATING FAN COOLING

Two Accessories for the Home Ciné Enthusiast

By G. H. Dowsett

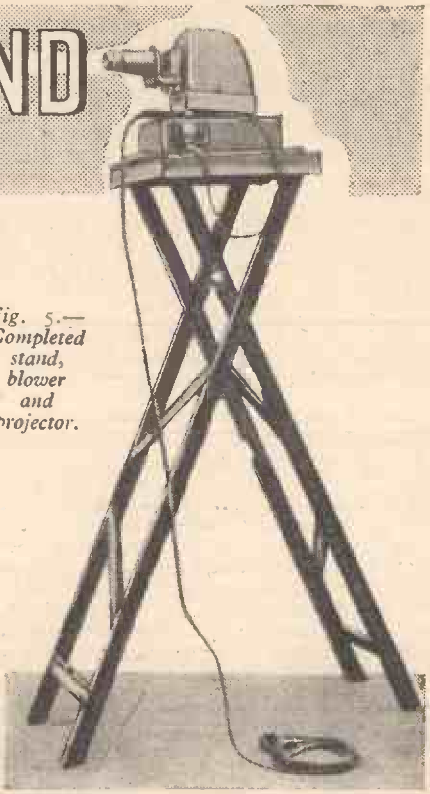


Fig. 5.—Completed stand, blower and projector.

THE smaller projectors for 2in. × 2in. colour transparencies are not provided with "blowers" but depend upon convection currents for cooling. Anything that can be done to reduce the heat to which the slide is subjected is advantageous. With adequate cooling the danger of the development of "Newton's Rings" is removed and cooler operation has a beneficial effect upon the life of the projector lamp.

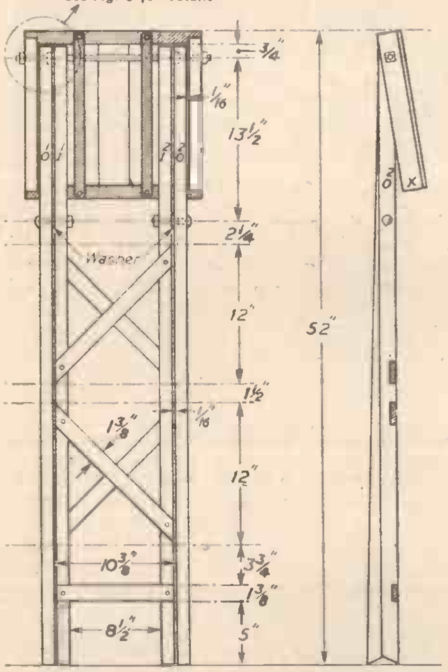


Fig. 1.—Front and side elevations of the stand folded.

It is always necessary to arrange the projector so that its beam is clear of the heads of the seated audience and the usual arrangement of stools, books, etc., is seldom satisfactory. A reliable and rigid stand of suitable height is virtually a "must."

Stand Construction

The stand is simply constructed of wood on the principle of the folding card table or domestic ironing board. The blower is a separate unit for greater portability and the same stand can be used for projectors with or without built-in blowers. For this reason there was no interference with the wiring of the projector itself so that it can be used on or off the stand with or without blower.

Hardwood is used in readily obtainable "planed" sizes. It is important that the dimensions of the legs and the positions of the bolt holes are accurate or it will not stand rigid when erected. The platform is simple in construction but this, too, must be accurately made and assembled so that the action of folding is smooth and easy but without looseness. The completed stand is shown in Figs. 5 and 9.

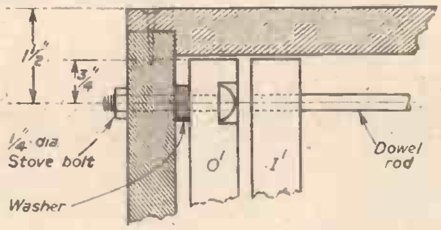


Fig. 3.—Detail in circle enlarged.

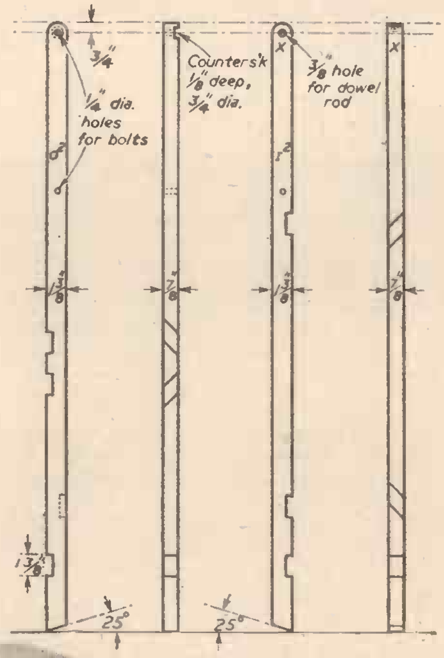


Fig. 4.—Outer and inner legs made in opposing pairs.

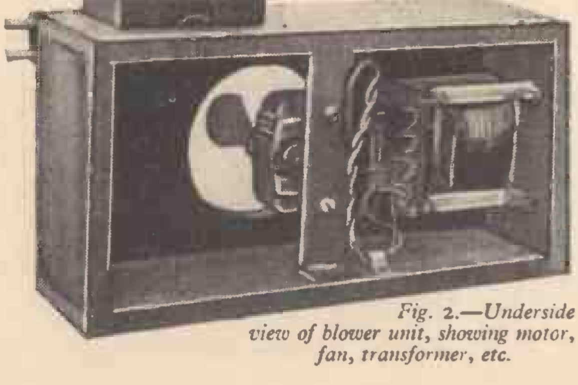


Fig. 2.—Underside view of blower unit, showing motor, fan, transformer, etc.

The Legs

The four legs should be cut first and Fig. 4 shows the plan and elevation of the "inner" and "outer" legs, while their relative positions are shown in Fig. 1, which shows the stand folded for storage or transit. Two of each leg are required, in pairs, opposite hand. Cut the timber to exact length and radius the ends as shown at the top and cut the opposite ends to an angle of 25 deg. Mark out the positions of the slots to take the cross and angular battens but carefully note the direction of the sawn angles in relation to these slots. It is better not to cut these slots at this stage but merely mark their approximate positions for guidance.

Being satisfied that the slots will come in the right places, particularly with respect to the sawn angles, the assembly of the legs can be carried a stage further. Nail a batten across the bench, select the pair of "inner" legs (I^1 and I^2 in the diagrams) and lay them in their positions, parallel and with their angle ends against the batten on the

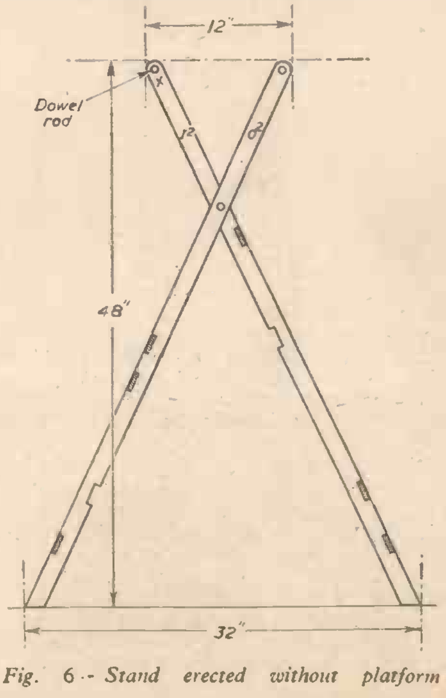


Fig. 6.—Stand erected without platform

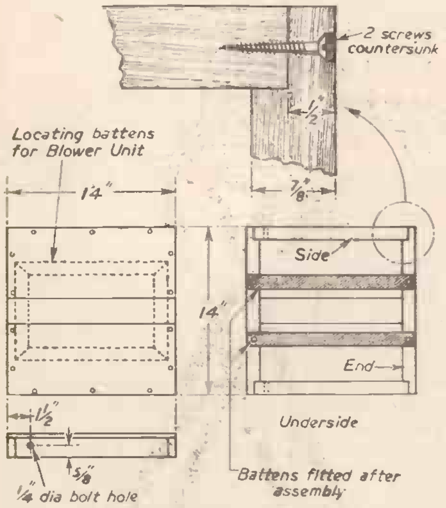


Fig. 7.—Platform details.

bench. Nail two more battens to the legs, one at each end, so that the legs are held truly parallel and 8½in. apart. The cross batten and the two angular battens can now be offered up and their positions accurately marked. The slots for them can be cut and they should be made as good a fit as possible because these battens give sideways rigidity. They can then be fixed into place using 1in No. 6 woodscrews well countersunk.

The outer legs (o^1 and o^2) are assembled in the same way and it is best to turn the inner legs over on the bench so that the battens, now fixed in position, are underneath. The outer legs are placed outside the inner legs with 1/16in. between them and these are secured in their correct positions by means of temporary battens nailed on.

Again the permanent cross and angular battens are "offered up" and the positions of the slots marked and cut. The battens are then fitted and screwed in place. Making quite sure that everything is in order.

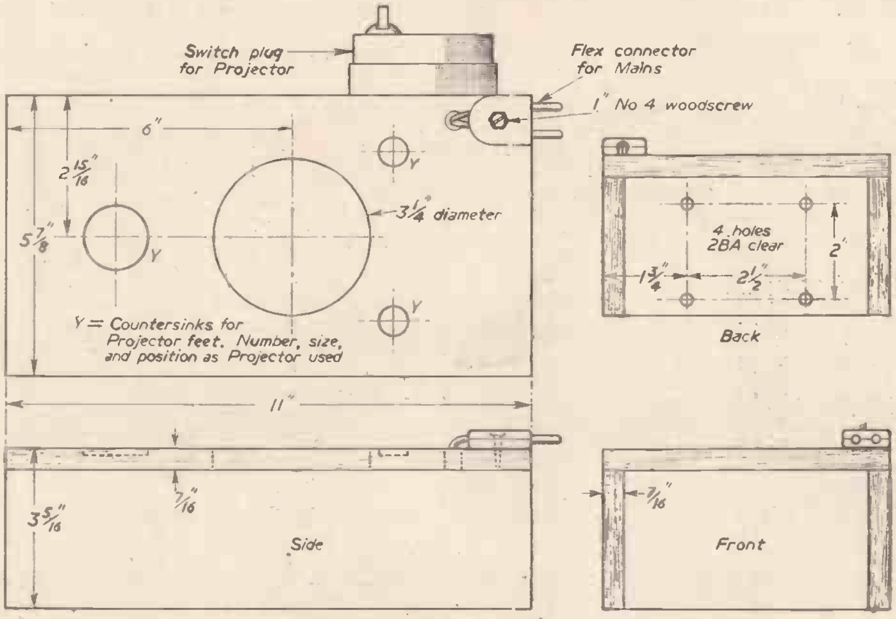


Fig. 10.—The blower unit.

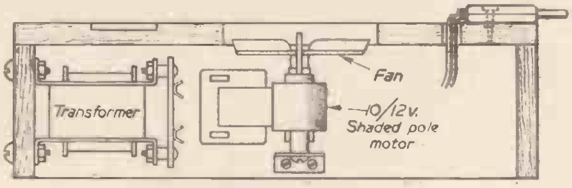


Fig. 8.—Section of blower unit.

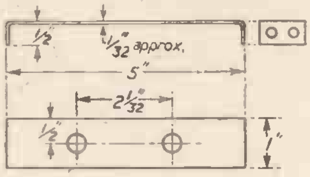


Fig. 11.—Support for motor.

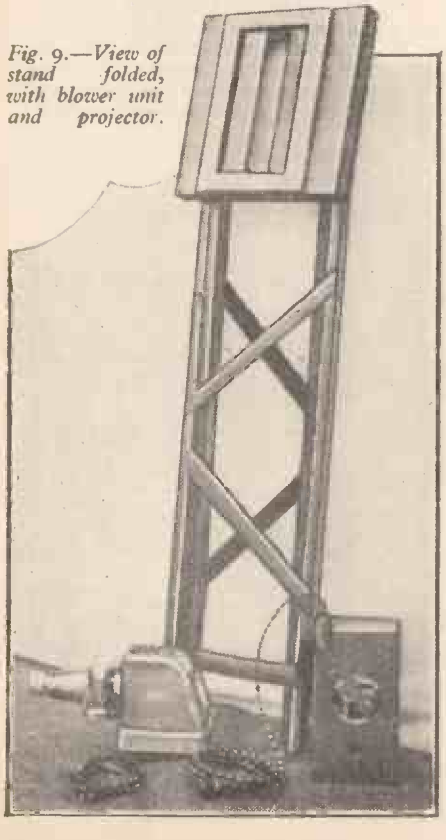


Fig. 9.—View of stand folded, with blower unit and projector.

and that both sets of legs are in contact with the batten nailed to the bench, mark out where the inner legs will require slots cut in them to allow the outer legs to lie nearly flush with them. It is not suggested that the two pairs of legs will be absolutely flush with each other when the stand is closed as this will make it difficult to open it when required. They nearly close, as shown in the side elevation in Fig. 1.

Making sure that the legs are in proper contact with the batten nailed to the bench the ¼in. dia. holes for the bolts can be marked out and drilled. Again absolute accuracy is necessary. Remove the battens used for holding the legs in place and separate the assembled pairs. With a gouge or chisel cut a countersink for the bolt heads on the *inside* of the outer legs. If this is not done it will be seen that the bolt heads will prevent the legs being closed.

The legs can now be finished by sanding and staining and then are bolted together with washers between the surfaces and under the nuts. The dowel rod can be put in place, care being taken to see that the inside dimension of 8½in. is not altered by not fitting the dowel rod accurately. The legs will now appear as in Fig. 6.

The Platform

This is quite straightforward as Fig. 7 shows. The sides and ends of the platform are of the same size of timber as the legs, and a simple method of making the joints at the corners is shown. Note the position of the holes for the bolts and bore them accordingly. The two battens 14in. × 1in. × ⅜in. can be prepared, stained and varnished with the platform but they are not fitted until the legs have been bolted to the platform. All screws should, of course, be countersunk and the holes filled with plastic wood before sanding to give a neat appearance. If the blower unit is to be made, the battens for it should be made and fixed to the upper surface of the platform as shown in Fig. 7.

If the dimensions given have been accurately adhered to, it will be found that the legs will fit inside the platform with 1/16in. clearance. Insert the bolts with a washer between each bearing surface and under each nut. Saw off the excess thread on all four bolts and burr over to prevent the nuts becoming loose. The joints should be a little stiff, but not too stiff to prevent easy manipulation. Finally, turn the stand upside-down and fix the two battens underneath the platform. These prevent the legs swinging out if the stand is picked up by the platform.

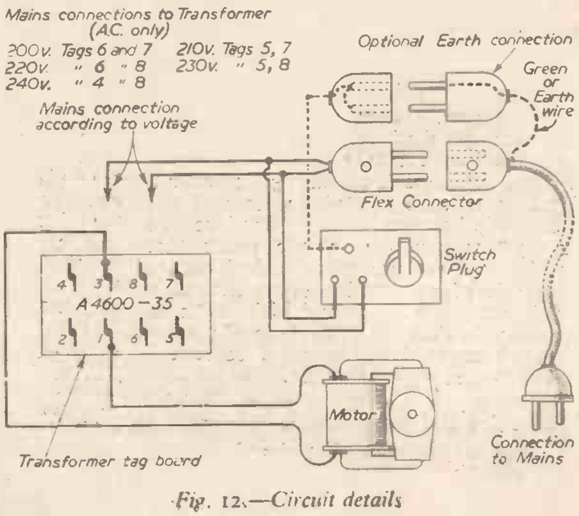


Fig. 12.—Circuit details

The Blower Unit (For A.C. Mains Only)

The actual size of this unit will depend upon the projector used and the dimensions given in Fig. 10 are suitable for an "Aldis 250." The centre of the 3¼in. hole is arranged exactly under the projector lamp and thus a current of air is sent up the "chimney" surrounding the lamp. At the same time there is an overspill of air that finds its way up past the transparency thus keeping it cool. The depressions marked "Y" in Fig. 10 accommodate the feet of the projector and locate it in the correct position relative to the fan.

The blower motor, which is of the "shaded pole" type and self-starting, is secured to a piece of steel strip (Fig. 11). This is fixed inside the unit so that the fan is central with, and slightly below, the hole. As the fan is fixed to the motor spindle by means of a setscrew there is scope for experimental adjustment after assembly. Inside the unit is also fixed the transformer that feeds the motor and its position is clearly shown in Fig. 8. Connection to the mains is made by a length of flexible cable terminating in a suitable plug for the mains socket and having, at the other end, the female half of a "flex-connector." The male half of this connector is fixed to the blower unit as shown in Fig. 10 and the connections are given in Fig. 12. Fig. 2 shows this unit complete.

The author's projector is fitted with a 3-pin plug for convenience and so a 3-pin socket is provided for this on the unit. This was done so that the projector could be used with or without the stand or the blower unit as previously explained. If 2-pin plugs are used then a 2-pin socket should be fitted. If it is desired to do the right thing and have the whole thing earthed then the mains lead should be three core and provision made for completing the connection to the blower unit of the "green" or earth wire via the earth pin of the switch plug. This will necessitate the provision of an additional "flex-connector," only one pin of which is used and wired, as shown in Fig. 12. It seems that newer projectors are provided with a 3-core flex and are earthed, while earlier models are not.

Wiring the unit in this manner with a separate switch plug for the projector means that as soon as the unit is connected to the main supply the blower will start. The projector can then be switched on as required, and when switched off after use the blower will continue to run. This will cool the projector so that it can be stored away after the show.

The blower unit should be a snug fit within the battens on the platform which locate the unit and prevent it being moved whilst slide changing. If the blower unit is not to be used, the projector will stand inside these battens and the central slot in the platform will ensure adequate ventilation. If the blower unit is to be used without the stand, it must have corner pieces fitted to it so as to leave a space between its lower edges, and whatever it is standing on, in order that air may be sucked in by the fan. Failure to allow the air to enter the unit will prevent the fan from producing any cooling draught.

The transformer used is an ex-Government component having the number Y04520 on its external packing and A4600-35 on its terminal board. (See materials list.) The tag terminals are arranged in an unusual manner and the motor is connected to the secondary terminals tags 1 and 3. Tag 2 is a centre tap. The mains are connected to the primary terminals tags 4 to 8 as detailed in Fig. 12.

MATERIALS REQUIRED

Hardwood Stand

Legs	4 off	52in. × 1⅜in. × ⅞in.
Cross Struts	4 off	Approx. 16in. × 1⅜in. × ⅞in. (diagonal)
	1 off	12⅛in. × 1⅜in. × ⅞in.
	1 off	10⅛in. × 1⅜in. × ⅞in.
Platform Top	2 off	14in. × 5⅞in. × ⅞in.
Sides	2 off	13in. × 1⅜in. × ⅞in.
Ends	2 off	14in. × 1⅜in. × ⅞in.
Locating Battens	2 off	13in. × 1in. × ⅞in.
	2 off	7⅞in. × 1in. × ⅞in.
Safety Battens	2 off	14in. × 1in. × ⅞in.

4 2½in. long, ¼in. dia. stove bolts with nuts and 8 washers. Quantity 1in. by No. 6 woodscrews, stain, etc.

Blower Unit

Top	1 off	11in. × 5⅞in. × 7/16in.
Sides	2 off	11in. × 2⅞in. × 7/16in.
Ends	2 off	5in. × 2⅞in. × 7/16in.

1 or 2 flex connectors

1-, 2- or 3-pin switch plug to suit projector.

1-, 2- or 3-core mains lead with plug, of convenient length

4 2 BA × 1in. brass bolts with nuts and washers

Wire for internal connections

Transformer. Ex-Govt. pattern Y04520 (A4600-35) from West End Radio Ltd., Lisle Street, London, W.1. (10/6 inc. postage).

Motor and fan. 12 v. 50 cycles A.C. shaded pole motors with 2½in. fan. Midland Instrument Co., Moorpool Circle, Birmingham 17. (11/6 inc. postage)

Lightweight Jet Engine

AMERICA'S General Electric Company have developed a small jet engine for aeroplanes which weighs only 250lb., measures 16in. in diameter and is 55in. long. The engine delivers a thrust of 1,050 horsepower.

Aircraft Pilots' Blackouts

AN American psychiatrist at the European Congress of Aviation Medicine has said that anxious pilots black out quicker from high speed manœuvres than do hot-tempered ones. When a pilot is subjected to greater gravitational pulls than on the ground a blackout may occur. Resistance to these blackouts is called "g" tolerance. Experiments were carried out to find the relationship between a pilot's emotions and his "g" tolerance, with the result that experimental subjects who blacked out at low levels of acceleration stress showed a high degree of anxiety and high levels of adrenaline in their body. Feelings of aggression and anger, however, were associated with increased "g" tolerance.

Radioactive Fallout

IT is already known that the danger in radioactive fallout was strontium-90, but now another lethal compound has been found—manganese-54. The discovery was made when a fallout sample which was giving out gamma rays was chemically analysed. Calculations show that a large amount of manganese-54 is produced at the time of the explosion.

Drinking Water from the Sea

SCHEMES for the purification of large amounts of sea water by freezing have been perfected technically, but are too expensive to be a useful answer to water shortage problems.

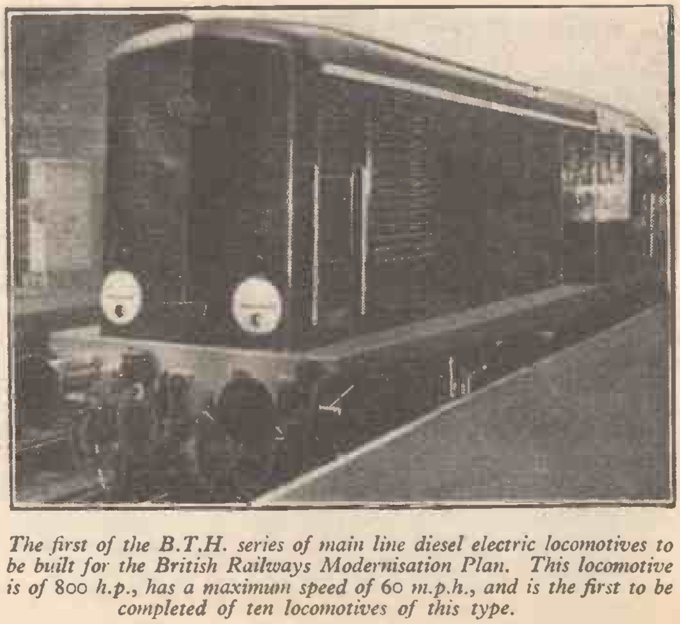
Chromium Plating and Sound Waves

SLIGHT but definitely beneficial is the description of the effects of sound waves on chromium plating. It is reported that the sound waves make the plated surface less porous, make the chromium plate harder, stick better to the base metal and increase in brightness.

The Convergatron

THIS is a new device which will enable an atomic reactor to be built which is free from the danger of explosions. Two new types have been designed to use it, a fast neutron breeder reactor and a natural uranium and water system.

The convergatron is a neutron amplifier in which the neutron output is greater than the input. A series of these convergatrons would amplify neutrons from a weak source to a large power reactor, yet the power plant itself would shut off on removal of the source. There is no danger of losing control of the chain reaction as all parts are subcritical.



The first of the B.T.H. series of main line diesel electric locomotives to be built for the British Railways Modernisation Plan. This locomotive is of 800 h.p., has a maximum speed of 60 m.p.h., and is the first to be completed of ten locomotives of this type.

An Alarm Clock Timeswitch

The Clock May be Used Separately

By S. W. Clements

THE possibility of using an alarm clock as the basis of a timeswitch has often excited the interest of the experimenter, but the usual arrangement provides only for the switching of low voltages and currents because the clock itself is part of the circuit.

The advantages claimed for the one shown in Figs. 1 and 2 are:—

1. It can safely be used on the mains.
2. No alterations are required to be made to the clock itself which may be used for its normal purpose.
3. It is capable of switching on or off. If two outlet sockets are provided instead of the changeover switch, it will switch two circuits on and off simultaneously.
4. The construction is simple. No special skill or tools are necessary.

The measurements given suit the Westclox "Good Morning" clock and alterations may be required for others. Reference to the drawings and photographs make the construction clear. Fig. 3 shows the front view indicating the position of the aperture which is ½in. wide × 3/16in. high. It is 3/16in. down from the top and 1 7/16in. in from the right edge of piece G. Also shown are the side view and the plan view.

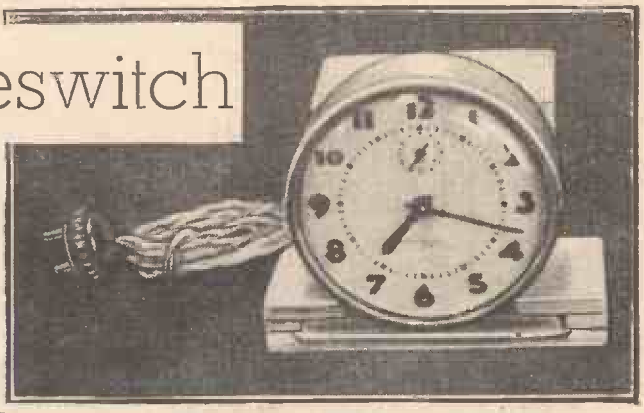
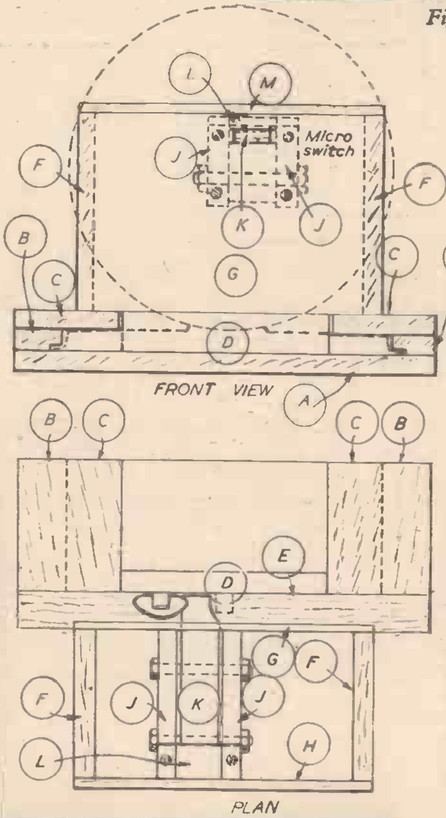


Fig. 2.—The alarm clock timeswitch ready for use.



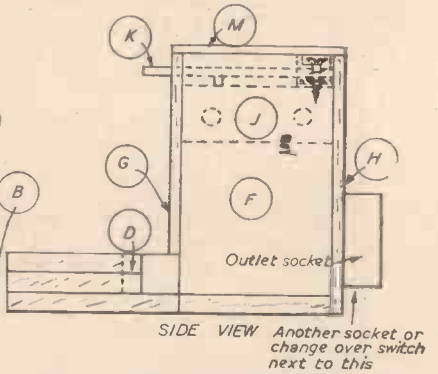
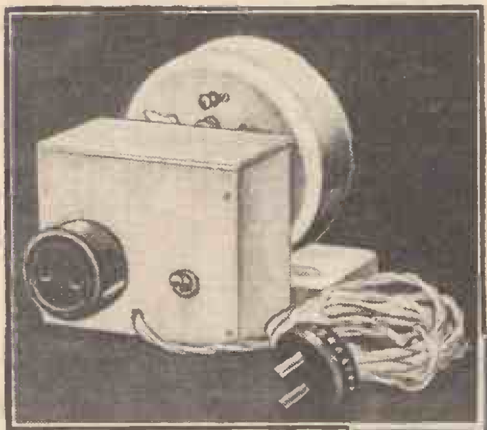


Fig. 3.—Front, side and plan elevations.



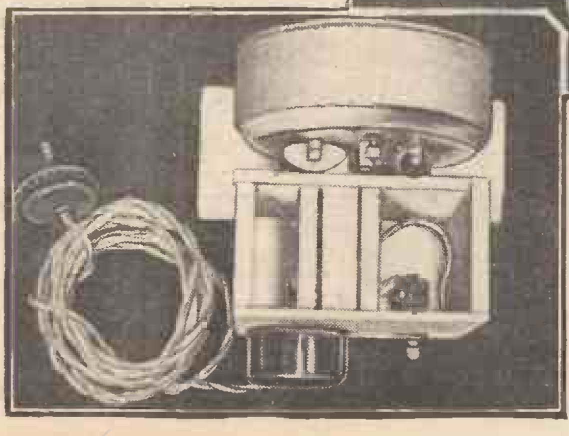


Fig. 1.—Three views of the timeswitch. (Above) rear view; (right) front view with clock removed; (below) view with top removed.

Fig. 4 shows the shapes of pieces A, J and K, which are not given in the cutting list. Fig. 5 shows alternative wiring diagrams.

Parts Required

One two-way toggle switch.

One two-way microswitch obtainable from Government surplus stores.

One two- or three-pin socket (or two sockets if simultaneous switching is required).

Two 1¼in. × 4BA bolts and nuts, rubber grommet, insulated connecting wire, flex, plug, plywood and screws.

Construction

Cut out the parts as detailed in the cutting list and Fig. 4. Remove a shaving about 1/32in. thick from along edge of each of pieces B. This is to allow the flange of the wedge-shaped base of the clock to enter. Sandpaper all the pieces smooth and assemble with pins and glue or ½in. × 2 csk. screws by first taking the base A and fixing it to the clock retaining pieces B and C. Add pieces D and E and the front section is complete. If pieces B and C are screwed on it will be found that there is enough flexibility to enable the clock to be pushed in or out and yet remain firmly held.

Next, put on the side pieces F and the front G with the aperture at the top. Now position the microswitch behind G so that the top of the button, which should be at the forward end, comes no more than 1/16in. above the lower edge of the aperture, and mark the inner face of the front where the top of the body of the microswitch comes. This will be about 13/32in. from the top. Measure this distance down the 1¼in. sides of pieces J and clamp the microswitch between them by bolting right through. There are two holes in the switch for this purpose. Then fix the whole switch assembly inside the front by screwing through from the outside.

Take piece K and place it on top of the microswitch so that it protrudes through the aperture, then pack up the rear end with cardboard so that it is horizontal. Screw down piece L on top of pieces K and J and K will be firmly held, but will not be depressing the button. Test for satisfactory working by pressing the protruding end of K which should operate the switch.

Wiring

It remains only to drill the back H (or the sides F if preferred) for socket/s and/or

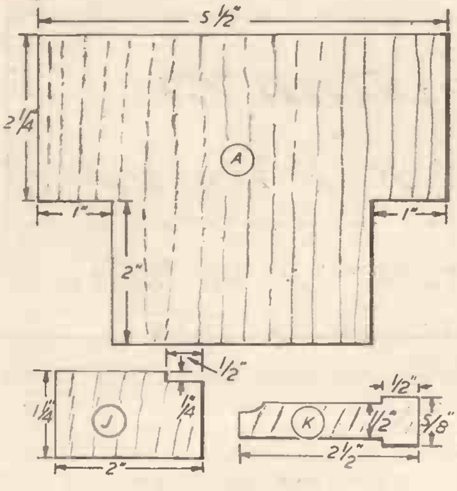


Fig. 4.—Dimensions for cutting pieces A, J and K.

switch and mains lead before wiring up. Thread the mains lead through the grommet in a hole in H or F and connect one side to a terminal of the outlet socket. The other lead goes to the common terminal of the microswitch. The common terminal of the changeover switch is connected to the other side of the outlet socket. The other two terminals of the changeover switch are connected to the remaining two on the microswitch. If two sockets are used instead of the changeover switch, one side of the mains lead is connected to one side of each of the two sockets and the other to the common terminal of the microswitch. The remaining terminals on the switch are connected to each of the two sockets. The wiring completed, screw on the back H and the top M.

Finish by rounding all corners and edges and varnishing or painting as desired.

Set the alarm as usual and push the clock into the slot formed by pieces A, B and C. The position of the alarm winder key will determine how long the bell will ring before the switch is operated. If it is underneath piece K, then it will have to make almost half a complete revolution before being stopped by contact with the top of K. If it is nearly horizontal but above K then the switch will operate after a short warning ring. Contact with K automatically stops the bell.

CUTTING LIST

Piece	B	cut	two 1¾in. x ⅝in. x ¼in.
„	C	„	two 1¾in. x 1⅜in. x ¼in.
„	D	„	one 2¾in. x ½in. x ¼in.
„	E	„	one 5½in. x ½in. x ¼in.
„	F	„	two 3⅜in. x 2in. x ¼in.
„	G	„	one 4in. x 2⅝in. x ¼in.
„	H	„	one 4in. x 3⅜in. x ¼in.
„	L	„	one 1½in. x ½in. x ¼in.
„	M	„	one 5½in. x 2¼in. x ⅛in.

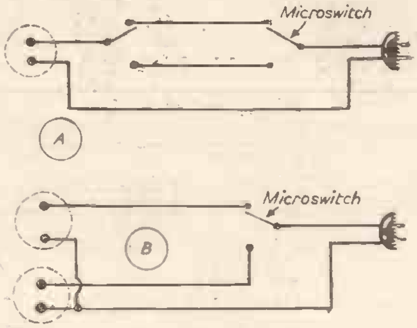


Fig. 5.—Alternative wiring diagrams.

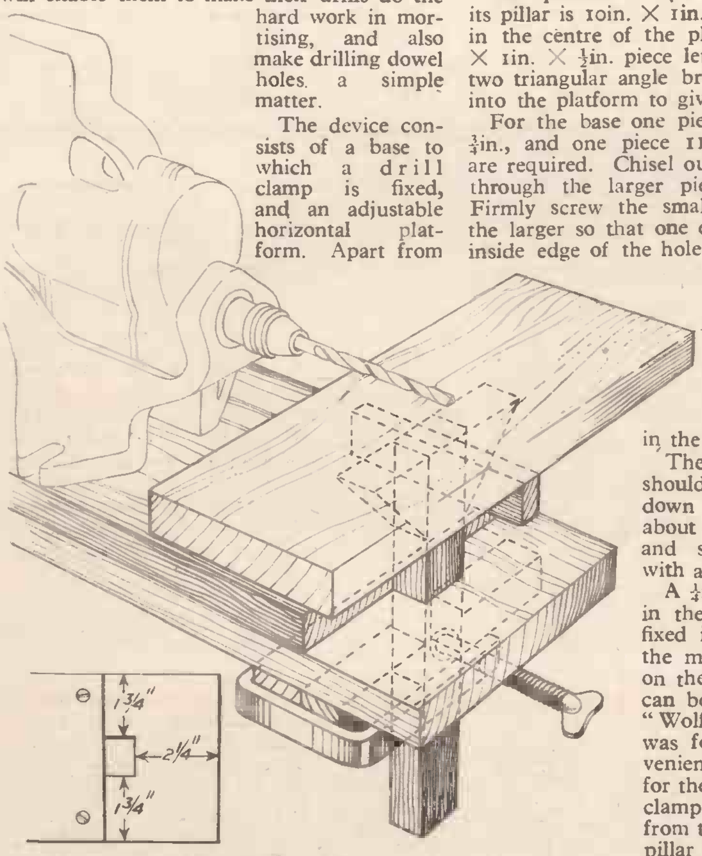
An Easily-made Mortiser

A Home-made Device for Use with One of the Portable Drill Units

By J. C. FRISBY

MANY owners of "Wolf Cub" and similar kits must have wished for a mortiser, especially if they have not thought it worth while to buy the vertical bench drill attachment. This simple device will enable them to make their drills do the hard work in mortising, and also make drilling dowel holes a simple matter.

The device consists of a base to which a drill clamp is fixed, and an adjustable horizontal platform. Apart from nuts and bolts, glue, wood screws and two or three small G clamps, nothing but a few pieces of unwarped hardwood is needed.



Constructional details and dimensions of the mortiser.

The dimensions given may be modified to suit the maker's convenience.

The platform is 4in. × 9in. × ¾in., and its pillar is 10in. × 1in. × ¾in., and is fixed in the centre of the platform, using a 4in. × 1in. × ½in. piece let into the pillar, and two triangular angle brackets (preferably let into the platform to give added rigidity).

For the base one piece 14in. × 4½in. × ¾in., and one piece 11in. × 4½in. × ¾in. are required. Chisel out a hole 1in. × ¾in. through the larger piece, as shown inset. Firmly screw the smaller piece on top of the larger so that one end is flush with the inside edge of the hole. On the bottom of the larger piece screw a block 4½in. × 1in. × ¾in., and two blocks 1¾ × ¾in. × ¾in, so that they are flush with three sides of the hole (dotted in the sketch).

The platform pillar should now be pushed down through the hole about as far as it will go and secured in position with a G clamp as shown.

A ¼in. bit should be put in the drill and the drill fixed in its clamp. Then the most suitable position on the base for the clamp can be determined. With "Wolf Cub" equipment it was found that it is convenient to have the holes for the two bolts fixing the clamp to the base 7½in. from the inside edge of the pillar hole. These bolts should be countersunk.

Since it is easier to stand behind the drill and pull the work on to it, the device should be clamped or bolted across the corner of the bench with the platform end projecting sufficiently to allow easy adjustment of the platform.

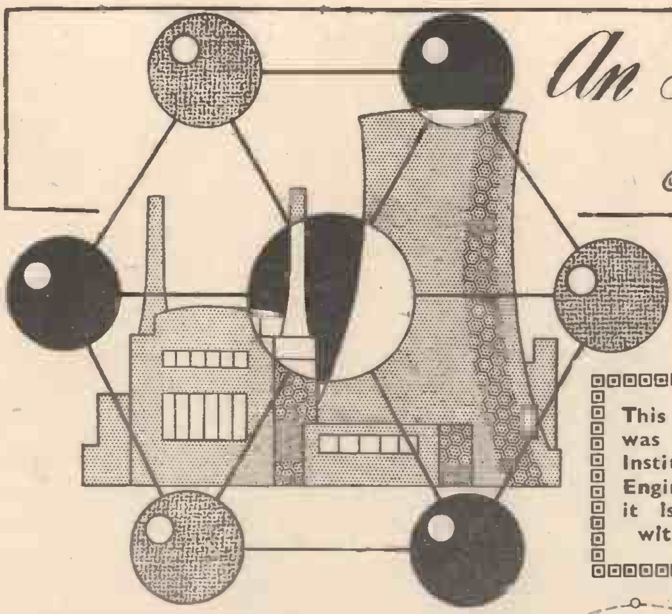
It is advisable to have a piece of wood about 1in. × ¾in. in cross section to clamp on the side of the platform facing the drill. Quarter-inch holes should be drilled through this piece at suitable distances (e.g., ¼in., ⅜in., ½in.) from one face. If the drill bit is put through the appropriate hole and the platform pushed up till it meets the piece of wood, then the platform will be the right distance from the bit and can be clamped. This piece of wood also acts as a stop and, equally important, keeps the drill bit stable.

When making holes for dowels, it will be found easier to be exact if a small chisel cut from either side to what is to be the centre of the hole is made; in this way the bit is guided as it enters the wood.

Mortising

To use the device for mortising, the mortise hole should be marked out in the usual way and then as much as possible of the waste should be removed by pulling the work straight on to the bit. The final clearing is done by sliding the work gently so that the bit passes along the hole. Either the ends of the hole can be squared with a chisel or the edges of the tenon can be rounded with a file.

It is simple to cut mortise holes that are not at right angles to the face of the wood. To do this a hole is drilled through the stop at the appropriate angle, the drill bit inserted in this hole and the stop clamped to the platform in the ordinary way. The work is then held parallel to the stop as it is pulled onto the bit.



An Introduction to Nuclear Power

By P. T. FLETCHER, B.Sc.(Eng.), M.I.C.E., M.I.Mech.E., M.I.E.E.

This is a paper which was presented to the Institute of Marine Engineers recently and it is reproduced here with their pemission

THE latest source of power makes its appearance in the form of the nuclear power plant. The nuclear power plant is far more revolutionary than the internal combustion engine, for the internal combustion engine is only an alternative means of converting the heat of a chemical reaction into work. The power from a nuclear power plant, on the other hand, does not stem from a chemical reaction at all.

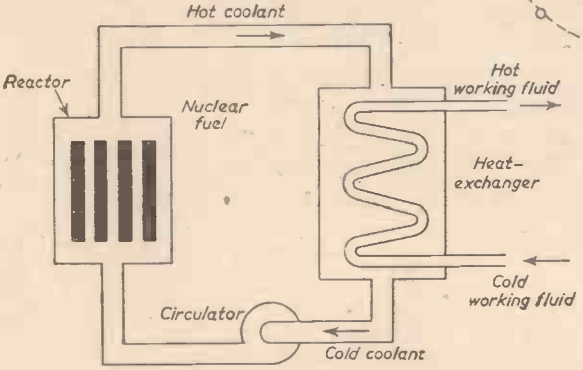


Fig. 1.—Outline of a nuclear power plant.

Just as the steam engine ushered in a long period of power production from a chemical reaction, the nuclear power plant opens up the prospect of power production from quite a different sort of reaction, a "nuclear" reaction.

The Alliance of the Heat Engine and Nuclear Fuel

In the nuclear power plant, as in an engine running on hydrocarbon fuel, the reaction from which heat is evolved takes place in the fuel. In this case, however, it is a nuclear reaction in a nuclear fuel. It takes place in a nuclear furnace, known generally as a "reactor" or "pile." Once the heat has been released from the nuclear fuel in the reactor, it is transferred to the reactor coolant, which may be a gas or a liquid.

This process is illustrated in Fig. 1 and is as if the nuclear fuel were an array of immersion heaters in a domestic storage tank and the coolant a domestic hot water supply. The hot coolant then forms the heat source of a heat engine. It may, for instance, pass through a boiler to generate steam for driving a steam turbine, or through a heater of a closed cycle gas turbine. It follows that an engine producing power from nuclear energy does not differ from any other externally fired heat engine in so far as concerns the working fluid circuit. The difference is one of fuel and of transfer of the heat liberated from it to the working fluid. With this transfer accomplished, the specialities of nuclear energy are behind and in front is the conventional machinery; boilers, heaters, pumps, compressors, turbines and heat exchangers.

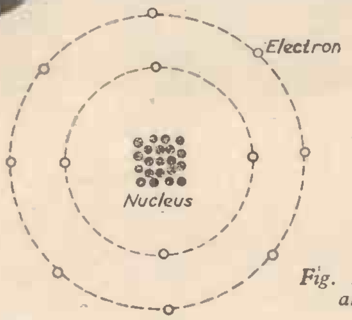


Fig. 2.—The atom.

The nuclear power plant is, then, a heat engine drawing upon the heat evolved by a nuclear reaction in a nuclear fuel.

Outline of Nuclear Technology

The Atom

According to present-day ideas, the atom consists of a comparatively large particle, the "nucleus," around which are situated, in successive orbits, very much smaller particles, called "electrons." This concept is shown diagrammatically in Fig. 2.

In chemical reactions, such as that of combustion, the atoms merely regroup themselves by a rearrangement of their electrons, as shown in Fig. 3, and the nucleus is completely unaffected. In nuclear reactions, such as that of fission, the nucleus itself is changed and the part played by the electrons is very small. From now on, therefore, attention is confined to the nucleus.

As shown in Fig. 2, the nucleus is built up of a number of particles of very nearly equal mass and carries an electric charge. This electric charge completely determines the chemical properties of the corresponding atom. The total number of particles a nucleus contains is called its "mass number," which is very nearly the same as what is known as the atomic weight. Although the mass number is of no consequence in chemical reactions, it is of very great importance in nuclear ones.

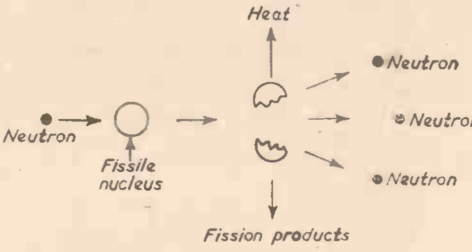


Fig. 4.—Nuclear fission.

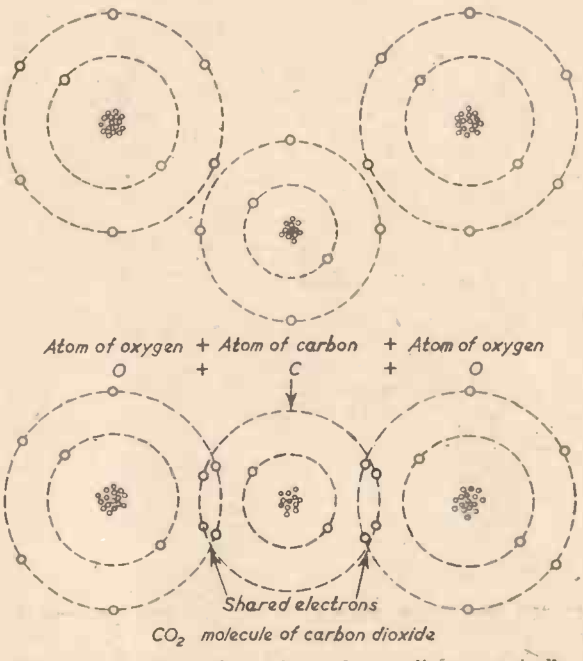


Fig. 3.—A chemical reaction shown diagrammatically.

Atoms of the same substance, and carrying, therefore, the same nuclear electric charge, may yet have different mass numbers. Such atoms are said to be "isotopes" of one another. Having the same chemical properties, isotopes cannot, therefore, be chemically separated. They may, however, be separated physically, such as by gaseous diffusion through a porous membrane or by centrifuging.

Nuclear Fission

A particle which plays a prominent part in nuclear energy is the "neutron." This particle has the same mass as one of the particles in a nucleus but carries no electric charge.

If a neutron collides with the nucleus of what is known as a "fissile" material, the nucleus of this material may split into two "fission fragments" of approximately equal mass and at the same time emit further neutrons. This process is illustrated in Fig. 4. It is the process of "nuclear fission," and is accompanied by the release of an immense amount of energy, which is manifested as heat. The energy released per atom of fissile material in nuclear fission is some 50 million times as great as that released per atom in the combustion of hydrogen, which is the primary heat producing constituent of coal or oil.

The amount of energy released from one atom alone would be of little use but since the number of neutrons emitted per fission exceeds one, there is the possibility that each fission will give rise to a further fission and so on, as shown in Fig. 5. The process then becomes a "chain reaction" releasing heat from many more atoms, just as the progressive combustion of a length of fuse constitutes a combustion chain reaction. If only one fission is induced in a fissile material, therefore, it may give rise to a chain reaction and thus be capable of releasing large quantities of heat over a considerable period of time and the objective of a nuclear fuel will have been attained.

Uranium

Only one fissile material occurs in nature, namely uranium, which is a very dense, black metal. Only one type of uranium is fissile, however, and that is an isotope of uranium having a mass number of 235. It is therefore called "uranium 235." Unfortunately, natural uranium consists almost entirely of the non-fissile isotope, uranium 238, and only 1/40th part of it is the vital uranium 235. Immediately the importance of mass number in nuclear reactions is emphasised. U.235 and U.238 are chemically indistinguishable, yet the one is fissile and the other is not.

When a neutron produces fission in a nucleus of uranium 235 the loss of this neutron is made good by the emission, on the average, of a further 2½ neutrons. A chain reaction would thus appear to be possible. In the case of natural uranium, however, so few and widely separated are the uranium 235 atoms that these 2½ neutrons have little chance of finding them before being absorbed elsewhere. So slender is this chance that a chain reaction in a bare solid mass of natural uranium is impossible.

The Behaviour of Neutrons

A means of overcoming this setback is revealed by a closer study of the behaviour of neutrons. The neutrons ejected by the fission process travel at a speed of about 10,000 miles per second. Even to nuclear physicists, this is considered quite fast and so neutrons of this speed are called "fast" neutrons. These fast neutrons as they travel strike other atomic nuclei on all sides, becoming either inextricably attached to some or slowed up by collision with others. There is, however, a limit to the speed to which a neutron can be slowed and this speed is that of the normal thermal agitation of the surrounding atoms. A neutron which reaches this speed is therefore said to be a "thermal" neutron. In contrast to their fast counterparts, thermal neutrons move about at only a mile per second or so, and are thus often called "slow" neutrons.

There is an important point to note about this slowing down process. As the neutron slows down to some speed intermediate between fast and thermal, its chances of being captured by an unproductive uranium 238 nucleus increase greatly. Below this speed, however, the chances of absorption in this way rapidly diminish and become virtually negligible for thermal neutrons. Nor is this all, for as the neutron slows down its chances of producing fission in any uranium 235 nucleus that it hits are continually rising and are very high indeed by the time it has become thermal.

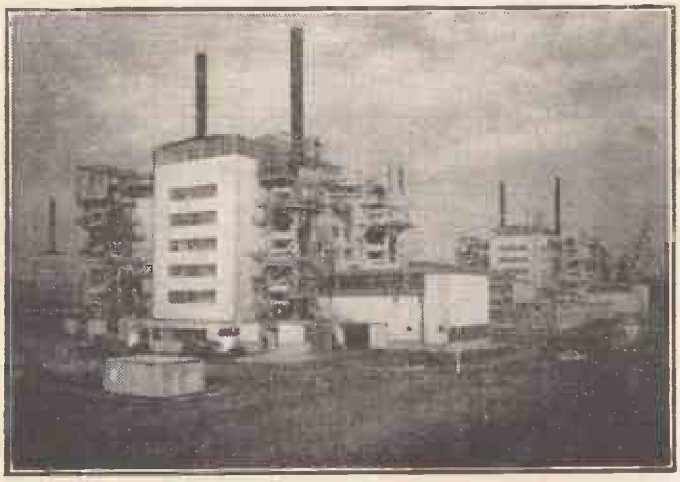


Fig. 7.—Calder nuclear power station.

The Moderator

By taking advantage of these properties of a neutron, a chain reaction can be achieved even in natural uranium. Instead of forming the uranium into one solid mass, it is broken down into a large number of small pieces, and these are arranged in a dispersed manner in another material called a "moderator." The moderator must have a very small absorption for neutrons but a strong tendency to slow them down to thermal energies. In this way, as shown in Fig. 6, quite a large number of fast neutrons will leave one piece of uranium and be slowed down in the moderator to become thermal. When they reach the next piece, therefore, they are unlikely to be absorbed by the 238 atoms and highly likely to produce fission in the 235 ones. By suitably proportioning the uranium and moderator a chain reaction can be achieved and it is precisely in this way that it is achieved in what is known as the "thermal reactor."

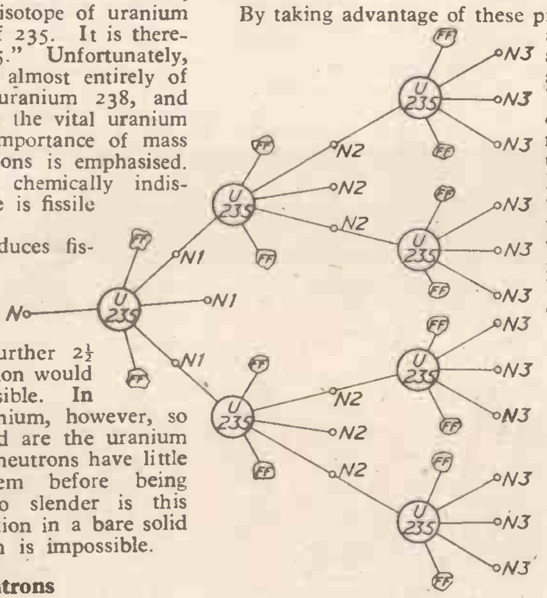


Fig. 5.—Divergent chain reaction.

Suitable properties for a moderator can be deduced by regarding a moderator nucleus as one billiard ball and a neutron as another. If the moderator nucleus is much larger than the neutron, the neutron is likely to rebound with the speed at which it hit it, and no slowing down would be achieved. If, however, the moderator nucleus and neutron are identical, the neutron may be completely stopped. It follows that a moderator should consist of very light atoms, so that among suitable materials are carbon, beryllium or water.

The Nuclear Reactor

The Core

As a first example of a nuclear reactor, a description will be given of the nuclear reactor recently commissioned at Calder Hall having a net electrical output of 35MW. Fig. 7 gives a general view of this station and Fig. 8 a diagrammatic section through the reactor.

The moderator of the reactor consists of a large number of graphite blocks built up into the form of a solid cylinder having a diameter of 36ft. and a height of 27ft. This mass of graphite forms the "core" of the reactor and weighs over 1,000 tons. Vertically through it run a large number of parallel holes, or "channels" as they are more usually called.

Rods of natural uranium, 1.15in. in diameter, are lowered into the channels and stacked one on the other until each channel is filled with rods standing end to end. Each rod is contained in a magnesium alloy can, partly to prevent oxidization of the uranium, partly to contain any gaseous fission fragments and partly to provide a finned surface for cooling purposes.

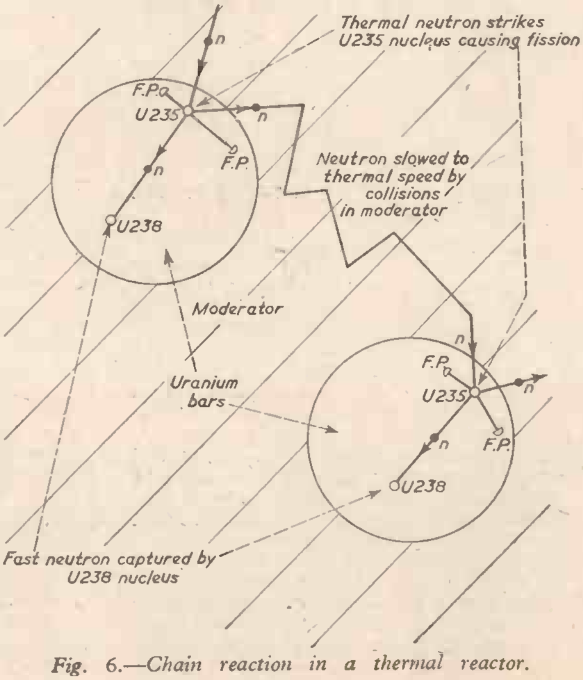


Fig. 6.—Chain reaction in a thermal reactor.

The Coolant

The heat generated in the uranium rods is removed by a coolant in the form of carbon dioxide gas. This gas passes up the clearance space between the cans and the channel walls. The blowing power is reduced as gas pressure is increased and a pressure of 100lb. per sq. in. gauge is chosen.

The gas, which has been heated in passing up the core, leaves at a temperature of 350 deg. C. for the heat exchangers. Here it gives up its heat to generate steam which, in turn, is used to drive conventional steam turbines coupled to alternators. The gas leaves the lower end of the heat exchangers to pass through the blowers, which re-circulate it to the lower end of the core.

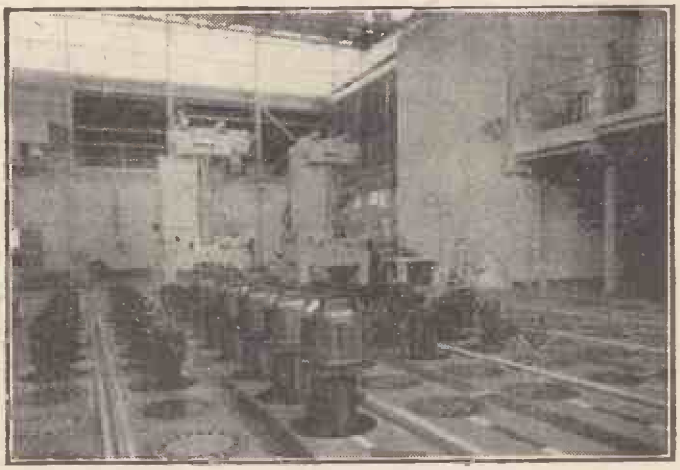


Fig. 9.—The charge face at Calder.

The Reactor Vessel and Shield

The use of a pressurised coolant demands that the whole core be contained in a steel pressure vessel. In this case the vessel is some 40ft. in diameter and 60ft. high, and is fabricated from 2in. steel plate.

The reactor vessel is surrounded, first, by a steel shield and, outside this, by a thick concrete shield. The primary duty of the steel shield is to absorb the thermal neutrons escaping from the core. It is therefore often known as a "thermal" shield. In this case it is of 6in. mild steel plate.

The fast neutrons escaping from the core are scarcely affected by the steel shield, however, and these are attenuated to the point of biological safety in the concrete shield, which is thus called a "biological" shield. The biological shield of the Calder Hall reactor is of octagonal plan form and is 7ft. thick. The space between the thermal and biological shield is used for induced draught air cooling.

The power output of the reactor is regulated by means of control rods, which can be raised or lowered in special channels in the core. The control rods contain boron, which is a strong absorber of neutrons. When they are lowered right into the core neutrons are absorbed at such a rate that out of the $2\frac{1}{2}$ produced by each fission, less than one is left to produce a further fission and a chain reaction is impossible.

If the control rods are now gradually raised there will come a time when they absorb so few neutrons that a chain reaction becomes a possibility. In fact, due to the few stray neutrons invariably present in fissile material, a chain reaction is now not only a possibility but a certainty. Nuclear fission will take place at an ever-increasing rate and the power of the reactor will rise.

When the power output has reached the desired level, the control rods are lowered back into the core just so far that, out of the $2\frac{1}{2}$ neutrons produced by fission, exactly one, on the average, is left free to produce a further fission. The other $1\frac{1}{2}$ neutrons are lost by absorption in the uranium, the control rods or the materials of construction of the reactor. The rate of fission now remains constant and the power output levels off.

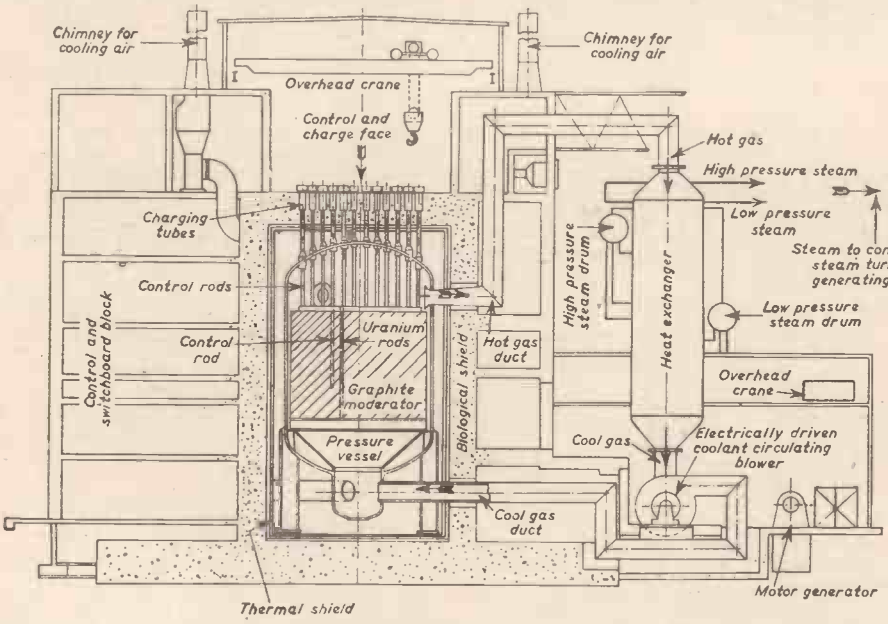


Fig. 8.—A section through Calder nuclear power station.

To increase the power still further, the control rods are first raised from the constant position and then returned to it. In the same way, to reduce the power, the control rods are lowered below the constant power position and then returned to it.

Each control rod has a working travel of 21ft. and is suspended by means of a flexible stainless steel cable. This cable runs up through one of the "charge tubes" to the "charge face," where it is attached to its individual winch mechanism and electric motor combined. A view of the charge face is shown in Fig. 9, in which the motors at the head of each control rod mechanism are clearly visible.

Charge and Discharge

Charging and discharging of the fuel elements are carried out through the charge tubes. To charge the reactor, the cover plate over the appropriate charge tube, or, in certain cases, a control rod mechanism, is first removed.

A "charge chute" is then lowered into the charge tube to come to rest on the top of the core. It can be actuated to serve any one of the sixteen neighbouring channels.

A "charge machine" containing a number of fuel elements is next traversed over the charge face until it is immediately above the particular charge tube. This machine is equipped with a winch by means of which the fuel elements are lowered into the appropriate channel.

The operation of discharging is carried out in a similar manner after the reactor has been shut down and the pressure released.

The charge and discharge machines can be seen in Fig. 9.

Critical Size

Having established an idea of the principles of the nuclear reactor, consideration can be given to some of its important features—firstly, how big does it have to be? This question is answered by considering the possible fates of a newly-born fission neutron. It may be slowed down in the moderator and produce a further fission, or it may be captured in uranium 238, or in any of the materials of construction. A further possibility still exists, however. It may escape from the core altogether. Its chances of escaping may be quite large, especially when it is realised that the diameter of an atom, complete with orbital electrons, is some 20,000 times the diameter of its nucleus. So many neutrons may be lost in these various ways that, even with a moderator, a chain reaction may yet not be realised.

(To be continued)

SHED and GARAGE Building Materials

G. Haskell Discusses the Relative Advantages and Disadvantages of the Various Materials Now on the Market

IF you are still undecided about how to build a workshop or garage, then these practical suggestions are worth considering when choosing the covering material and for reducing the total cost and subsequent maintenance.

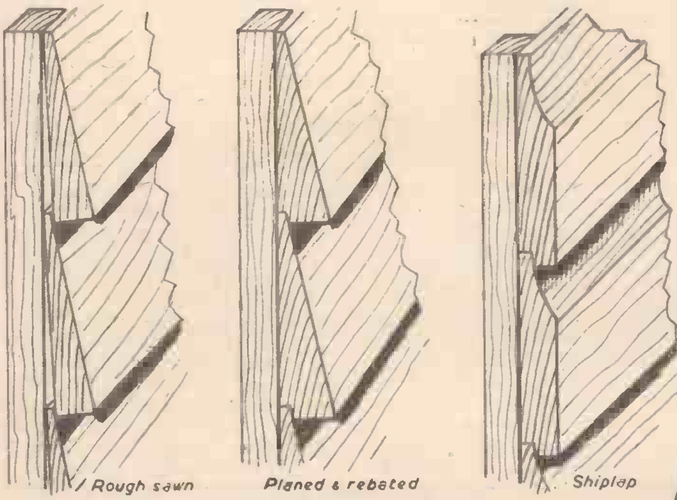


Fig. 1.—Three types of timber cladding material.

You will have studied the price lists of the various firms who specialise in these buildings and will know the purchase price of the size of shed you have in mind, as there is not much variation between firms. By building your own you can expect to save about one third of that figure.

Choice of Cladding Material

Consider the three chief materials. The points to take into account are set out in the table at the foot of the page.

The chief item in this list is probably that of outside treatment. For a timber shed the initial priming, undercoat and finishing coats are expensive items and the cost and labour of subsequent paintings must be borne in mind.

Creosote is cheap and easily applied, but not always suitable for a particular outdoor colour scheme. Incidentally, the local gas works usually supply creosote very cheaply.

Ordering New Material

The cost of these three materials is approximately the same to cover a given area.

The cheapest timber covering is the sawn weatherboard, but the cost rises with the extra refinements of planed rebated weatherboard and shiplap (Fig. 1).

In estimating quantities, remember that the coverage of a 6in. weatherboard is 5½in.

Inquire the price of timber required from various sources, at the 100-foot rate, which is cheaper than the price per foot.

It may be possible to order weatherboard and 2in. × 2in. from an importer direct at a cheaper rate than from a local source, including a charge for carriage.

Timber is available in specified lengths (that is, multiples of a foot), or in random lengths from stock. The latter is about 10 per cent. cheaper, but, of course, entails some wastage in cutting.

Standard Sizes

In using asbestos or galvanised sheet, account must be taken of their standard sizes in planning the framing of the shed so that complete sheets can be secured direct to it, thus avoiding wastage or difficulties of cutting. These sizes are set out in the table on page 240.

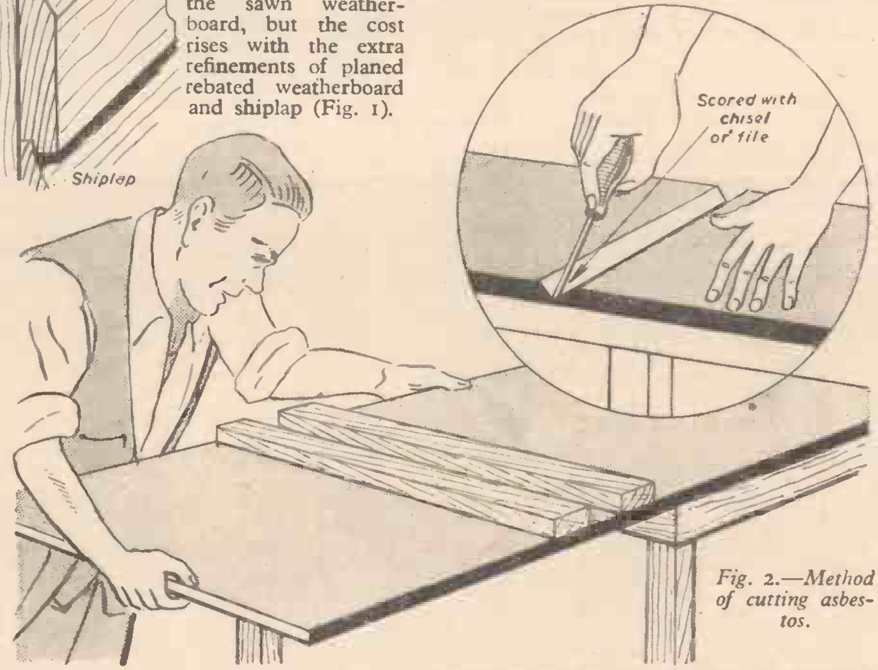


Fig. 2.—Method of cutting asbestos.

Cutting flat asbestos sheet is done by scoring deeply along the line to be cut, using the corner of a file or a cold chisel. The sheet is then supported as shown in Fig. 2, and steady pressure applied downward on the shorter length.

Combining Two Materials

A practical and pleasing combination of asbestos and timber is suggested by Fig. 3. for a sectional workshop 12ft. × 8ft.

(*Concluded on page 240.*)

	Advantages	Disadvantages
Timber	Most easily handled of all, in construction, repair and transport. Reduces internal condensation to a minimum.	Requires protection against weather. Timber roof needs additional protection of Pluvex covering.
Asbestos (flat)	No outside treatment required. Neat appearance.	Liable to damage necessitating a new panel. Some difficulty in cutting to size.
Galvanised Iron	Strong, rigid structure.	Requires protection against weather. Almost impossible to cut.

Building an Outboard Motorboat

A Sturdy All-wood Craft, Ideal for the Week-end

(*Continued from page 181, January issue.*)

ASSUMING that the battens are now in place (with the exception of the fastenings to the stem post) the chines can be fitted.

These are made from oak 1in. × ⅞in. planed finished sizes, and each 11ft. long, and are fitted in exactly the same manner as the seam battens, but care must be taken to see that the point where they meet the stem post is the absolute bottom so that when the slot is cut it will be partly in the side and partly in the bottom.

The gunwales are fitted in the slots at the top of the frames. The method of fitting is similar, but a little difficulty may be experienced in making the rather sharp bend downwards and outwards from the transoms to frame No. 6. If so, it may be as well to soak this end of the timber for a quarter of an hour in very hot water or to apply steaming hot rags for an equal period; the bend should then be easy.

When the rail reaches the stem post do not attempt to bend the timber up to the top of it, but allow it to sweep round in its own natural curve. The stem post is longer than necessary, some extra length being allowed for shaping. Mark off the position on the stem post as for the other rails.

The stem post now marked off may be removed from the setting-up batten and notched out where the seam battens are to be secured to the post 1in. × 5/16in. for a distance of ¾in. This will give sufficient landing.

The chines and gunwales are dealt with in a different manner. These, owing to their thickness, must be half-jointed into the post so that the slot will be 1in. wide but 7/16in. deep. A notch must be cut in the chines and gunwales 7/16in. deep; when they have been trimmed off the required length on assembly, ¾in. will be sufficient landing, so the slots in the post will be ¾in. long, 1in. wide, 7/16in. deep, whilst the rails will be notched ¾in. × 7/16in. deep.

Fig. 21 shows the stem post ready for fitting. It is simply put back on the setting-up batten, the rails cut off to the required length and secured, in the case of the seam battens, in a similar manner to the method used in fixing them to the frames. The chines and gunwales should be secured with 1¼in. No. 6 brass screws well countersunk.

Although the main framing is now completed, the temporary battens, shore and supports should not be removed until the sides are partly planked, which will be the next operation.

Planking the Sides

The material used for the side planks may be either spruce or mahogany. Spruce is lighter, but supplies of good quality are more difficult to obtain.

Planks 8in. wide, 5/16in. thick and 11ft. long will be required, three being used on each side.

Since the seam battens run behind the seams of the planks it is obvious that the distances between the centre lines of these battens represent the shape of each plank.

The centre plank should be fitted first, and to do this tack one end of the plank on to the bevelled side of the stem post, allowing a little surplus wood to project beyond it, and bend it round the frames till it reaches the transom, to which it may be secured by a clamp.

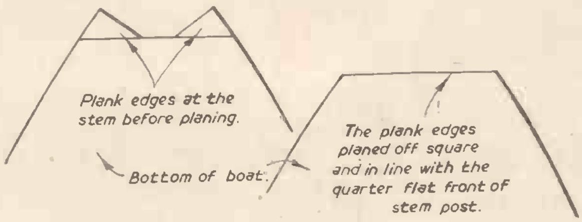


Fig. 22.—Before and after trimming the side planks square to the front edge of the stem.

Secure the plank to the other frames in a similar manner.

The plank should now cover the two seam battens, and is ready for marking off, which is simply done by running a pencil round the upper edge of the top batten and round the lower edge of the lower batten.

Now remove the plank and it will be seen that a dimension which is the overall distance from top to bottom of the battens has been marked.

The plank, however, is required only to come half-way up them as they have to cover the seam, and form a landing for the remaining planks. Therefore, it will be necessary to mark a line ⅛in. inside each line previously scribed.

This requires patience and must be carefully done, and when completed the plank can be sawn down these lines a fraction clear of the mark, and afterwards trued up with a plane. Mark out and cut the centre plank for the opposite side before fitting the first so that both can be dealt with at one sitting and the framework not subjected to the pull of an odd plank for any time.

When ready to fix these planks, smear the seam battens, frame edges and stern with a mixture of half white lead and half putty mixed to the density of soft butter, with linseed oil, and coloured pink with red lead.

The stern end of the plank should now be drilled with a row of four holes, to take No. 8 screws, and countersunk for the heads. Now tack the plank back again, using the original tack holes as a guide to ensure its going back in the same position.

It is now possible to counterbore for the screws, as they cannot be driven directly into the oak without doing so. When all is ready, secure the plank by driving in the screws, which should be 1½in. No. 8 brass countersunk head.

The plank is now clamped back as before to the frames and transom, and is bored and screwed to each frame with four screws per frame. These screws may be 1¼in., as there is plenty of thickness of wood for them to enter.

The edges of the plank will ultimately have to be secured to the seam battens, but that part of the job can be left until all the planks are on. Any surplus wood overhanging at the stern or transom can now be trimmed off.

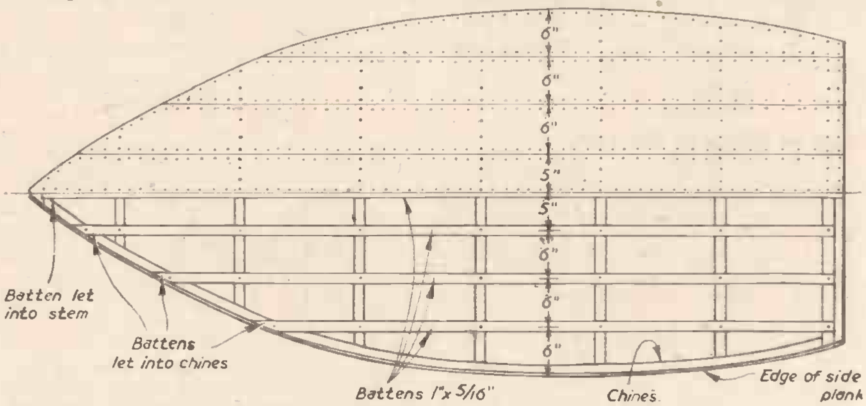


Fig. 23.—Method of fitting the seam battens and planking.

When the centre planks are on each side, the next ones will be the top planks, which, it will be noted, are shaped. To do this place the edge of the plank along the edge of the one just fitted and clamp it to the frames, tacking the end to the stern as before. If the contact is not regular the high places must be planed down until it is a perfect fit.

When this has been done and the plank clamped up in position, it is only necessary to run a pencil round the top of the gunwale, remove the plank and cut out to this line.

The plank will then be fitted in exactly the same way as the centre one.

When both sides are finished the lower plank can be taken in hand, but since it will be an awkward job in this position, and since the boat is now strong enough, the shore and supports can be taken away and

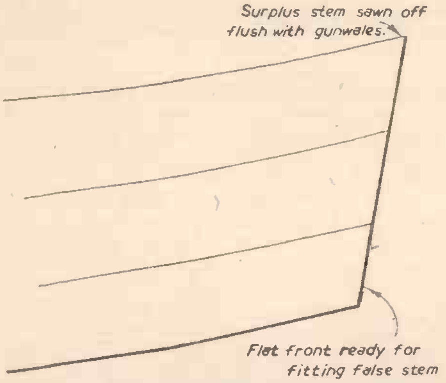


Fig. 24.—Boat with stem post cut flush and awaiting false stem.

the boat turned over, when the operation of putting on the remaining planks is in every way similar to the top ones.

The planking so far completed, the edges must be secured to the seam battens, which is best done with small copper nails, driven right through and clenched. It may, however, be necessary to drill small holes to prevent the wood splitting. A nail every two inches should be put in, but do not put the top and bottom row opposite each other; they should be staggered or the batten will be appreciably weakened.

For the chine and gunwale fastenings, screws are preferable. Use No. 6 screws 1in. long every inch and a half along the chine and every two and a half inches along the gunwale.

Provided the fastenings have been well driven and plenty of white lead mixture applied, there need be no fear about these seams being water-tight. If there are any irregularities in the seams they can be caulked with ordinary putty. Slight gaps will take up when the wood swells.

Bottom Planking

The temporary setting up batten can now be removed and the bottom prepared for planking. The bottoms of the frames will have to be faired up in a manner similar to that of the sides, with the exception of the fact that in this case they are done in position and not removed. By placing a batten down the length of the boat the high edges can be seen, and these must be carefully planed down so that the planking, when put on, will be fair on them all.

The seam battens can now be fitted in a manner similar to the side ones, and letting them into the chines when they meet it; do not, however, let them into the side planking.

Where the centre batten meets the stern post this must, of course, be let into it. The battens should be tacked at each frame position, but care must be taken with the centre rail not to put the tack in the centre of the slot, as a screw will ultimately pass through this point to secure the keel.

Provided that all these battens fit flush, the planking of the bottom, which is a comparatively simple job, may be commenced.

The planks are 6in. wide with the exception of the two centre ones, which are 5in. wide. Although the boat is only 10ft. long, it is as well to order the planks in 11ft. lengths, so that any end splits which frequently are found in timber can be cut away; further, the planks will be easier to bend if a little longer. The planks are laid very simply, and no marking off is called for because this was taken into consideration when working out the positions of the batten slots.

The first plank to be laid will be one of the 5in. ones. Lay this along the boat so that its edge falls along the centre line of the middle seam batten, and clamp it in this position. It may now be secured by screws to the transom and each frame, until the stern is reached, where it is secured by a screw into the bottom of the post. You can now trim the plank off round the chine line and flush at the transom; the forward plank end is now screwed to the chine with No. 6 brass screws 1in. long, spaced every 1½in.

It is, of course, taken for granted that the edges of the frames, battens and chines have been liberally smeared with the white lead putty mixture previously mentioned. The next 5in. plank may now be fitted on the other side of the centre line in a similar manner. Having fitted the two centre planks it will be observed that the outer edges fall on the centre line of the two next battens, that is if they have been spaced correctly.

The remaining planks are put on alternately, gradually working outwards on each side from the centre, and trimming each one off as it is laid.

Trimming Off

In trimming off the planks, it is as well to cut somewhat wide with the saw and complete the work with a small, sharp and finely-set plane. When all the planks are laid, the edges must be secured to the seam battens. Nailing is rather an awkward job, since it is necessary to drive them all

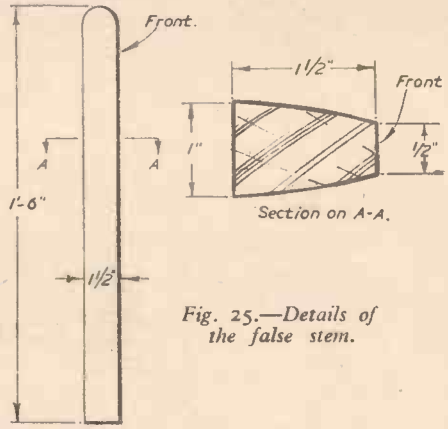


Fig. 25.—Details of the false stem.

first and then turn the boat over to clench them. If assistance can be obtained, the boat can be raised up on blocks, and with the assistant inside, the hammer can be kept on the nail heads while he clenches them. An alternative method is to use screws which should be ½in. No. 6. It is more expensive and a longer job, but gives better results than doubtful single-handed nailing. If you use the screw method turn the boat over and screw through the batten into the plank. If the screw heads are put on the outside, filling in over each head with putty will be necessary to make a sound job, whereas if they are put on the inside, this labour is saved. Fig. 23 shows the bottom partly planked.

With the boat still upside down run a very sharp plane down the outside of the stem until the edges of the side planks are square to the ¼in. flat or front edge of the stem. Fig. 22 shows the state of affairs before planing, and the desired result.

Now the planking is 5/16in., but since it has been planed on the diagonal, the resulting cross section of the plank is a fraction under ⅜in., thus there should be a flat surface, a bare 1in. wide, made up, of course, of the two planks each ⅜in. and the ¼in. front of the stem.

Get this true right along the stem and

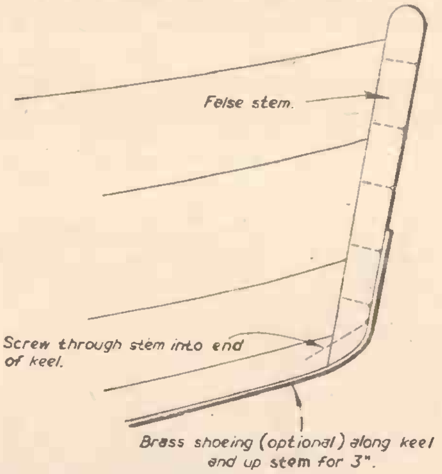


Fig. 26.—Fitting the false stem.

with a straight edge see that the surface is fair for its entire length. Next turn the boat over and cut off the surplus top of the stem post flush with the chines. Fig. 24 shows the work at this stage. The false stem can now be made from a piece of 1in. × 1½in. oak about 18in. long; this is bevelled so that the back edge or, rather, surface, is 1in. and the front ½in. One end is rounded off as shown in Fig. 25.

Starting from the top end make a dot 3in. down, and then one every 2in. for a distance of 12in. Now bore holes to take a No. 8 screw and countersink them. Apply some white lead putty mixture to the planed front surface of the boat, and with some 2½in. screws fix the false stem, as shown in Fig. 26, screwing into the actual stem post, the screw holes, of course, being on the centre line of the false stem.

(To be concluded next month)

A 6" TELESCOPE MIRROR

Grinding the Mirror Disc : Testing for Accuracy : Polishing and Figuring

By J. PARKER

(Concluded from the January issue)

The Foucault Test

AT this stage the polished mirror is approximately spheroid in form. In this condition it is optically unsuitable for use in a telescope; parallel light, such as would be received from a star, when received by a spherical mirror, could not be reflected to a true point image ; the more central rays would be brought to a focus farther away than those from the periphery of the reflector. This defect must be corrected before the mirror can be incorporated in the telescope.

To do this the spheroidal surface must be made paraboloidal, as shown in Fig. 11. At first sight, this might appear to be a considerable undertaking with the limited resources at our disposal; yet the methods used are quite simple, and consist of polishing away minute amounts of glass from the central zones of the mirror, using a suitably modified pitch tool. This reforming of the mirror surfaces, or "figuring," is controlled by frequent testing.

The apparatus used for testing, whilst making possible results of the utmost accuracy, can be simply constructed from odds and ends. The type of apparatus required is shown in Figs. 9 and 10; details can be modified to suit such equipment as may be available so long as the principle of the test remains unaltered. The essentials are these: an approximate point source of light; this must be a radiant source, that is to say, the light emitted from the point must radiate evenly in all directions, and must not be parallel or convergent; the other essential is the knife edge, which is a straight, sharp edge capable of smooth lateral movement in or about the plane of the light source. The knife edge and light source should be as close as possible.

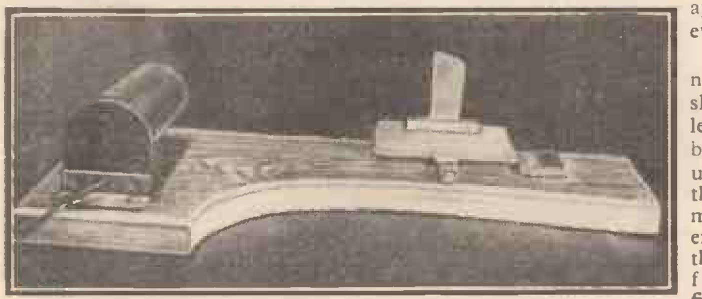


Fig. 9.—The Foucault test apparatus.

In the diagram showing the Foucault test the knife edge is assumed to be on the right of, and approaching, the light source. The positions of light source and knife edge can be reversed if more convenient, but this must be kept in mind when interpreting the shadow figures, which would be reversed.

The apparatus must be fixed securely upon a common base, which in turn must be secured in a permanent position. This, for comfort, should be about eye level, and a similar position provided for the mirror, at a distance equal to the radius of curvature, which in this case is ten feet.

The pinhole light source should be sighted on the mirror, which is adjusted so that an image of the pin hole is formed upon the knife edge ; this is best carried out in a darkened room, using a piece of white card to find the image. A support should be made for the mirror, so that it can be replaced in exactly the same position when required.

The image on the knife edge should be the same size as the pinhole light source and in sharp focus.

The eye is placed directly behind the knife edge, which is moved to the right, thus permitting the light reflected from the mirror to fall upon the eye ; the mirror will then appear as a bright disc of light. This is because the image of the pinhole is formed so close to the eye that the eye lens is incapable of forming an image upon the retina ; the aperture of the mirror being so small, however, all the reflected light enters the eye through the iris ; the result is that whilst the shape of the mirror and its surroundings are in focus on the retina, the pinhole light source is not, and the mirror appears brightly and evenly illuminated.

The knife edge is now advanced slowly from right to left until the edge begins to encroach upon the light from the mirror; if the mirror surface is exactly spherical and the knife edge at the focus the light-filled mirror will appear to darken gradually and evenly as the knife edge advances.

Should the knife edge be within the focus a shadow will advance across the surface of the mirror, the movement being in the same direction as that of the knife edge; outside the focus the movement will be in the opposite direction.

The radius of curvature can be determined exactly by measuring the distance between the knife edge or the pinhole and the mirror. Since half this distance is equal to the focus of the mirror, a note should be made of the measurement for later reference when constructing the telescope.

Once the principle is grasped the shadow phenomena exhibited by the Foucault test are easily interpreted. In the Foucault set-ups illustrated in Fig. 11, two types of surface are shown under test: (a) is a true spheroid, with shadow figures for three positions of the knife edge. These are inside focus, showing the shadow moving in the same direction as the knife edge ; at focus, where the mirror darkens gradually as the knife advances (this is rather difficult to illustrate, as the mirror fades from full illumination to darkness without any movement of shadow either from right or left as the knife advances) ; and outside focus, with the shadow moving towards the knife edge.

Fig. 11 (b) shows a paraboloidal surface, at the centre of curvature, no position can be found for the knife edge, where the mirror darkens evenly over its entire surface ; this is because the radius of curvature increases gradually from the centre outwards. In Fig. 11, for the purposes of illustration, two zones are shown, inner and outer, and the knife edge is placed at the focus of the inner zone, at the mean focus, and at the focus of the outer zone.

At the focus of the inner zone the centre portion of the mirror is darkened by the advancing knife edge, whilst a fainter shadow advances from right to left around the outer edge.

At the average focus the inner zone shadow moves from left to right, whilst the outer zone shadow moves from right to left.

At the focus of the outer zone only the right-hand portion of the inner zone is free from shadow.

Other types of shadow figures are depicted, in Fig. 12 (a) is a mirror with a turned-down edge and (b) has a depressed centre.

Figuring

This operation is the "bogy" of amateur telescope makers ; with a little extra care, however, together with common-sense interpretation of the Foucault test, the beginner may tackle figuring without undue trepidation and with every expectation of producing an efficient reflector.

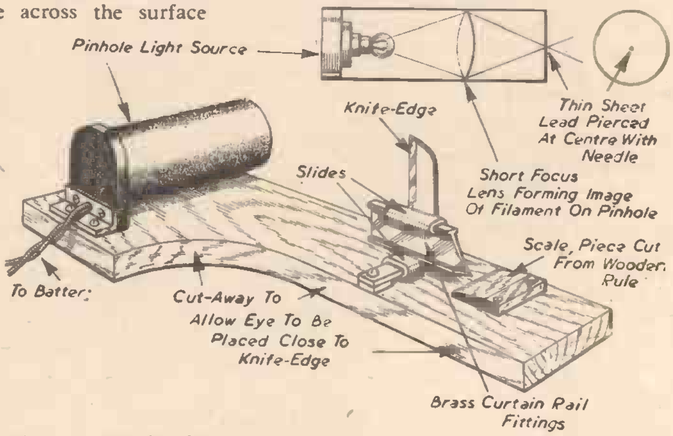


Fig. 10.—Details of the Foucault test apparatus and pinhole light source.

Figuring consists of altering the spheroidal surface of the mirror to that of a paraboloid, as mentioned earlier ; the difference in form between the two types of surface shown in Fig. 11 is greatly exaggerated for the sake of clear illustration.

In practice, the more central zones of the mirror are polished away to form the required paraboloidal form. The amount of glass removed by this operation is extremely minute, and is measured in millionths of an inch. This small surface difference, impossible to detect by mechanical methods, is easily and accurately controlled and measured by the Foucault test.

After the initial polishing, the mirror is tested by means of the Foucault knife-edge test; if the test shows an imperfect surface, such as a turned-down edge, time will be saved by returning the mirror to the glass tool and repeating the fine grinding. A turned-down edge, or a depressed centre, which amounts to the same thing, is very difficult to correct on the pitch tool. It is because of the possibility of having to return the mirror to the glass tool for regrinding that the writer prefers to use a hardwood base for the pitch tool.

If the preliminary test shows the surface to be spherical, then parabolising can be proceeded with. The pitch tool must be so modified that the polishing action is greatest towards the centre of the mirror; this is accomplished by trimming as shown in Fig. 13. The facets are thus made to decrease in size as they approach the edge of the tool.

The mirror is then polished for a short period; it is wise to err on the side of caution in the first stages of figuring, so this first spell should be a short one, say 10 minutes. There are so many variable factors involved that it is impossible to give an estimate of the time required, such things as hand pressure, stroke and pitch temper all influence the cutting speed.

The mirror is cleansed of rouge and the surface polished with a clean cloth, it is then placed in position on its stand on the shelf for the Foucault test and allowed to stand there for at least half an hour. This is to allow the heat generated in polishing to dissipate; if the mirror is tested immediately this heat, small as it is, will so distort the surface as to give an unreliable knife-edge reading.

At the end of the half-hour period the mirror is tested: the surface is carefully inspected by means of the knife edge for traces of tool edge zones, these are characteristic of hard pitch and regular polishing strokes, and are caused by the tool edges reaching the same radial distance from the centre of the mirror at each stroke. The remedy is to stagger the lengths of the strokes.

Two or three short spells may be required before the mirror exhibits the characteristic paraboloid shadows shown in Fig. 11b.

A perfect paraboloid would exhibit an infinite number of different radii of curvature, increasing in focus from the centre outwards. It is obviously impossible to measure the focus of each tiny zone separately, so for practical purposes the mirror is imagined to have two or three separate zones, each with its own centre of curvature, the inner zone having the shorter focus.

In Fig. 11 the knife edge is shown in three positions—at focus of the inner zone, at the average centre of curvature, and at the focus of the outer zone (focus in this case refers to the focus when the radiant is at the average centre of curvature).

The difference between the foci of the inner and outer zones when measured from the centre of curvature is a definite quantity for any paraboloidal reflector, and is obtained from the formula $\frac{r^2}{R}$ where r is the radius of the mirror disc, and R is the mean radius of curvature.

In this case, where r = 3in., and R = 120in., the difference should be 9/120in., or 0.075in., and represents the difference in focus between the centre zone of the mirror and the outer edge zone.

A cardboard mask (Fig. 14) placed over the mirror will permit the measurement of three zones—centre, inner and outer, the formula $\frac{r^2}{R}$ is applied for each of the two radii 2in. and 3in.

The two differences to be measured will be between the centre and inner, and centre and outer zones, and are found as follows:

$d_1 = \frac{2^2}{120} = 0.033$in., and $d_2 = \frac{3^2}{120} = 0.075$in.

The scale (see Fig. 10) is used for these

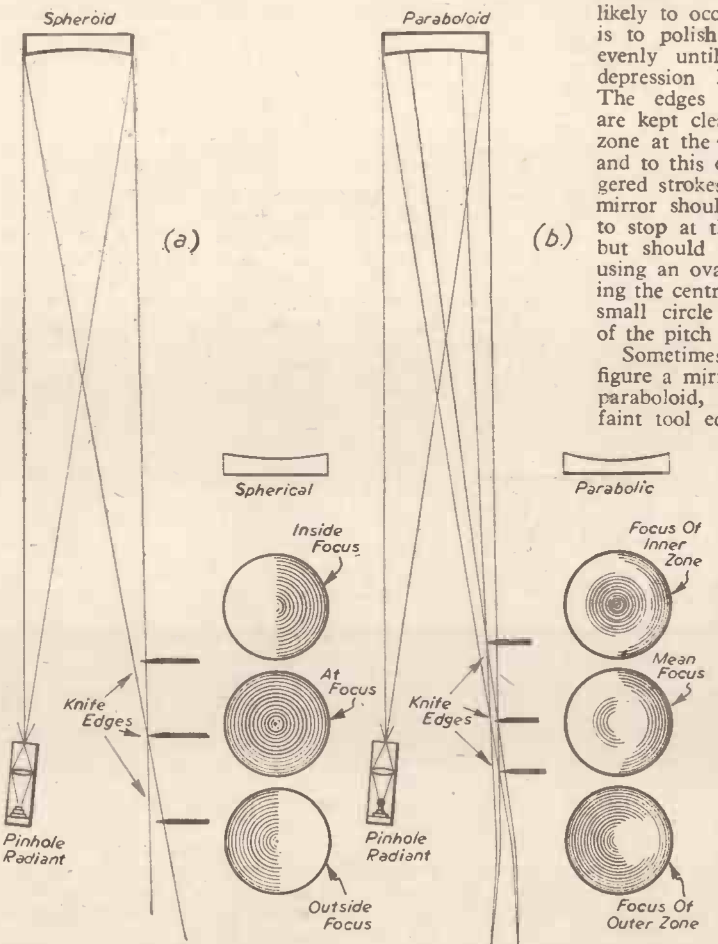


Fig. 11.—The method of testing mirrors by the Foucault apparatus shown diagrammatically.

measurements; the procedure is as follows: The knife edge is adjusted so that the centre disc darkens evenly—this is the focus of the centre, and a note is made of the scale reading, which will be termed f_1. The knife edge is then withdrawn a little, and f_2, the focus of the inner zone, determined. Similarly, f_3, the focus of the outer zone, is found.

Then, $d_1 = f_2 - f_1$, and should be 0.033in. and $d_2 = f_3 - f_1$, and should be 0.075in.

Actually, it is not likely that a perfect paraboloidal form will be obtained quite so easily as might be inferred from the preceding paragraphs. Knife-edge tests are likely to show up various imperfections, such as turned-down edges or various forms of ring zones.

As mentioned earlier, the quickest and surest method of dealing with a turned-down edge or a depressed centre is to return the mirror to the glass tool. Repeating the fine grinding until the turned edge or depressed centre has been removed, followed by polishing, is preferable to long sessions on the polishing tool, with irritating delays for testing.

Ring zones, on the other hand, are caused by the edges of a hard pitch tool, and zones caused by the polishing tool must be removed by the polishing tool. It is difficult to give precise instructions for correcting these defects, which might have widely varying characteristics in individual mirrors; in other words, the remedy must depend upon the symptoms, and it is this stage which requires common sense and correct interpretation of the shadow test.

Ring zones are invariably depressed zones—raised ring zones are not likely to occur. The treatment is to polish the entire surface evenly until the level of the depression has been reached. The edges of the pitch tool are kept clear of the depressed zone at the end of each stroke, and to this end shortened, staggered strokes are employed; the mirror should not be permitted to stop at the end of a stroke, but should be kept in motion, using an oval stroke, and working the centre of the mirror in a small circle around the centre of the pitch tool.

Sometimes it is possible to figure a mirror to a satisfactory paraboloid, but which exhibits faint tool edge zones. These faint zones can be removed by "smoothing" on a full-scale soft pitch tool. Soft tools need to be handled with circumspection owing to the tendency of the outer facets to become depressed, thus causing a seriously depressed central zone.

Silvering (Chemical Method)

The silvering process consists of depositing a thin film of pure silver upon the surface of the glass; this film will take the character of the surface upon which it is deposited; that is to say, silver deposited upon a surface which has not been fully polished will exhibit a corresponding lack of reflectivity in the silvered surface. A fully polished surface, on the other hand, will take a silver film of maximum efficiency.

It is evident, therefore, that since two reflecting surfaces will be required (objective mirror and prism) the mirror surface should be fully polished before any attempt is made to deposit silver upon it, so as to keep light

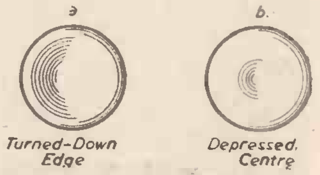


Fig. 12.—Shadow formations on the surfaces of mirrors.

losses to a minimum.

A cleansing operation of the most thorough nature is necessary before silvering. The mirror, after the polishing and figuring have been completed, is first of all well rinsed under the tap; the disc is then laid face downwards on a soft dishcloth in the sink, and the back and sides well scrubbed with soap and water. When all traces of rouge and pitch have been removed (a little paraffin is useful for removing any traces of adherent pitch) the disc is turned over and the surface well soaped, using a pad of cotton wool. Particular attention should be paid to the edges; pitch and rouge and other contaminations lodge very readily in the innumerable tiny chips and splinters which are usually to be found around the edge of the worked surface. When the soap washing is finished the disc is thoroughly rinsed.

The surface is now treated with precipitated chalk; a swab of cotton wool is wetted, dipped in the chalk, and rubbed over the surface of the disc; the chalk must be very thoroughly rubbed in to every portion of the surface. The swab must be used until nearly dry and then discarded, the disc is then rinsed and the treatment repeated with a fresh swab. It will be found that an appreciable amount of rouge, etc., will be removed by this treatment. Repeated applications of the wet chalk will have the effect of removing the surface greasiness, it should be possible, after the precipitated chalk treatment to wet the surface without the water drawing back and leaving the edges dry. When this condition has been achieved the disc is rinsed to clear it of all traces of chalk. From this stage onwards the mirror surface should not be touched by the fingers or allowed to become dry until the silvering has been completed.

The next operation is to swab the surface with concentrated nitric acid.

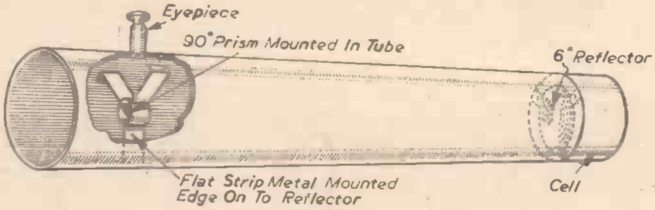


Fig. 15.—A telescope tube part broken away to show prism mounting and eyepiece.

The acid is poured on and mopped over the surface with a swab made from cotton wood tied to the end of a smooth-ended glass rod.

The acid is rinsed off under the tap and all surplus water drained away.

A concentrated solution of stannous chloride is now prepared and poured on so that it covers the entire surface; this is allowed to stand for a few moments and then rinsed off under the tap. No traces of chloride can be permitted to remain and this rinsing must be very thorough.

After the tap rinsing, the disc is rinsed in distilled water. The cleaning operations are now completed and the surface is ready to receive its deposit of silver.

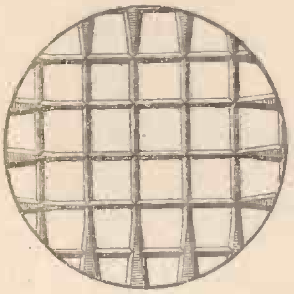


Fig. 13.—Pitch tool modified for parabolising.

If it is not convenient to silver immediately, the mirror should be kept immersed in distilled water. On no account should the surface be allowed to become dry until the silvering is completed.

Silvering—Brashear's Process

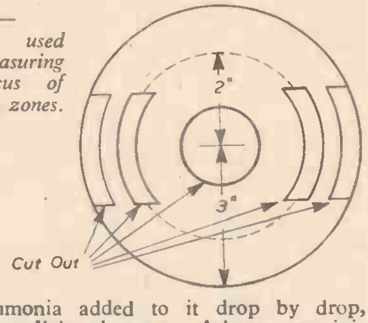
The following solutions will be required for the silvering process.

Solution A. 75 c.c. water.
5 grammes silver nitrate.
Solution B. 25 c.c. water.
3.5 grammes potassium hydroxide.
Solution C. 15 c.c. water.
1 gramme silver nitrate.
Concentrated ammonia.
Reducer Solution:
30 c.c. water.
2 grammes dextrose.

All water must be distilled.

The method of preparation is as follows: Solution A is poured into a clear tumbler and ammonia added to it drop by drop, using a medicine dropper. A brown precipitate will be formed, and the solution should be stirred with a glass rod as the ammonia is added. As the cloudiness begins gradually to disperse, the liquid should be stirred vigorously between each drop until the solution just clears. Great care must be taken not to add too much ammonia, and a few drops of the second silver nitrate solution—Solution C—are added until the liquid assumes a faint straw colour.

Fig. 14.—Mask used when measuring the focus of different zones.



The solution is now ready for the addition of Solution B. This should be added cautiously, using a clean medicine dropper, and stirring constantly. There is a possibility, under favourable conditions, of the solution forming crystals of the explosive silver fulminate; for this reason the solution should be stirred constantly, and the preparation of these solutions should be carried out in a cold room if possible.

When all of Solution B has been added, more ammonia should be added, drop by drop, until the mixture just clears, as before drops of Solution C are added until a brown precipitate begins to appear.

The solution is filtered through cotton wool, and is then ready for use.

The temperature at which the silvering is carried out is most important—it should be not less than 65 to 70 deg. F. The solutions and mirror should both be at this temperature for satisfactory results.

If the operation is being carried out on a warm summer day, silvering can proceed without further delay; but in cold weather steps must be taken to take the chill off the mirror and the solutions.

The mirror disc can be allowed to stand in warm water for a short time until the glass feels warm to the touch, taking care, of course, to handle only the back and sides of the disc.

A strip of clean stiff paper is obtained 2in. to 3in. wide, and long enough to wind once or twice around the edge of the mirror; a length of the red paper backing used on camera films is ideal for this purpose.

The paper is wound tightly around the edge of the disc and secured by binding with string.

The two solutions already prepared are then filtered through cotton wool into clean glasses; to each solution is added an equal volume of distilled water.

The glass containing the reducer solution is also allowed to stand in warm water until it has absorbed sufficient heat. The silver solution is not heated.

Assuming that the disc has been warmed and bound with its paper "collar" the silvering operation can now be carried out.

The solutions are mixed by pouring the reducer into the ammoniated silver nitrate solution in the proportion 1 to 2; that is to say, if there is 100 c.c. of silver solution, then 50 c.c. of reducer would be poured into it.

The mixture is stirred, when it will become straw-coloured, and then dark brown. At this stage it is poured immediately over the mirror. The whole of the solution is poured on, and the mirror gently rocked. If properly bound on, the paper will prevent any serious loss of solution over the edge.

By this time the liquid will be quite black with broken films of silver floating on the surface. As the disc is rocked a heavy black precipitate will be seen in the solution; this must not be allowed to settle on the surface of the mirror but must be kept in motion; if necessary, the surface can be lightly swabbed with cotton wool.

In a short time—5 to 10 minutes—the liquid will clear; the disc is immediately rinsed clear of solution and the paper removed.

The mirror, which should now have a perfect silver surface free from stains, is immersed in clean water and allowed to stand for an hour. At the expiration of this period it is removed and excess water removed with clean blotting paper. A little alcohol is then run over the surface and removed with dry blotting paper; the mirror should then be completely dry in a few minutes.

The silvered surface is then burnished using small clean pieces of chamois leather. The pressure applied should be very light at first, and very gradually increased. Each piece of chamois leather should be used for a short period only, and then discarded.

A little dry rouge may be used after the first two or three pieces of chamois, but this is usually not necessary.

The Telescope

The actual construction of the telescope is outside the scope of this article; in any case since design is likely to be dictated by available materials it is unlikely that any two home-constructed telescopes will be alike.

As mentioned in the opening chapters, the optical system is very simple and consists of a 6in. reflector, small 90 deg. prism or silvered flat mirror (surface silvered—an ordinary back-silvered mirror would be useless, producing a doubled image) and eyepiece. It is important that the prism or silvered flat should possess high quality worked surfaces; it is of little avail to spend long hours working the 6 in. reflector to a high state of perfection if the resulting image is to be marred by prism distortion.

The design of the telescope tube is shown in Fig. 15; the reflector is seen mounted in a cell, which should be removable, so that the mirror can be covered up when the telescope is not in use. The author's tube was made cheaply and efficiently of tinplate by the local tinsmith, with a simple bayonet type release for the cell. There is no necessity for the tube to be cylindrical—

(*Concluded on page 238*)

A Wind-Powered Garde

An Attractive and Economical Unit for Your Garden

By C. J. Pike

THE pump and fountain unit shown in Figs. 2, 3 and 6 is inexpensive to construct and costs nothing to run, its motive power being the wind. The unit, built two years ago, has given quite satisfactory results, starts to work whenever there is a slight wind, and has required only the minimum of maintenance.

How It Works

The mode of operation is quite simple—a wind-wheel works a small oscillating air-pump by means of a simple crank and piston-rod. At each delivery-stroke air is forced through a non-return valve and down a small-bore rubber pipe leading to the ornamental pool. This pipe is joined to the bottom of a simple jet-tube which slopes from the bottom of the pool up to the surface, where the fountain-jet is situated. A simple leather flap-valve, also fixed in the bottom of the jet-tube, admits water when no air is being delivered, that is, on the up-stroke of the piston.

As soon as air is admitted, the pressure inside the tube increases and the valve closes. The whole column of water is then forced by the air beneath it up through the jet, reaching a height of several feet, while the spray produced towards the end of the operation is thrown even farther. When the piston reaches the end of the delivery stroke and the air pressure falls, the flap-valve in the bottom of the tube is forced open by the depth-pressure of the water. The tube then fills with water ready for the next operation. It should be noted that the bore of the jet-tube is small enough to prevent the air from by-passing the water and breaking up the column before it is ejected.

The depth of water in the pool is 18in.—but if the jet-tube is installed in one of a depth of several feet it should be possible to do away with the flap-valve, the fountain then would work on the principle of the air-lift pump, which is sometimes used in oil wells.

Construction

The wind-wheel is constructed first, and is a bicycle front wheel equipped with 14 curved blades cut out from light gauge sheet iron. A suitable shape for these is shown in Fig. 1, and they are attached to the spokes by a fold along the straight edge, being afterwards clinched by pliers. The blades are attached to the spokes at what will be the back of the wheel, and are then bent in a slight curve towards the front at an average angle of 45 deg. A narrow slot is cut as shown, in order that the blade may clear the adjacent front spoke, which would otherwise foul it. It will be found possible to spring the blade into place, and if the slot has been positioned correctly the blade will be automatically secured without any further fitting.

A multi-blade wheel was chosen, instead of a simpler two-bladed model, on account of its slower speed and greater torque.

To mount the wheel, a 2ft. length of 2in. × $\frac{1}{4}$in. strip steel is drilled, as shown in Fig. 4, and the wheel bolted to it, the spindle passing through the top hole and being secured by one of the original spindle nuts.

The Pump

The air-pump shown in Fig. 4 was actually made from a cut-down motor-tyre pump, using the upper end complete with the screwed cap. It may be noticed that this is drawn the right way up, but in the photographs is shown upside down. The only reason for this is that it prevents water entering the pump. Having been cut to length, a brass disc is prepared to fit the end of the barrel and then drilled with a $\frac{1}{8}$in. hole, this being where the non-return valve will be soldered.

The non-return valve consists of a short piece of $\frac{3}{8}$in. brass rod drilled with a $\frac{1}{4}$in. hole to within about $\frac{1}{4}$in. of one end, after which the hole is continued right through with a $\frac{1}{8}$in. drill.

A ball-bearing is selected to give a loose fit in the larger hole, and is well hammered down upon the shoulder formed in the tube to give a good seating, using a small pin-punch to reach it.

A light spring will be required in order that the ball will be just held upon its seat. This can be formed by winding a strand of thin steel wire tightly round a piece of stiff, thicker wire. The spring is inserted in the hole and cut off roughly flush with the end; it should just bear lightly upon the top of the ball. It is kept in place by means of a plug, made by slightly tapering down a short piece of copper tubing. This is driven lightly into the open end. The ten-

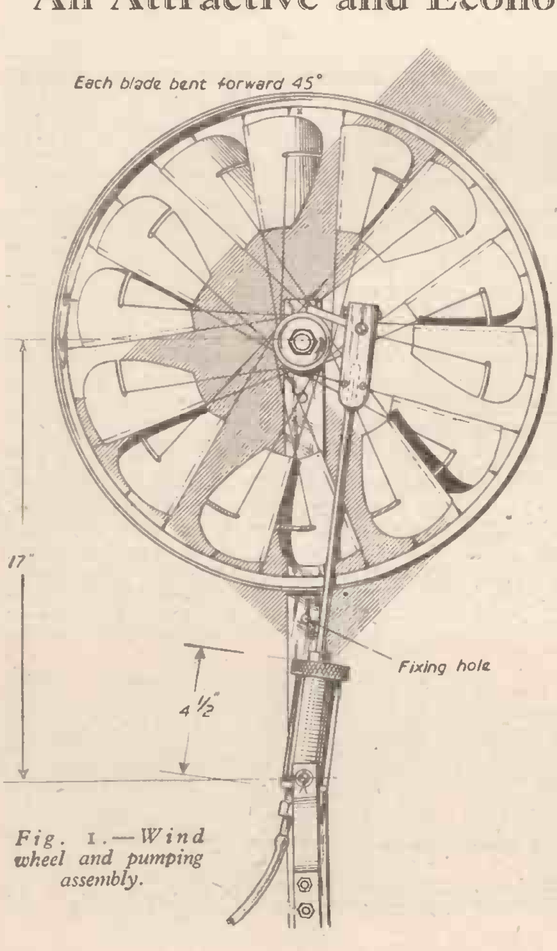
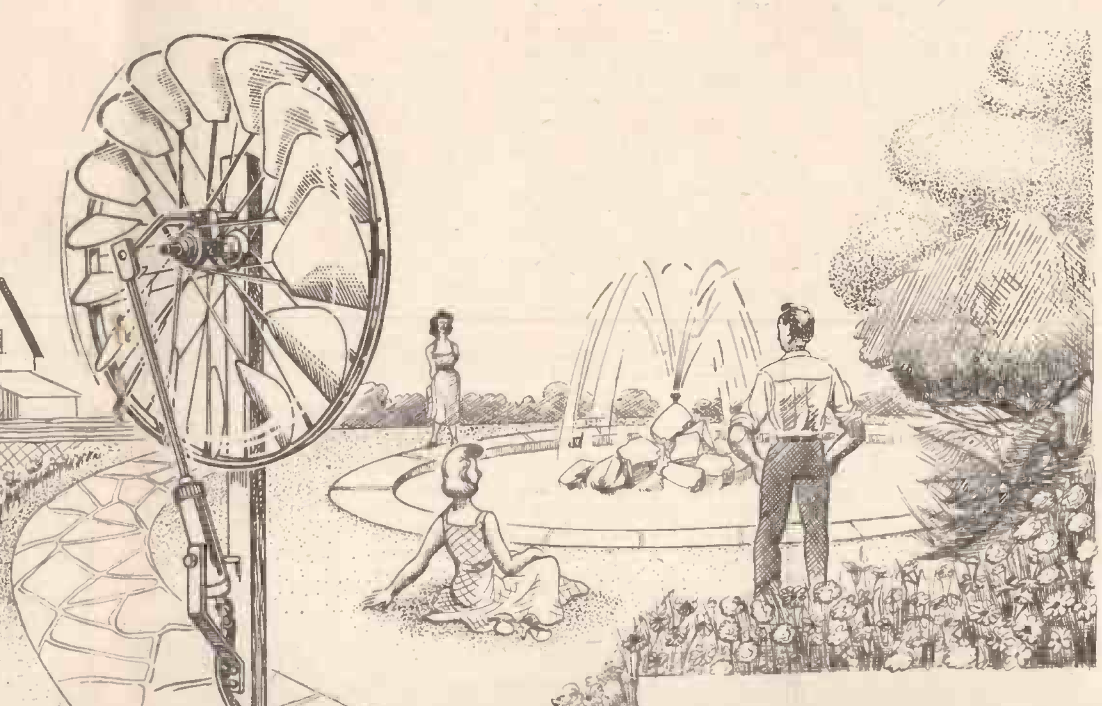


Fig. 1.—Wind wheel and pumping assembly.



sion should be checked by pushing a pin into the small hole and lifting the ball, then adjusting the length of spring if necessary.

The hollow plug also forms the air-outlet where the rubber pipe will be fitted. When the job has been completed and the pump has been tested, it can be lightly soldered in place if necessary.

The oscillation bush fitted in the bottom of the pump is made from a piece of brass tubing of approximately 5/16in. bore.

This is located across the tube at the bottom, holes being drilled in the wall into which it will be soldered.

Fig. 2. (left).—A view of the author's fountain playing.

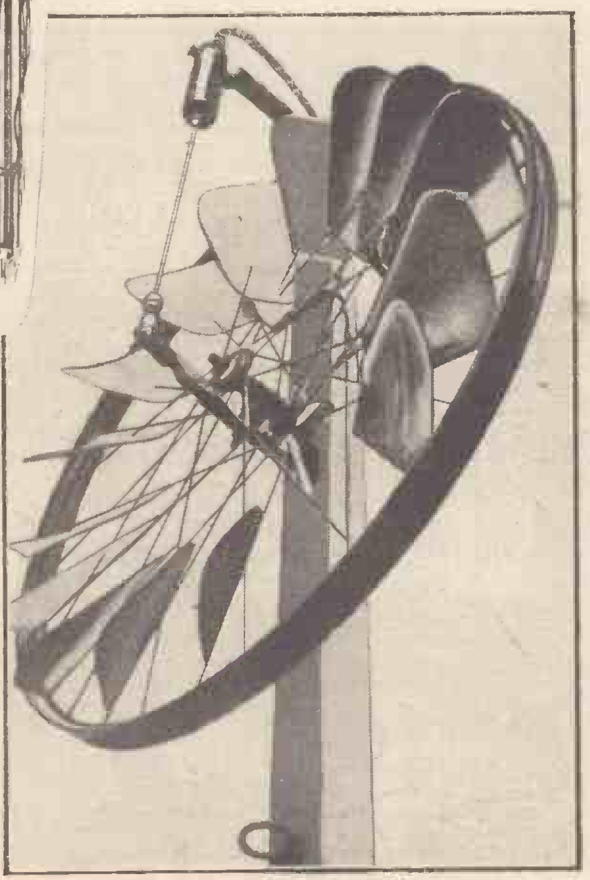


Fig. 3 (right).—A view of the wind wheel and pumping assembly.

Soldering

The quickest and easiest way to solder these fittings into the end is to fit them in place first, after thoroughly cleaning them. Killed spirit is then applied to the end of the pump—which is stood upright — and the melted solder simply run straight into the cavity containing the fittings and finished off with the blow-lamp. Finally the brass bush is cleaned out to take a 5/16in. steel rod.

Concerning the remaining pump parts, the original rod and piston may be used, if in good condition, renewing the leather washer if necessary. Should the piston rod prove too short, the length may be conveniently made up by fitting a longer wooden bearing at the top.

Hardwood Bearing

This bearing, or big-end, is made from hardwood (maple) and is drilled as shown in Fig. 5, slots being provided for adjustment. Wood was chosen as it was found to be quiet in operation and—especially when well soaked in oil—to a large extent self-lubricating.

The crank was made by bending a piece of 5/16in. steel rod. The portion which passes across the hub of the wheel is reinforced by sleeving it with a piece of tightly-fitting iron pipe. It is secured to the hub as shown in Fig. 5, by means of a Jubilee clip—this will hold it quite firmly and permits a simple means of adjusting the stroke to suit the pump. When loosened, the crank can be turned round to allow the crank-pin to move away from or to approach the centre of the hub.

Finally a bottom bracket is made up by bending a piece of the 2in. × ¼in. strip steel, which is then drilled and bolted to the bottom of the other strip (see Fig. 4). This will carry the outer end of the 5/16in. steel pin, upon which the pump oscillates.

The bracket is marked off and drilled to take the pin after it has been bolted to the strip to ensure that the pin will be horizontal. The pin itself is held in place by means of a hole each end fitted with a split-pin, and the pump located at the correct distance along it by means of distance pieces cut from piping.

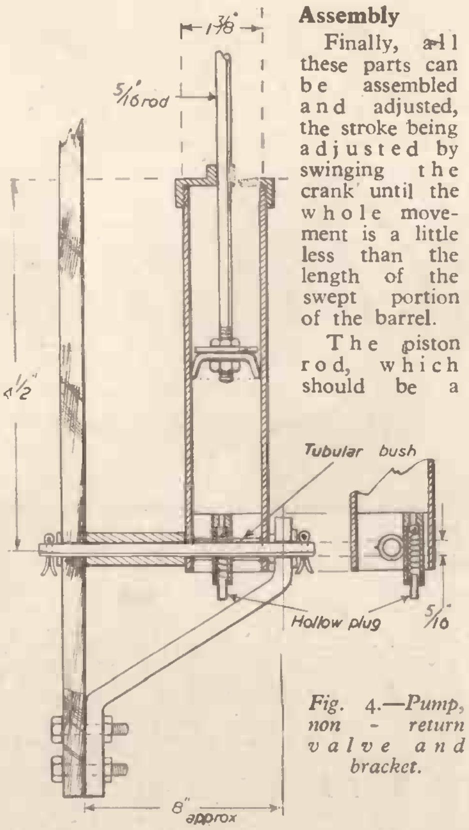


Fig. 4.—Pump, non-return valve and bracket.

Assembly

Finally, all these parts can be assembled and adjusted, the stroke being adjusted by swinging the crank until the whole movement is a little less than the length of the swept portion of the barrel.

The piston rod, which should be a sliding fit in the bottom of the big-end, is eased downwards until the leather cup-washer just clears the bottom of the pump when the crank is at the bottom of its stroke; it is then locked in place by means of the two bolts passing through the big-end.

When the wheel is slowly rotated, all the parts should work quite freely; make certain that the piston clears the top and bottom of the pump.

The whole unit is then finished off with a coat of paint, and the moving parts oiled.

When dry, the unit can be bolted to the top of a pole, approximately 12-15ft. high, using the two free holes in the steel strip and recessing the protruding bolt heads into the wood.

The air-line is then connected. This should be ¼in. bore rubber or plastic tubing but not much larger than this otherwise the flow of air will tend to be too continuous owing to the greater capacity.

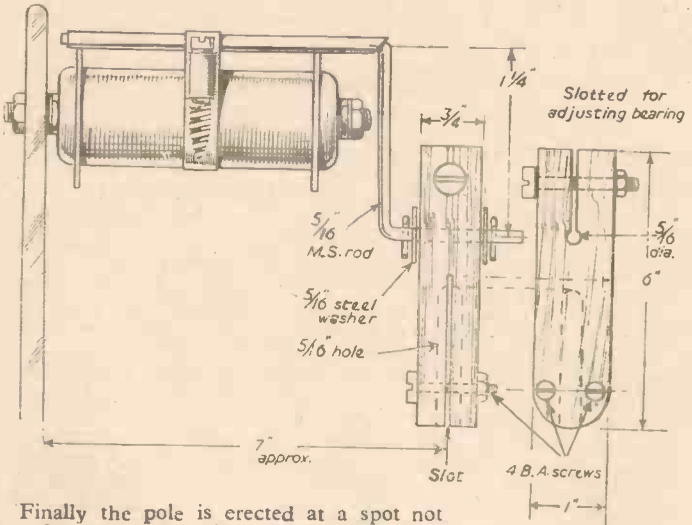


Fig. 5.—Details of the hub, crank and big-end.

Finally the pole is erected at a spot not too far away from the pool and provision made for turning the wheel into the wind (by hand, for simplicity).

The Jet

A piece of ½in. O.D. copper tube, roughly 2ft. in length, is well annealed at one end and drawn down by hammering to form a tapered jet, approximately ⅛in. bore. It may be necessary to re-anneal at intervals during this operation, the jet being finally cleaned up with a ⅛in. drill.

The tube is bent to the shape shown in Fig. 8 so that the jet will be vertical and protrude 1in. above the water when put in place.

Next, the pipe is flattened in a vice, as shown in Fig 7, the final measurement of this portion being about ¼in. between the flats formed. These flats are then drilled, and any burrs inside the pipe carefully filed down, as the bottom row of holes will form the valve-seat. A short piece of ¼in. O.D. copper tube is soldered into the top hole, this is the air-inlet.

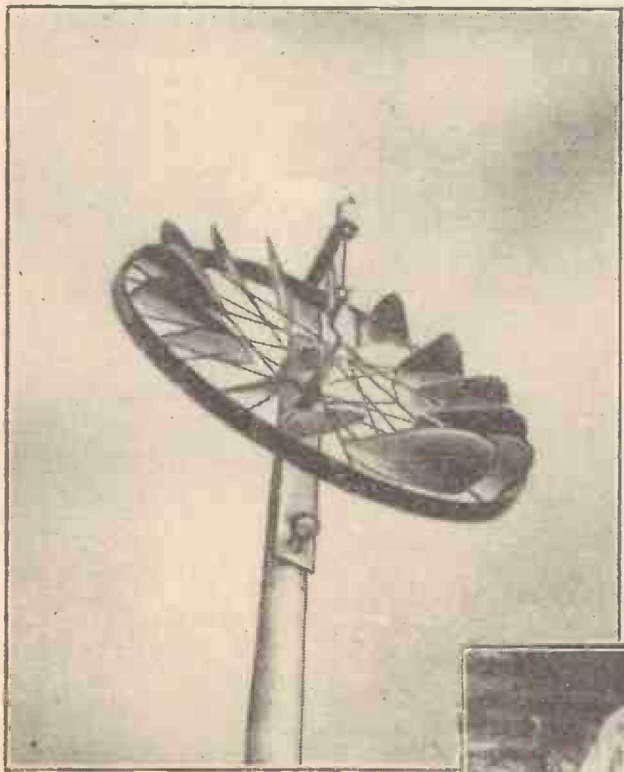


Fig. 6.—A further view of the wind wheel.

The Flap Valve

The flap-valve is cut from a piece of soft leather—probably rubber would do instead—and secured in place with a small nut and bolt as shown in Fig. 7. It should be tested by moistening with water and trying to blow into one of the openings of the tube, the others being temporarily plugged up. It may be necessary to move the flap about until the best position for closing the holes is found. Having done this the lower end of the tube is carefully plugged by a well-fitting cork, or better still, a rubber bung. Finally, the air-line is connected and the unit tested, the pipe being temporarily mounted on a wire stand resting on the bottom of the pool.

There are numerous ways in which the pipe may be hidden or camouflaged when finally installed, probably one of the simplest is to completely embed it in an ornamental concrete block, leaving access to the valve, and with just the tip of the jet protruding, as shown in Fig. 8. An ornamental jet will improve the appearance of the fountain, as shown in Fig. 9.

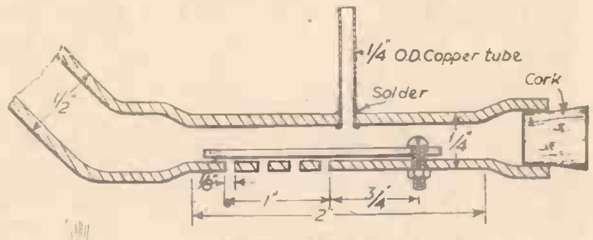


Fig. 7.—Flap valve details.

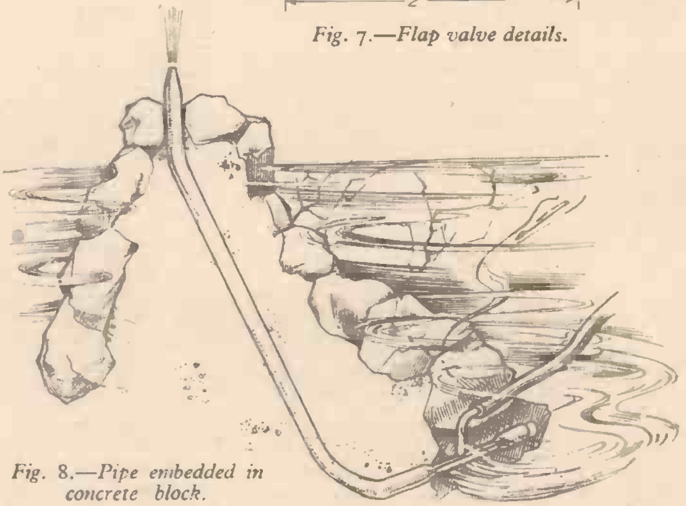


Fig. 8.—Pipe embedded in concrete block.

Alternatively, the apparatus can be used to lift water to a second pond, about 2ft. above the first, and allow the water to drain steadily back through an ornamental spout.

Fig. 9.—A view of the fountain equipped with a shaped nozzle.

Making a 6in. Telescope Mirror

(*Concluded from page 235*)

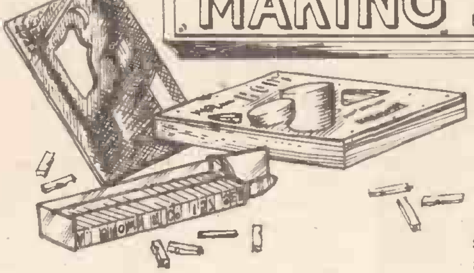
it can be square section and built of wood, if more convenient. Indeed, a tube is not entirely necessary, and many of the world's largest reflectors are of open-work girder construction.

The prism fitting should be constructed of flat-strip metal, edge on to the reflector to minimise the effect of silhouetting.

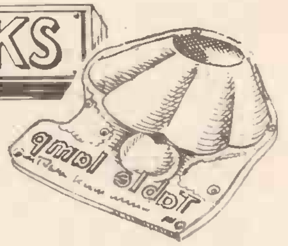
The completed telescope tube will be quite heavy, and will require to be mounted on a stout base, with provision for horizontal and vertical movement.

The image is inverted, as in a refracting astronomical telescope, so it is not convenient for use as a terrestrial telescope, although an erect image can be obtained by turning one's back to the view, and looking down into the eyepiece.

The construction of the telescope mounting may present many difficulties; but the constructor who has the patience to grind, polish and figure a 6in. reflector and who constructs a makeshift mounting, is not likely to abate his efforts until he is the proud possessor of a first-class home-made telescope with an efficient equatorial mounting.



MAKING ZINC PRINTING BLOCKS



Details of the Complete Process for the Amateur Printer

THE amateur printer can, of course, buy type from stock for the reading matter, but an illustration requires a "block," which must be specially prepared for each illustration. It is quite possible for an enthusiastic amateur to make his own blocks by a method similar to that used by process engravers, but modified to avoid the necessity of special apparatus.

Making the Negative

Usually a special camera fitted with a mirror for reversing the image is used for this, but if the original drawing—exactly as required in the illustration—is made on tracing paper or tracing linen the negative can be made simply by placing a process plate or film in contact with the tracing in an ordinary printing frame, exposing to electric light and developing in the ordinary way. A negative can be made on an ordinary plate or film but a process plate will give a better result, the dark parts will be denser and the light parts clearer. The tracing must be made very firm and black, so that the lines, etc., appear quite opaque when examined against the light, and the negative when finished should be very dense in the background, with the lines showing as clear glass. When viewed on the film side of the negative the image must appear the right way round.

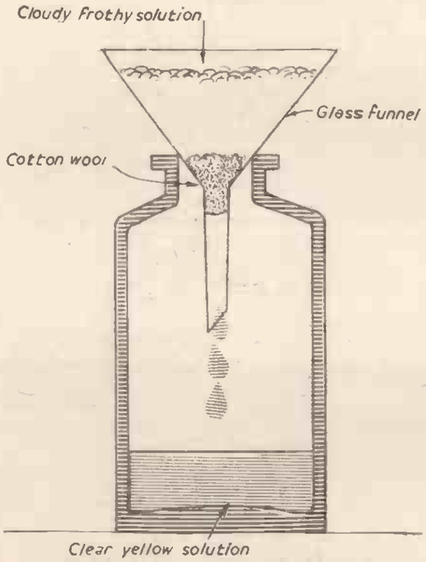


Fig. 1.—Filtering through cotton wool.

The Material Required

The next step is to obtain the actual material which is to form the block. Sheet zinc is used for this, generally of 16 gauge with a specially polished surface. You can get this zinc cut to any size required from Messrs. Hunter Penrose, Ltd., 109, Farringdon Road, London, E.C., who will also supply the other special materials required.

The zinc must be coated with a sensitized solution of albumen. To make this obtain a new laid egg, crack it open and pour the white only into a glass measure; the yolk is not required at all. Add 4oz. of water to the white of egg and beat it up thoroughly with a stirring rod. In another vessel dissolve 15 grains of ammonium bichromate in 1oz. of water, and when dissolved, pour the solution into the albumen (i.e., the white of egg), and stir well again. This mixture must be filtered through cotton wool as shown in Fig. 1, and all the vessels used must be quite clean. Do not use any culinary articles as the ammonium bichromate is poisonous.

Preparing the Zinc

Prepare the zinc by scouring it with a moistened pad of clean rag and some finest levigated pumice powder; you may obtain this from a chemist, the sort used by painters for scouring paintwork is apt to be coarse and scratchy. Do not touch the surface of the zinc with the fingers, but wash off any loose pumice under the tap and then put the zinc into a dish containing very weak nitric acid (1 part acid to 100 parts water will do very well). Rock the dish to and fro to keep the acid moving, and after about a minute the zinc will acquire a dull grey matt appearance. Lift out the zinc, taking care not to touch the surface (the acid is not strong enough to harm the fingers), rinse under the tap, and at the same time rub the surface with wet cotton wool until the wool comes away quite clean. The zinc is then ready for sensitizing.

While the zinc is still wet hold it by one corner and pour a small pool of the albumen solution into the middle of the zinc plate as shown in Fig. 2. Tilt the zinc about until the albumen solution runs all over then stand it up in a negative rack to drain for a few minutes. When the albumen ceases to drip off, but before it begins to dry, coat the plate with albumen as before, but this time put it in the rack so that the corner which was at the bottom after the first coating is now at the top; this procedure helps to produce a coating of even thickness. The negative rack and the zinc plate should then be placed in a warm, dark place to dry. The plate becomes sensitive to light as it dries hence the necessity for darkness, though total darkness is not required.

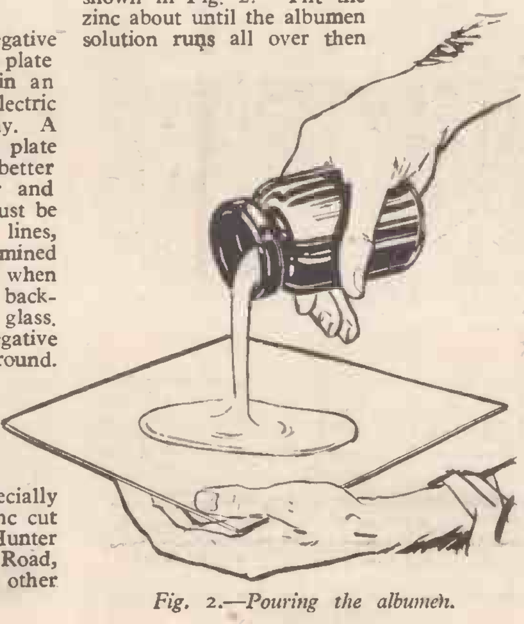


Fig. 2.—Pouring the albumen.

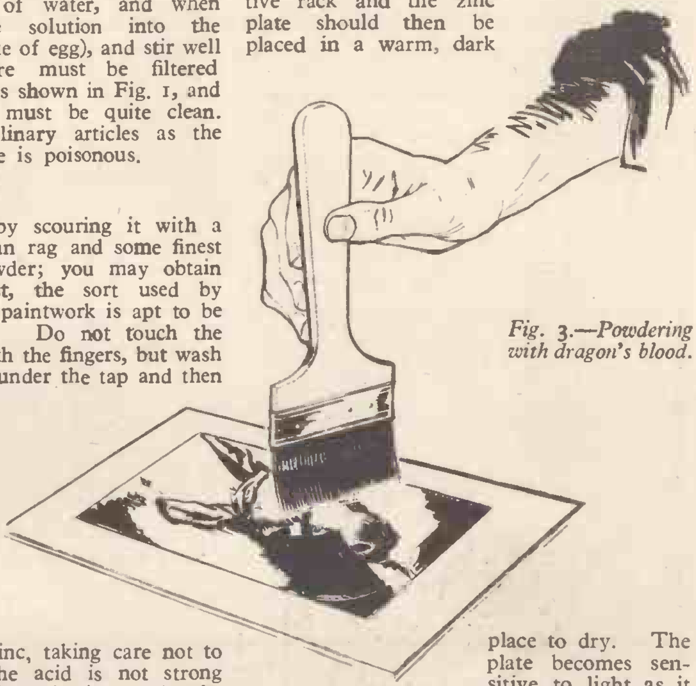


Fig. 3.—Powdering with dragon's blood.

The Exposure of the Negative

When the zinc plate is quite dry, but not before or it will stick and spoil the negative, warm the negative slightly to make sure that it is quite dry. Place the zinc and the negative (film to film, of course) in an ordinary printing frame.

The exposure must be found by trial and error, and should be about one minute in full sunlight, but it may take half an hour or more on a dull day.

Plate Development

When the exposure is completed the zinc plate is taken into a darkened room and covered with Litho printing ink; it should be thinned down on a slab with a little turpentine to the consistency of cream, and applied with a roller. The object is to cover the zinc with a thin film of ink; the surface should be of a dull olive green colour if the inking is correct; if very black, the ink is probably applied too liberally. After rolling with ink, the plate is warmed slightly (not more than hand warm, or it will be spoilt) and left for a few minutes in the dark to dry the turps out. It is then laid under the tap or placed in a dish of water. After a few minutes the film of ink should begin to lift, owing to the albumen washing away where the light has not acted, leaving a perfectly sharp reproduction of the original picture on the zinc. If the ink all washes away, the exposure was insufficient but if it does not wash away at all, either the exposure was excessive, the plate was overheated, or the ink too thick to allow the water to reach the albumen. The zinc plate may be mopped over with wet cotton wool to assist the development, but if rubbed too hard the ink may smear.

After the development is complete, shake off as much water as possible and dry the plate by heating gently, and while still warm and dry, dust the surface of the plate with finely powdered bitumen, applied with a loose pad of cotton wool. Wash off the surplus bitumen under the tap, at the same time wiping over with wet cotton wool to remove every trace of bitumen from the bare zinc. Dry the plate by gentle heat as before, then place it on a gridiron and heat strongly until the bitumen and the ink fuse together, giving a glazed appearance to the black parts. When nearly cool, paint the back of the plate and the edges of the front up to within ½in. of the work with shellac varnish and the plate is ready for etching.

The Etching Process

Dilute nitric acid is used for zinc etching; for the first bath mix 1 part of strong acid (this need not be pure and the commercial quality will do quite well) with 26 parts of water. Place the plate in a photographic developing dish several sizes larger than the plate, pour the acid solution over and rock the dish to and fro fairly vigorously, so that bubbles do not collect on the zinc. Keep the surface of the zinc bright by brushing over with a camel hair mop from time to time; the plate need not be removed from the bath for brushing. After about two minutes in the acid bath, the plate should be removed, rinsed and mopped under the tap and then dried off over a gas stove. An examination of the plate at this stage will show the lines, etc., standing up in slight relief; but it is impossible to continue the etching until the plate is deep enough for printing, because the acid will attack the sides of the lines and etch them away.

Four-way Powdering

To prevent this the sides of the lines must be protected. Obtain an ounce or so of "Dragon's Blood," which is a sort of resinous powder obtainable from the address

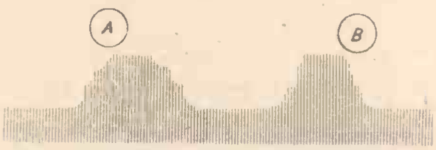


Fig. 4.—Before and after the finishing etch.

mentioned earlier; also obtain two flat camel hair brushes about 3in. wide as used by photographers. Spread a large sheet of newspaper on a table and put a small heap of dragon's blood on the paper; now with one of the flat brushes brush the dragons' blood across the plate from left to right. This will bank it against the left side of the lines. Brush off the surplus from the background with the clean brush, working the brush from left to right only, then heat the plate over a gas stove until the bright red dragon's blood powder fuses up against the lines and turns to a much deeper colour. This protects the left side of the lines.

When cool the plate is brushed again, but from right to left this time, then heated again exactly as before, thus protecting the right-hand side of the lines; repeat the procedure, dusting from top to bottom and heating, then cool off, dust from bottom to top and heat again. This series of operations is called "four-way powdering," and the result is to protect the sides of the lines from the action of the acid.

The Second Bath

The plate is now ready for the second bath, for which the acid should be diluted in the proportions of 1 part acid to 12 of water. Place the plate in this bath, rock and brush as before until the zinc between the lines becomes clean and bright. Do not continue the etching after this or the lines themselves may become attacked by the acid. Take out the plate, brush it over under the tap and dry it, then powder again four ways as before. The third bath may be about 1 part acid to 10 of water and the plate should be etched in this for about five minutes.

The zinc plate will require at least another four-way powdering and a fourth acid bath, say about one part acid to six of water, before it is deep enough for printing. The acid is now fairly strong and care should be taken not to get it on your clothes. Also, if it gets on your fingers, rinse it off as soon as possible, or it will leave a yellow stain. About 10 to 15 minutes in the fourth bath should give sufficient depth for printing. The plate should then be cleaned off with a mixture of methylated spirits and turpentine and a proof can be pulled.

An examination of the sides of the lines with a magnifying glass will show a series of steps as illustrated in Fig. 4 at A. As these steps sometimes show in the proof it is usual to give the plate a "finishing" etch to smooth off the shoulders of the steps. To do this the plate is thoroughly cleaned with hot soda solution, dried and rolled over lightly with a roller and litho printing ink.

The inked plate is then dusted with powdered bitumen, the surplus bitumen being washed off as after the development of the print. The plate is then heated until the bitumen becomes glazed, and when cool is ready for the finishing etch; acid as used for the first bath will do for this, rock the dish and brush gently for one to two minutes, leaving the lines as shown in Fig. 4 at B. If you carry this too far, the lines will become "underbitten" and ragged.

Shed and Garage Building Materials

(*Concluded from page 230*)

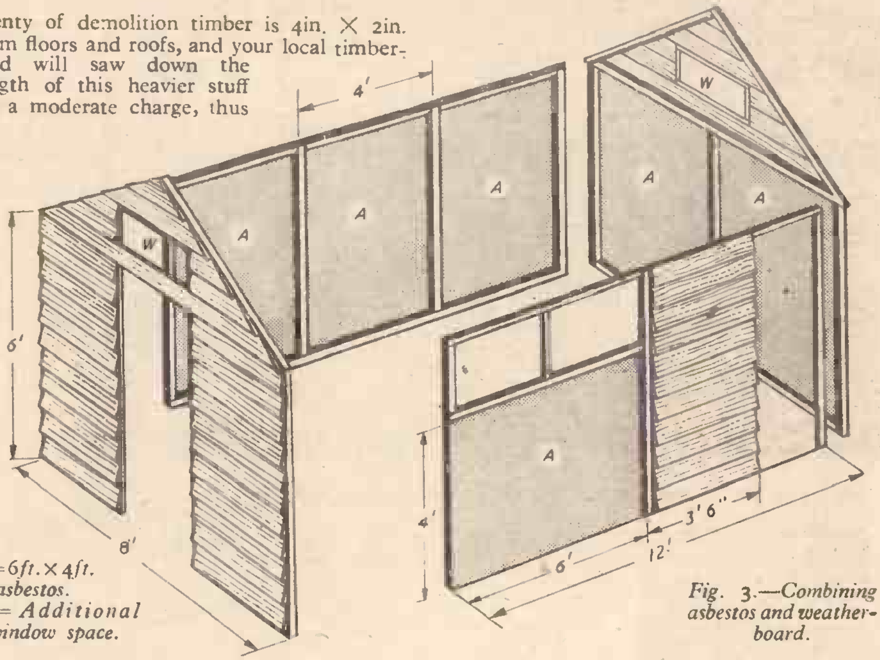
This method reduces outside maintenance to a minimum but allows for gable ends, door and window sections to be fitted easily with weatherboard. One end and one side, not fitted for door or window, are covered with 6ft. × 4ft. asbestos sheet.

Second-hand Materials

Demolitions are a fruitful source of material for shed construction. Demolition is invariably going on somewhere or other in most districts. Ask the foreman on the site if any material is for sale—he is often authorised to dispose of it personally, or he may refer you to his firm's office.

In addition to all kinds of timber, guttering, drain pipes, doors and window frames are but a few of the many items which can often be acquired at a fraction of their present-day value.

In this connection, it is worth while noting that most of the framing of a sectional building is of 2in. × 2in. wood. Plenty of demolition timber is 4in. × 2in. from floors and roofs, and your local timber-yard will saw down the length of this heavier stuff for a moderate charge, thus providing a quantity of 2in. square section very cheaply.



A=6ft.×4ft. asbestos.
W=Additional window space.

Fig. 3.—Combining asbestos and weatherboard.

STANDARD BUILDING MATERIAL SIZES

Asbestos—flat ...	8ft. × 4ft., 6ft. × 4ft.	
„ corrugated	2ft. 6in. width, 3in. corrugation, lengths 5ft. to 10ft.	Expensive.
Galvanised iron ...	2ft. 3in. width, lengths 5ft. to 10ft.	

The householder's main problem before commencing any job is invariably how to get the maximum result from the minimum outlay. It is hoped that these notes have made some contribution towards solving this problem.

VIBRATING RECTIFIERS

The Various Types Discussed

By J. L. WATTS

FOR charging accumulators, electro-chemical processes and many other purposes direct current is required. There are various types of rectifiers which may be used to obtain direct current from alternating current supply mains, one of the least known types being the vibrating rectifier.

Essentially this consists of a vibrating switch which opens and closes its contacts in synchronism with the A.C. supply so that a contact is closed during the half cycles when the A.C. supply is in one direction and opened during the other half cycles when the supply is reversed. Fig. 1 shows the arrangement and connections of one type of full-wave rectifier, which depends on the

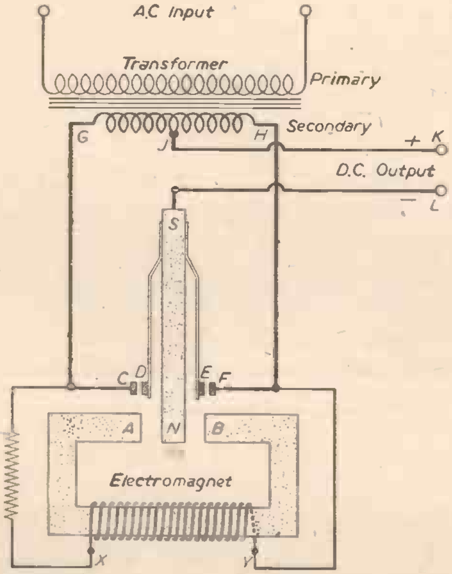


Fig. 1.—One arrangement of a vibrating rectifier.

fact that poles of unlike magnetic polarity attract each other, whilst poles of like polarity repel each other.

The coil of the electromagnet is fed from the single-phase A.C. supply through the centre-tapped secondary winding of the transformer, and acts on a light pivoted magnet N-S which carries the contacts D and E on light springs. During the half cycles of the A.C. supply when G is positive and H negative the poles A and B of the electromagnet will have north and south magnetic polarity respectively. The north (N) pole of the pivoted magnet will then be repelled by A and attracted by B, so that the pivoted magnet will swing to the right to close the contacts E and F. The output terminal L will then be connected to the negative pole H, so that half the secondary voltage of the transformer will be applied to the terminals L K from H J. As the A.C. voltage falls to zero the electromagnetic pull is reduced and the pivoted magnet swings back to open the contacts E F. After passing through zero the A.C. supply then reverses so that the end H becomes positive, causing the pole B to have north magnetic polarity and A to have south polarity. The magnet then swings to close the contacts C D, thus connecting the output terminal L to the negative pole of the A.C. supply again. Assuming that the moving magnet system is sufficiently light this will vibrate with the same frequency as the A.C. supply, in which case the output terminal K will be maintained positive to L during both halves of the A.C. cycles.

It is, however, necessary to take into account certain practical points. The moving contacts D and E are mounted on flexible springs and are normally arranged to close just after the magnet has moved from its mid point, the contact springs being slightly compressed as the magnet completes its swing. Contact is then maintained almost until the magnet returns to its mid point. The D.C. supply to the terminals K and L is discontinued during the instants after the contacts C D have opened until the contacts E F close and vice versa. This period can be adjusted by mounting the fixed contacts C and F on screws, by which means the rectifier can be arranged so that the circuit is only completed to the terminals K L after the A.C. voltage has risen to a value equal to the back E.M.F. of an accumulator which it may be desired to charge.

Effect of Inertia of the Vibrating System

It is advisable that the vibrating magnet should pass through its mid point when the A.C. voltage is zero; and should have maximum displacement from the centre position when the A.C. voltage has its maximum or peak value. Thus the best results are obtained by using a vibrating system which has a natural frequency equal to that of the A.C. supply. The oscillations of the magnet can then be kept practically in phase with the alternating current voltage wave.

Fig. 2 shows the effects of inertia of the vibrating system. If the contacts are adjusted equally about the mid point they will break circuit at equal intervals after and before the magnet passes through its mid points U and V. The vertical distances A-B, etc., of the dotted curve in Fig. 2a represent horizontal displacements of the magnet from its mid position. When the contacts close at the instant A, the output voltage at the D.C. terminals will immediately rise to the value A-W, and the voltage will have fallen to the value C-J when the contacts open at the instant C. All the contacts will be open between the instants C and D, during which instants the output voltage will be zero. With such a setting of the fixed contacts the output terminal voltage will be as shown in Fig. 2b. It will be noted that the output voltage then contains a small reverse voltage due to the lag of the vibrating system.

This reverse voltage can be eliminated from the output terminals by adjusting the

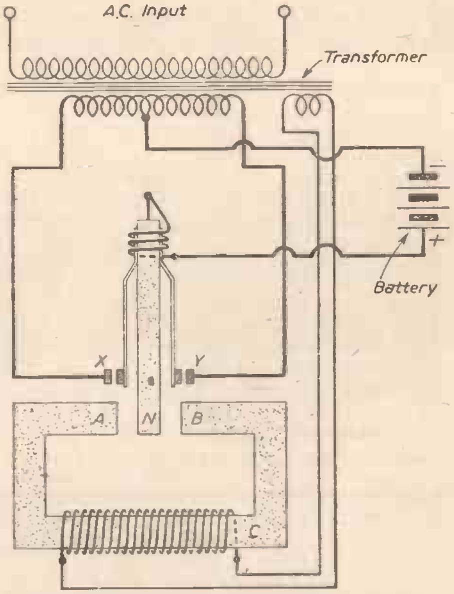


Fig. 3.—One arrangement of a battery-charging vibrating rectifier.

fixed contacts so that the moving contacts touch them for shorter periods. Thus, if the contacts are adjusted to close at the instants L and M and to open at the instants N and F, the voltage at the output terminals will be completely unidirectional as shown in Fig. 2c. This adjustment may, however, reduce the average output voltage slightly. In addition the shorter periods during which the contacts are closed will result in them closing at instants when the A.C. voltage has an appreciable value, so that a high value of current may rush through the contacts as they touch. This may cause sparking and burning of the contacts.

Vibration in Phase with Voltage

It will thus be seen that an important feature of a vibrating rectifier is that the vibrations shall be as nearly as possible in phase with the A.C. voltage. If the natural frequency of the vibrating system is the same as that of the A.C. supply, the vibrating system will then act as though it had zero inertia, and the electromagnet will then only require to create sufficient pull to overcome the slight frictional losses at the contacts and pivot. In some cases the vibrating system is suspended by means of a flat spring. A disadvantage of using a vibrating system of the same frequency as that of the A.C. supply is that the rectifier is then only

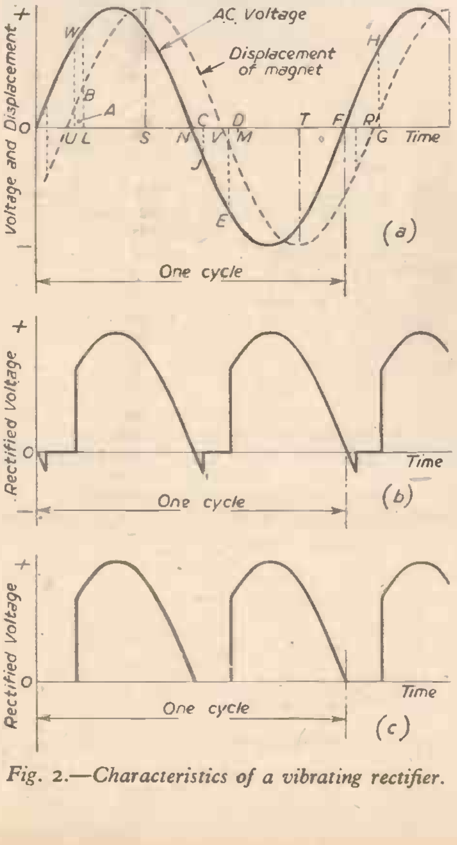


Fig. 2.—Characteristics of a vibrating rectifier.

suitable for that particular supply frequency; and trouble may be experienced if the frequency of the vibrating system alters, as may occur due to a screw working loose, or wear of the contacts. The natural frequency may, however, be adjusted by means of a very small weight, which can be screwed up or down like the pendulum of a clock.

Vibrating Rectifier with Soft Iron Armature

Practical difficulties in using a permanently magnetised vibrating system are that a permanent magnet of sufficient power tends to be heavy; furthermore continuous vibra-

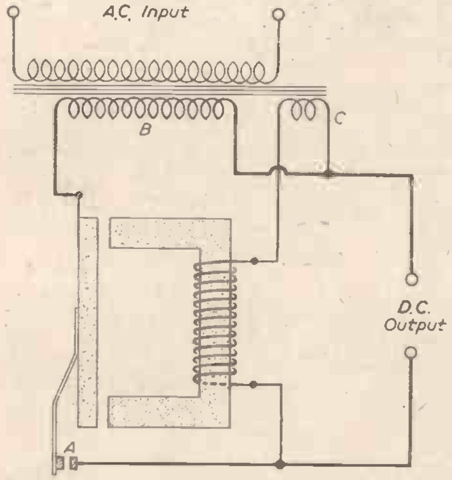


Fig. 4.—Another arrangement of a vibrating rectifier.

tion tends to destroy the magnetism. These difficulties may be overcome by using a light soft iron armature which can vibrate inside a fixed coil connected to the output D.C. terminals. Unlike a system in which a permanent magnet is employed the polarity of the output terminals cannot be predetermined when a soft iron armature is thus used. When the A.C. supply is switched on to the rectifier coil the armature will be attracted in one direction, but the direction will depend on the polarity of the residual magnetism in the soft iron armature, as well as the polarity of the A.C. supply at the instant of switching on. The energising coil of the armature is connected to the D.C. output terminals, the connections being such that the energising coil will assist the residual magnetism when the armature starts to vibrate; thus the D.C. terminals will retain the polarity they acquired at the instant of switch on until the rectifier is switched off again.

When such a rectifier is used for battery charging, therefore, the battery should be connected to the output terminals just before switching on the A.C. supply. This ensures that the armature will be magnetised by current from the battery, with a fixed polarity as determined by the battery connections. When the A.C. supply is switched on the direction of the armature movement will be determined by the polarity of the A.C. voltage at the instant the switch is closed. Assuming that the internal connections of the rectifier are correct, the rectified output at the D.C. terminals will then be maintained of the required polarity for charging the battery, whichever way the battery has been connected.

Other Types of Vibrating Rectifier

Various arrangements can be used in vibrating rectifiers. One design employs a fixed permanent magnet, with a vibrating armature of soft iron which is magnetised by alternating current. The construction of this rectifier is somewhat similar to that of a small spark coil, the primary and secondary windings of the transformer being wound on a straight core consisting of a bundle of soft iron wires. Thus the magnetic flux in the transformer core passes partly through the straight iron core and partly through air. The vibrating armature lies parallel to the transformer core, and is thus magnetised by the alternating magnetic flux passing along the armature. The armature vibrates between the poles of a U-shaped permanent magnet.

P.M. Armature Rectifier

Fig. 3 shows a rectifier having a permanent magnet armature, its magnetism being augmented by the charging current of the battery which is passed through a fixed coil surrounding the top of the armature. The connections are such that the armature is attracted to the left when the contact X is positive, and to the right when Y is positive.

The rectifier shown in Fig. 4 has a soft iron armature which is acted upon by an electromagnet which is energised by a coil which has A.C. and D.C. component currents. The coil is fed from the D.C. output terminals through an auxiliary secondary winding on the transformer. When used to charge a battery the auxiliary secondary winding is designed to develop a peak voltage approximately equal to the voltage of the battery, as shown in Fig. 5. During one half of each A.C. cycle the voltage of the auxiliary winding thus assists that of the battery so that a comparatively high current flows through the electromagnet coil. Consequently a considerable attractive force is exerted on the armature, so that it closes the contacts A to connect the main secondary winding B of the transformer to the battery and charging current flows. During the other half cycles of the A.C. supply when the input voltage is reversed the voltage of the auxiliary secondary winding C opposes the battery voltage and reduces the current through the electromagnet coil. Since the secondary voltage of C never exceeds the battery voltage, the coil current always flows in the same direction, but is a pulsating current. The coil current has maximum value when the A.C. voltage is in one direction and falls practically to zero when the A.C. voltage reaches its peak value in the reverse direction. The armature is thus attracted to close the contact A for one period during each complete A.C. cycle, charging the battery by half-wave rectification as indicated in Fig. 5.

When used to supply a purely resistive circuit, a vibrating rectifier can be arranged to close its contacts practically as soon as the A.C. voltage has reversed, giving a unidirectional, but pulsating, current through the D.C. load circuit. The average value of the voltage applied to the D.C. circuit will in all cases be less than the peak value of the A.C. voltage applied to the

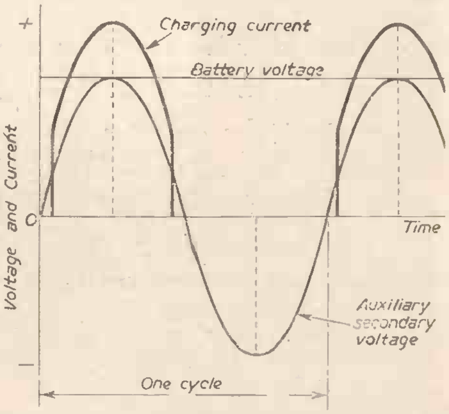


Fig. 5.—Characteristics of a battery-charging vibrating rectifier.

rectifier contacts. If the rectifier can be arranged so that its contacts remain open for a split second only, the average value of the D.C. output voltage might be about 75 to 85 per cent. of the rated value of the A.C. voltage applied to its contacts. For battery charging, however, the contacts must remain open for a longer period until the A.C. voltage has reached a value at least equal to the voltage of the battery, otherwise reverse currents may flow from the battery. Charging current will thus flow for only part of each A.C. cycle. Thus a fairly high A.C. voltage should be applied to the contacts of a battery-charging rectifier in order to charge the battery in a reasonably short time. The A.C. voltage may be about twice the battery voltage. If required the charging current can be controlled by means of tappings on the transformer windings, or by connecting a variable resistor between the rectifier and battery.

PUZZLE CORNER

Spare a Copper

THERE were five collection boxes in a church, each begging money for a different purpose. We will call them, a, b, c, d, and e. Here are some facts about them.

(1) In all the boxes there was a total of 30s.
(2) In a and b there was together 6s.
(3) In b and c there was together 10s.
(4) In c and d there was together 14s.
(5) In d and e there was together 18s.

With the particulars supplied can you say what was in each box?

Answer

a+b+c+d+e=30s.

Also, a+b+b+c+c+d+d+e=48s.

Subtracting, b+c+d=18s.

And as b+c=10s. it follows that d=8s.

We are told that d+e=18s. Therefore e=10s.

Also c+d=14s. Therefore, as d=8s., then c=6s.

Similarly, a=2s., and b=4s.

Another Old One!

THREE tourists go into a guest-house and stay overnight. The next morning, on enquiring for the bill, the maid-of-all-work says, "It will be 10s. each." The tourists pay, and the girl takes the money to her boss.

"You have asked them far too much," says he. "The correct charge is not 30s., but 25s. Take this 5s. back." The girl, however, is somewhat shrewd. She knows that the tourists did not quibble at paying 10s. each, and were not expecting any change. The odd 5s. might just as well go into her pocket. But it would not do if her boss got to know that she didn't give any change, so she compromised with her conscience by giving the tourists 3s. change and kept 2s. herself.

Thus, the tourists have paid 10s. each and got back 1s. each, i.e., they have paid 9s.

Three at 9s. equals 27s. The girl has 2s.
Total ... 29s.

What has happened to the other shilling?

Answer

Work it out another way. We know for a fact that the girl has 2s. The tourists have 3s. and the boss has 25s. Total 30s.

The correct charge is 25s. for the three, i.e., 8s. 4d. each. With the extra shilling rebate this is 9s. 4d. Three at 9s. 4d. equals 28s. This, with 2s. for the girl, totals 30s.

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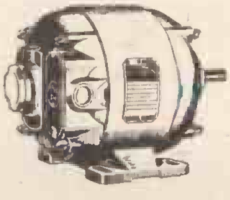

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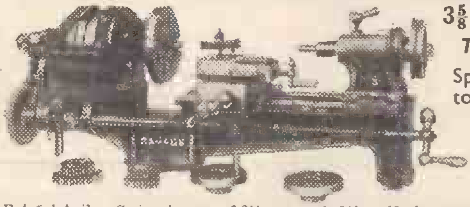

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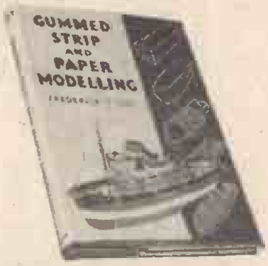

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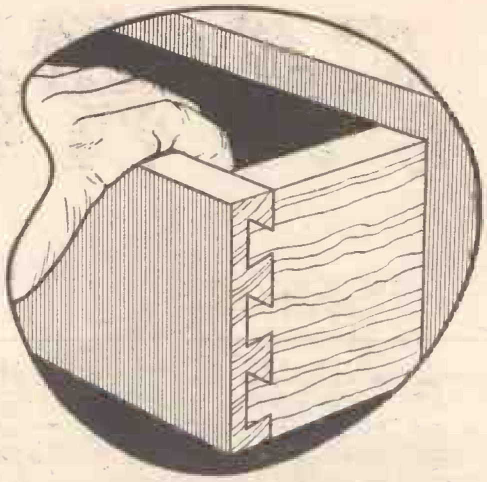
Woodworking Joints

No. 1 of a Short Series for the Junior Woodworker

By W. J. Stannage



IN this series of articles it is proposed to give details of the construction of the main joints used in woodworking projects, and the tools used in their making. Here we shall deal with the halved joint which is extremely useful when not-too-particular jobs must be done. Typical examples of these jobs are racks for the workshop, kitchen cupboards, etc., where the more complicated joints are not strictly necessary.

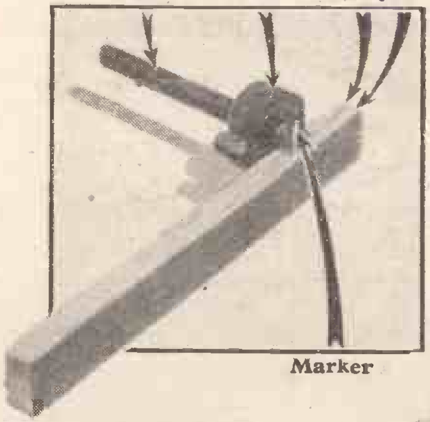


Fig. 1.—Marking depth with a gauge.

Marking Gauge

Fig. 1 shows the marking gauge in use and it will be seen that the tool is employed to mark the depth of the joint. The gauge consists of three main parts, the stem, the fence and the marker. It will be found that the fence is fitted with a screw which holds it in position against the stem. When setting the gauge, this screw is slacked off and the fence moved until the distance from the marker to the front face of the fence is equal to half the thickness of the wood. The main parts of the marking gauge and the position of the line it scribes are clearly shown in Fig. 1.

The marking gauge can only be used with the grain or across the end grain and the method of holding it can be seen in Fig. 2. Note that there is an angle formed by the top face of the wood and the lower face of the stem. This angle is by no means critical, but should be in the region of 45 deg. The angle is determined by the amount of marker projecting through the stem, so this should be adjusted accordingly.

Both sides of the timber are marked in this manner, also the end; that is, a mark is made across the end grain.

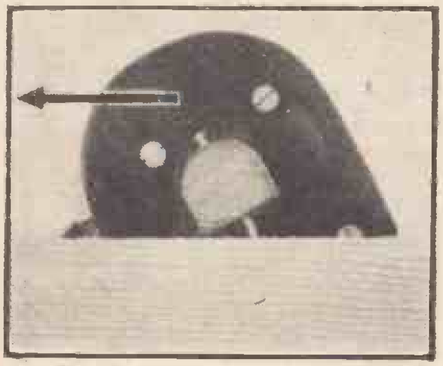


Fig. 2.—Head on view showing tilt of gauge. The arrow shows direction of movement.

Using the Try-square

To mark the length of the joint—which is equal to the width of the timber—the try-square is required. This consists of a blade which is riveted through the stock, and the tool in use is illustrated in Fig. 3. The stock must be held firmly against the timber to ensure that the blade sits at 90 deg. across the wood. The required distance is, of course, set off with the rule. When the square is in place the shoulder line is marked against the blade with a sharp knife.

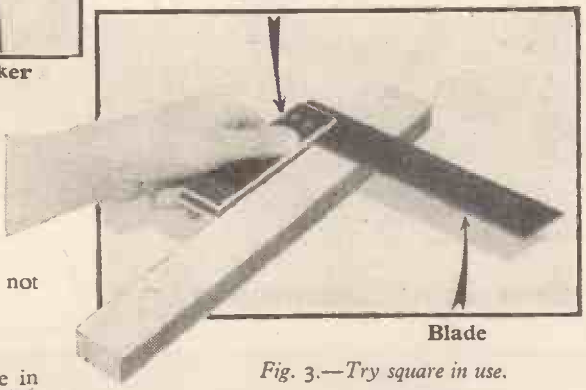


Fig. 3.—Try square in use.

Fig. 4 shows two pieces of timber marked off ready for cutting.

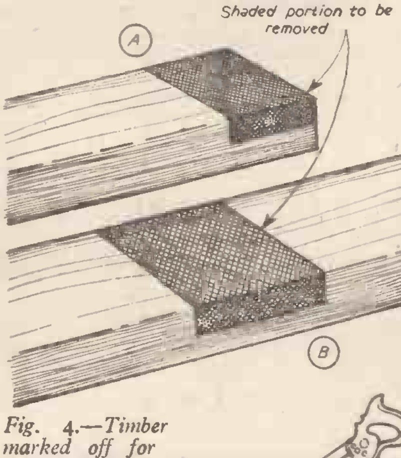


Fig. 4.—Timber marked off for cutting.

One half of the joint—A—is at the end of the timber, and the other half—B—is in the centre of the wood, and this forms a typical joint in many construction jobs. The shaded portions in the drawing must be removed and we will deal with "A" first of all.

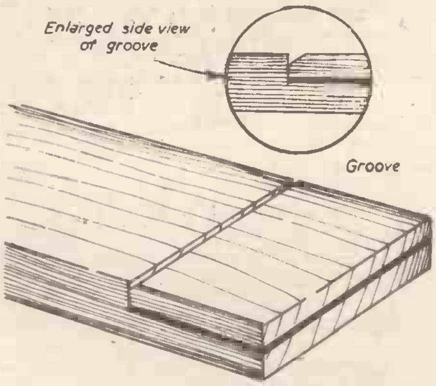


Fig. 6.—Groove cut with chisel to guide saw.

Sawing the Joint

Sawing must be done on the waste side of the line, and to achieve this it is a good idea to aim at leaving the guide line still showing, but only just. The saw required is a tenon saw which has a firm blade, strengthened by the strip of steel or brass along the back. The timber is clamped in the vice and cutting commenced at the furthest corner as seen at "A" in Fig. 5. While cutting, the saw handle is steadily lowered until it is horizontal, as shown at "B," and then lowered still further until the position shown at "C" is reached. At this stage the job is reversed in the vice and the operation repeated until finally the cut is finished as shown at "D."

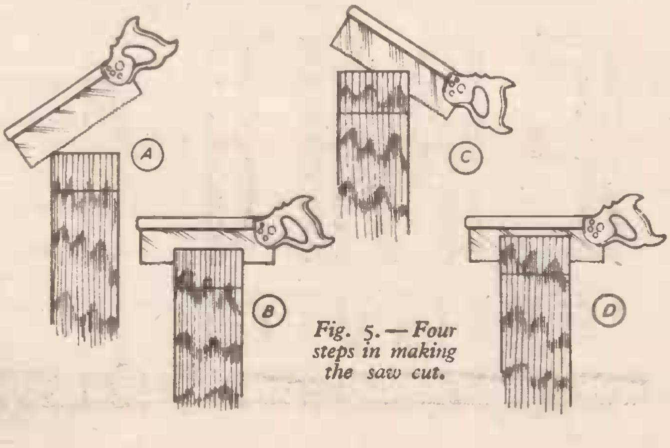


Fig. 5.—Four steps in making the saw cut.

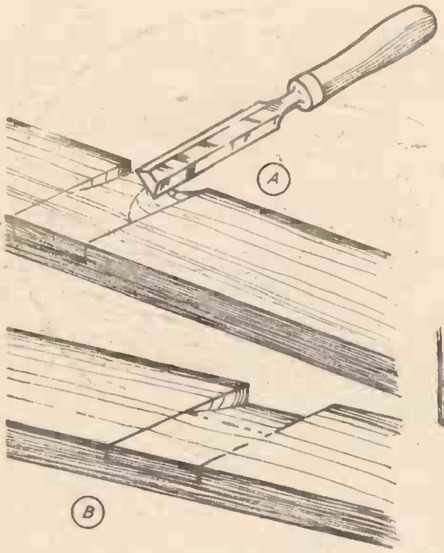


Fig. 7.—Removing waste.

The next operation is to cut a groove along the shoulder line as shown in Fig. 6. Particular attention is drawn to the enlarged view which shows the groove in greater detail, and it will be appreciated that again the actual cutting is done on the waste material which will be removed and that the rear face of the groove is at 90 deg. to the face of the timber. Cutting is again done with the tenon saw. A cut is made down to the lines marked with the gauge and when this point is reached the waste material will fall away. If cutting has been done as close to the guide lines as is practical there will be very little cleaning up to be done. However, a certain amount will be necessary if the joint is to be close fitting and this operation requires a bevelled chisel. A keen edge and light strokes will remove the still-remaining surplus and reduce the cut-away section to the required final dimensions.

For the second part of the joint ("B," Fig. 4), two saw cuts are required. Two grooves are cut with the chisel to guide the saw as previously described and the two saw cuts made down to the gauged lines. The bevelled chisel is used to remove the waste as illustrated in Fig. 7 "A." The first cuts are made at an angle starting at the outer edge and working towards the centre. It will be noted that no attempt is made at this stage to cut the full distance across the wood. Working in this way the cutting is progressively deepened until the position shown at "B" is obtained. The work is then reversed and cutting commenced from the other side. The result of this is to leave a "hill" of wood in the centre of the joint, the sides of which slope away to the gauged lines. This "hill" is now cut away starting at the highest point and working down to the required depth which will result in a flat base or bottom to the recess.

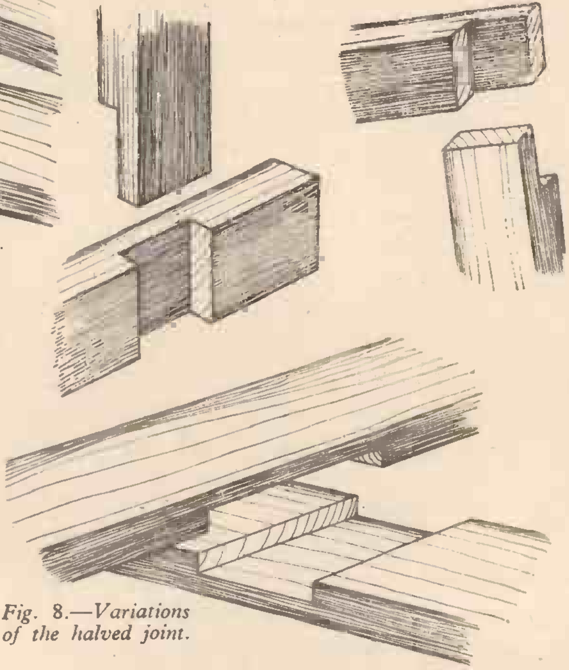


Fig. 8.—Variations of the halved joint.

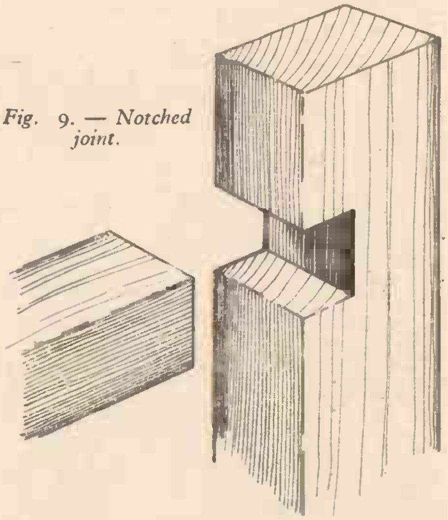


Fig. 9. — Notched joint.

At this stage the two halves are tried together, and any final adjustments made. The idea is to have both pieces of timber flush. Fixing is done with glue and wood-screws which should be of the countersunk variety. Joints such as these are usually specified as "halved, glued and screwed."

Although we have covered only one variety of this particular type of joint, there are several as will be seen from Fig. 8. All have their own place in constructional woodwork, but in each case the method of marking out and cutting is the same.

Not unlike the halved joint is the notched joint which can be used when it would be impractical or unnecessary to employ the halved variety. It is quickly and easily made and is much stronger than a plain nailed joint which is frequently used in the rougher carpentry jobs. Fig. 9 shows a simple type of notched joint. It will be obvious that only one piece of timber must be cut, in fact all we require is a simple notch wide enough to house the second piece of timber, and deep enough to give it some support. A joint of this type is usually only skew nailed, but the addition of glue will add greater strength.

(To be continued.)

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SAILING model boats is a favourite pastime with boys of any age and at any time of the year, and in London the Round Pond in Kensington Gardens is a rendezvous for all kinds of model boat enthusiasts.

The all-electric cabin cruiser shown in the photograph is radio controlled and the transmitter with aerial erected can be seen on the bank. The boat is called the "Jackie" and has a helmsman who moves his arms and is equipped with a searchlight.

Model boat enthusiasts in Kensington Gardens.

Computor Built by Schoolboys

SIXTH form boys at St. Albans School are building an electrical computor, which works on a relay system comparable with the set-up of a telephone exchange. Construction of the 5ft. high machine is being supervised by the assistant mathematics master, and many parents have helped to provide parts for the machine, which is valued at £75.

The photograph shows some of the boys who built the computor, also the machine itself. A fuse is being replaced in the power pack by one of the younger boys.

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(Continued on next page)

(Continued from previous page)

A RING GAME

Fig. 1.—Details of the completed board.

An Amusement for the Whole Family

THE board shown in Fig. 1 is simple to make, strong and light in weight. The material used is 3/16in. plywood and a sheet somewhat larger than the 14in. square used for the board should be obtained. The waste plywood can be cut into strips 14in. × ½in. to form the border.

The positions of the hooks are marked out as shown in Fig. 2 and each position drilled. The edging strips are then glued and pinned in position, using very fine nails. If the corners are mitred, the appearance is improved.

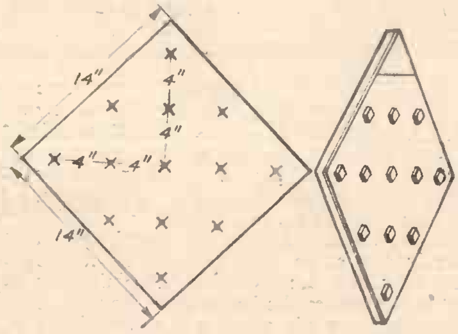


Fig. 2.—Marking out for drilling and supporting blocks.

Small blocks of wood about 1in. square and ½in. thick are glued behind each drilled hole in the board so that the hooks may be screwed into them, as shown in Figs. 2 and 3. A somewhat larger block is fitted at the top corner, providing a fixing for the top hook and the wall hanger, as shown in Fig. 3.

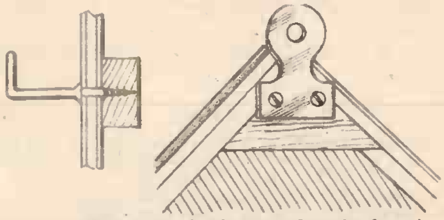


Fig. 3.—Fixing the hooks and plate for hanging.

Before the hooks are screwed into place the board should be painted and numbers painted in the positions shown in Fig. 1. Rubber rings 2in.-2½in. in diameter should be used. Needless to say, the idea of the game is to score more than your opponent by throwing rings over the higher numbers.

Making a Small Kite

A Smaller Version of the Giant Kite Described Last Month

By J. WYNER

LAST month's kite design is undoubtedly a very fine one, but some readers may wish to make something not quite so large, and so a smaller version, but one using the same principle, is described here.

In Fig. 1 are given details of the smaller kite which can be made from a single width of 36in. calico. It should be hemmed at the top and bottom, but will not need a cord in these hems. The sticks can be of either very light bamboo, strips of deal or some carefully selected round dowel sticks of about 5/16in. dia. The side stays can be ½in. tape sewn to the cloth, and here the greatest care must be taken to make them all exactly equal in the length. For attaching the corners and middle of the side to the sticks the largest of dressmakers' hooks can be used. These can be hooked tightly into the ends of bits of brass tube pushed tightly over the ends of the sticks. A single bridle only will suffice for a kite of this size, although the use of two secondaries and a primary bridle is to be recommended. A lighter material, such as a very light cambric, would be preferable.

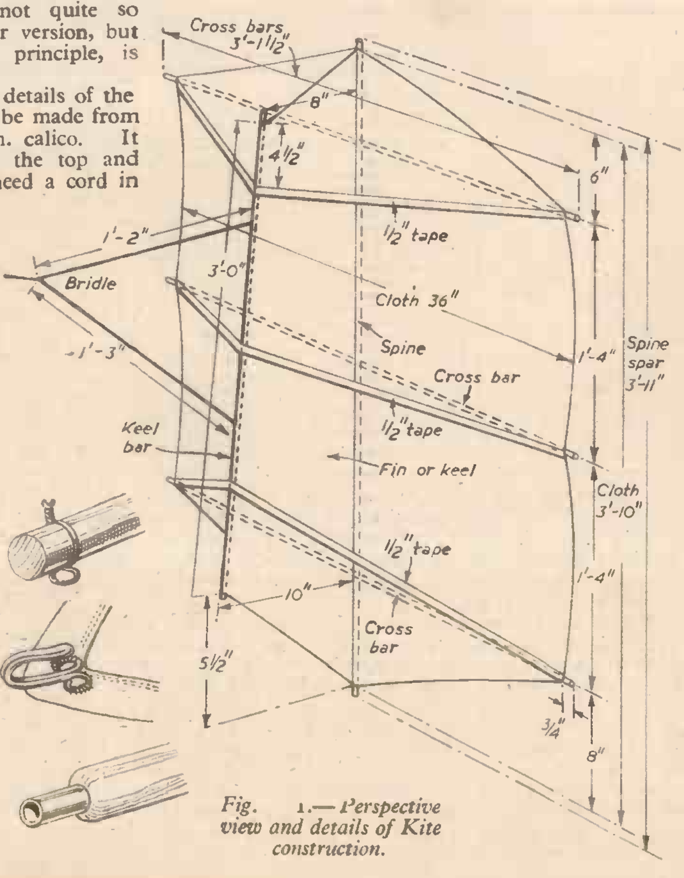


Fig. 1.—Perspective view and details of Kite construction.

Before making this smaller kite it is suggested that last month's article describing the giant kite should be read, as construction and particularly flying is described in detail.

Try These on Your Friends!

Leap Frog

DRAW ten squares side by side in a row on a sheet of paper and, starting at the left-hand end, number each square from one to ten.

Having done that, get out four pennies and four halfpennies. Arrange the pennies on the squares numbered 1, 3, 5 and 7 and the halfpennies on 2, 4, 6 and 8.

What you have to do is to manœuvre the coins so that in the end the halfpennies are together on squares 3, 4, 5 and 6 and the pennies together on squares 7, 8, 9 and 10.

Here are the rules. Two coins must never be on the same square and each move must be made by lifting two coins that are side by side. Can you do it?

The Answer

Here are the moves:
2 and 3 go to 9 and 10.
5 and 6 go to 2 and 3.
8 and 9 go to 5 and 6.
1 and 2 go to 8 and 9.

The Pile of Pennies

IF you had a neat pile of pennies stacked up on the table and then stood a shilling on its milled edge against the stack, how many pennies do you think would rise as high as the shilling? Understand that you are comparing the diameter of the shilling with the thickness of the pennies.

The Answer

Fifteen average pennies.

Letters to the Editor

Address letters to The Editor, "Practical Mechanics," Tower House, Southampton Street, London, W.C.2.

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

Danger for the Amateur Astronomer

SIR,—You might like to publish the following on your "Letters to the Editor" page.

We are frequently asked for equipment to be used with a telescope to reduce the sun's light sufficiently for direct eye viewing. It cannot be too strongly emphasised that an amateur should *never* under any circumstances look at the sun through any telescope, modified or not. Tinted glass is most unreliable, because the darker it is the better it absorbs the sun's heat (which is focused with its light) and is very likely to splinter instantaneously without warning before the observer's eye can be withdrawn.

Two tinted glasses in line have been suggested, the breakage of the first likely to give sufficient time to withdraw the eye before the second also breaks, but with this equipment both have splintered simultaneously (or melted), and observers have been permanently blinded.

There is a "sun diagonal" in use before the eyepiece for professionals, but even here there is a risk of a blinded eye, or possibly both from sympathetic action, is not worth the risk. The sun's disc should ALWAYS be projected on to a stiff white card placed some distance (say, 12in. to 18in.) behind the telescope, shaded from direct light, in which case the focusing position might require alteration.—SEREN ASTRONOMICAL MIRRORS (Ruislip).

Hub Dynamo Failure

SIR,—With reference to the query by A. J. Osman, of Kent, in December issue of PRACTICAL MECHANICS, the poor light is most probably due to failure of the rectifier (filter switch unit) due to corrosion.

This unit is used in conjunction with dry batteries (which are not rechargeable) and merely acts as an automatic cut-out in the following manner: Current from the dry batteries supplies the lamps until the voltage from the dynohub rises to a value higher than that supplied by the batteries, when flow from the batteries ceases. The rectifier is used to prevent drainage of the batteries on the reverse half cycle.

I suggest that Mr. Osman removes the battery case from his bicycle and returns it to the makers for repair. In the meantime he can connect the existing wires so that the dynohub supplies the lamps direct.

I have had the same trouble in the past!—R. S. SMITH (Cambridge).

Casting and Foundry Work

SIR,—In PRACTICAL MECHANICS December issue, Mr. G. M. Heathete requires information on casting and foundry work.

If he will write to Messrs. Foundry Services. Ltd., Long Acre, Nechells, Birmingham, for parting media, degasers, fluxes and refractory washes, Messrs. Fordath Engineering Co. Ltd. for sand, core compounds, etc., Messrs. James C. Waterhouse, Ltd., Soho Works, Wakefield, Yorks, for pots, fireclay and blacking, he will find the above firms in sympathy with the modest requirements of the amateur foundryman. The range of assistance and information given is wide, and the cost of the goods supplied in the small quantities required by the amateur is very reasonable.

Should Mr. Heathete require any further assistance *re* his foundry, I shall be pleased to help him via the Editor of PRACTICAL MECHANICS. I would also add that the production of castings in iron, brass and aluminium can be carried out in the home workshop. Only very modest equipment is required, production is only a matter of hours. The resulting castings are a delight to cut and work.—J. C. HAMLIN (Amersham).

Home-made Fireworks—Caution

SIR,—With regard to the article on indoor fireworks, the author mentions the unstable nature of potassium chlorate and the dangers of its use. This point cannot be stressed too deeply, $KClO_3$, is a highly temperamental compound and can literally explode without provocation; younger people should never be allowed to use it. Also the author mentions using barium nitrate and antimony sulphide, both these compounds are Schedule 1 poisons, highly dangerous, and should be treated with the greatest respect.—R. FAGAN (Bradford).

[*The manufacture of explosives is prohibited by Section 4 of the Explosives Act 1875 except at a licensed factory.*—ED.]

Tanning a Sail

SIR,—What Mr. K. Spink, who wants to tan a sail, probably requires is "cutch." This dye is used in preserving fishing nets and is a deep tan. Messrs. Sunrise Networks, of Lowestoft, use to be importers of "butel" from the East.—R. STEPHENS (Swansea).

SPACE STATION CONSTRUCTION

SIR,—William Ellwood, in his article on space satellites (page 138 December, 1957, issue), mentions a rather controversial point. He stresses the ease of construction of a space station once all the parts have been successfully brought into orbit, owing to the fact that girders, metal sheets, etc., will be virtually weightless and, therefore, easily manipulated. He omits, however, a very important fact. True, the space operator will not have to contend with the actual weight of the girders and other things much too heavy to move on earth without cranes, but these objects still have mass. So in order to move them the operator must use sufficient force to overcome the inertia of the object, which can be quite great if the object has large mass.

This, though, is only part of the difficulty, for once set in motion it will continue moving under the momentum it has been given and will need just as much force to stop it in its required position. With this in mind, then, it is quite possible that "lifting" mechanisms such as winches and pulley blocks will be invaluable. Another difficulty here presents itself, for the person or appliance pulling will have to be anchored to another part. As soon as the necessary force is applied, both the part being "lifted" and the anchorage will move, velocity being imparted to them in inverse proportion to their masses.

In addition, parts fitting perfectly upon Earth might be most difficult to bolt together in space owing to the fact that one surface would be receiving radiated heat from the Sun while the other experienced the almost zero of space. They would, therefore, suffer from distortion due to unequal expansion and contraction.

The best cure may be to subject each part to rotation, which could be easily maintained.—L. G. GREEN (Peterborough).

The Speed of Light

SIR,—Re Mr. Newton's query (December issue) on the fundamental nature of the velocity of light may I suggest he might find it interesting and his questions answered if he read a little on the special theory of relativity. Simply it states that a change in the motion of an observer does not produce any change in the velocity of light as measured by the observer, this was first observed in the Michelson-Morley experiment.

With regard to his statements on the Russian satellite, Mr. Newton interchanges the terms frequency and speed in a way which suggests he is uncertain about the true connection between them. The speed of a light wave (or radio-wave) is the product of its wavelength × frequency, and thus a change in frequency is accompanied by a corresponding change in the wavelength and does not necessitate a change in the speed of the wave.—R. FAGAN (Bradford).

More About the Speed of Light

SIR,—I would like to discuss some points in the letter entitled "Is the Speed of Light Fundamental?" which appeared in the December issue of PRACTICAL MECHANICS.

In my opinion the speed of light *as such* is not fundamental. It certainly can be varied—e.g., the speed of light is less in water or glass than it is in air.

There emerged, however, from Einstein's theory of relativity a fundamental velocity—299,860 km/sec. By a lucky coincidence this velocity was approximately equal to the velocity of sound in air.

Now if the theory of relativity is true, a body travelling with a velocity greater than the fundamental velocity mentioned above leaving one place would arrive at a second place some distance away before it had actually left the first place!

Now since the theory of relativity has been fairly well established it would be ridiculous to think that a body could go faster than this fundamental velocity. So nothing can go faster than light. (The Michelson-Morley experiment, which detected no difference in the velocity of light sent out from the earth in two directions at right angles, seems to verify this.)

F. J. Newton, in my opinion, arrives at a wrong conclusion from a misunderstanding of the Doppler Effect. It is the frequency of the note emitted by the moving body and not the velocity of the sound itself which changes due to the relative motion of the body and the observer.—T. G. MCCANN, B.Sc. (Co. Antrim).

★ ★ ★

SIR,—In reply to the letter from Mr. F. J. Newton in your December issue concerning the speed of light, I would like, if I may, to give an account of the reason for the belief in the fundamentality of the speed of light.

In a famous experiment by two scientists named Michelson and Morley of the United States, carried out in 1887, they projected a beam of light in the direction of motion of the earth in space, while at the same time projecting one at right-angles to this. They assumed that the time taken for the light to travel and be reflected over an identical distance would be less in the case of that moving with the earth, due to the speed of the earth (about 19 miles a second) in orbit round the sun.

That experiment, and all those carried out subsequently, showed that there is no discernible difference. The reason for this was suggested by Henrick Lorenz of Holland and George Fitzgerald of Ireland at about the same date. They deduced that as the average speeds of the two light beams must have been different and as the time taken for both journeys was found to be identical the only possible theory was that the two journeys must, in some way, not have been equal.

In 1905, when Einstein published his theory of relativity he suggested that the speed of light is constant in relation to an observer under all conditions, and nothing can vary it. Thus, whatever happens to the light source an observer will always get the same result if he measures its speed. This he suggested was due to the fact that all bodies shrink in the direction of their motion, this shrinkage being exactly proportional to their speeds, and as all the observer's instruments will be shrinking it will be impossible for him to obtain any measurements of variation in speeds of light beams which may be due to the movement of that beam's source.

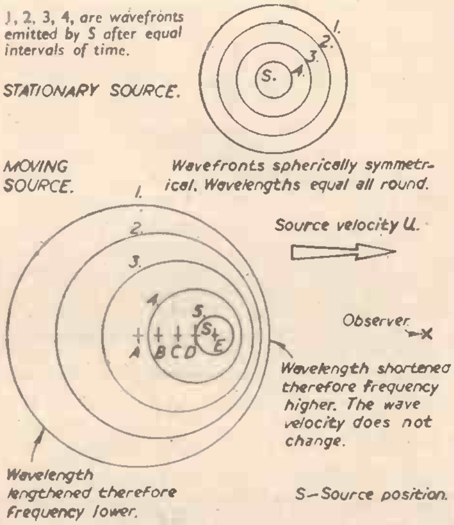
Thus, no matter how the source of a ray of light or a radio wave may move, no matter how its direction may change, it is not, and according to the theory of relativity never will be, possible to obtain any measurement other than the standard speed of light taken as the well-known figure of 186,000 miles a second.—COLIN A. FOSTER (Hove).

★ ★ ★

SIR,—Regarding Mr. F. J. Newton's query on whether the velocity of light is fundamental, in the December issue of PRACTICAL MECHANICS.

Mr. Newton seems to have been misinformed as to the cause of the frequency change as a moving source of sound (or electromagnetic radiation) passes a stationary observer.

The velocity of electromagnetic radiation



1, 2, 3, 4, 5, are the wavefronts emitted by the source at successive positions A, B, C, D in the line of motion at equal intervals of time.

Mr. J. M. Jenkins' diagram.

in free space and the velocity of sound in air, under given conditions, are constant.

The frequency change is brought about by a change in wavelength, the reason for which will be made apparent by the diagram above.

The apparent frequency is related to the stationary frequency by the following easily proved relation $f^1 = f\left(\frac{v}{v-u}\right)$

where f = stationary (true) frequency
f^1 = apparent frequency
v = wave velocity
u = velocity of source towards observer (reckoned as a velocity of approach) u will be −ve for recession.

I hope that this explanation will satisfy Mr. Newton.—J. M. JENKINS (Reading).

★ ★ ★

SIR,—In reply to F. J. Newton's query as to the fundamentality of the velocity of light I would like to put forward a rather different view in support of the constancy of light's velocity.

The theory of relativity showed that: 1, All mass equals energy. 2, A mass contracts in the direction of its motion as it approaches light speed, and at this speed it will be infinitely thin and infinitely heavy. Both of these are calculated on the assumption of constant velocity of light and are virtually proof of this.

Max Planck originated the Quantum theory of energy in radiation such as light and so if we think of these packages of light energy as the ultimate building bricks of matter we have another reason for accepting light's velocity as a fundamental constant.

If we assume that in the process of creating matter pure energy existed first, then we are concerned with energy units in motion. Such motion will be fundamental and immeasurable; it will just be a constant alteration of position.

According to Newton's first law of motion these units will not alter their comparative velocities because no force exists to do this.

When these units encounter mass they are freed to form circuits since their linear velocity cannot be retarded, and this gives mass inertia.

By accelerating a mass to light speed these units, by being of constant velocity, have no choice but to break circuit and form into a straight line—hence the contraction. The increase of mass is accounted for because at near light speed more energy is needed to form a circuit than is necessary to accelerate the mass as a whole—hence the difference in energy equivalents.

By creating circuits the overall velocity is reduced due to confinement of the constant velocity to a smaller space, like coiling up a hose pipe, the overall path of the energy being the same.

In emitting radiation waves the velocity of the source is of no consequence since the energy units are *released* at their natural velocity, not fired as from a gun.

And lastly the speed of light is not governed by time and space but by Newton's first law of motion. Time and space are dependent upon light's speed for their own existence since light is the physical quantity, although Einstein worked it out by the other way.

The energy unit may be described as follows:

1. It is a unit of "substance," and is indivisible.
2. It moves at a constant rate relative to other units of energy.
3. Mutual collisions give it a "work producing capacity."
4. Being fundamental it has no structure—hence no inertia.
5. Having no inertia linear acceleration is impossible.

Therefore radiation energy units must have a *constant linear velocity*.—R. B. TAYLOR (Kent).

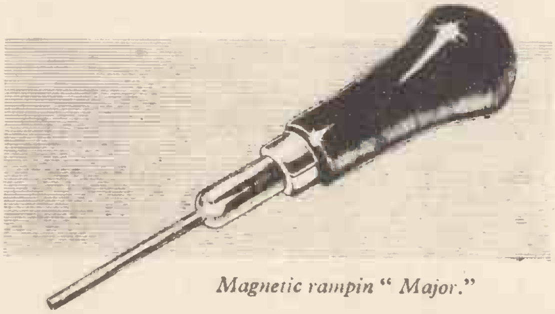
★ ★ ★

TRADE NOTES

A Review of New Tools, Equipment, etc.

Magnetic Ram for Panel Pins, etc.

THE very efficient magnetic ram shown below is obtainable from A.B.P. Supplies, 5 and 7, Ravenswood Crescent, West Wickham, Kent, price 6s. 11d. Small nails and panel pins can be quickly and effortlessly inserted into the most awkward corners by placing the pin in the barrel, and pushing. The idea of the magnetic rampin is to hold the pin in the barrel enabling it to be used in any position, leaving one free hand. A smaller version of the tool, the "Minor," designed for inserting veneer pins, retails at 5s. 11d.



Magnetic rampin "Major."

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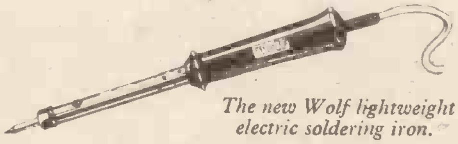
OF entirely new design, the Wolf No. 92 lightweight (3oz.) model soldering iron has been developed to meet the requirements of continuous small assembly and instrument work in the radio, television and electronic fields.

The element is wound on a flat mica strip and folded with an interposing mica insulating piece. It is then encased in mica and enclosed within a rectangular section steel casing.

The dull, nickel-plated copper bit is designed for easy replacement, being secured to the barrel by means of a special locking nut. A split moulded handle is used, with all terminals easily accessible. The cable and sleeve are securely clamped into position and an earth symbol, permanently marked, conforms to various international regulations. Slots are provided in the chromium-plated barrel to ensure that the temperature of the handle is maintained within comfortable limits. The soldering iron is ideally suitable for all intricate industrial and amateur requirements. Available for all standard voltages, the price is 22s. 6d.



The new Wolf lightweight electric soldering iron.

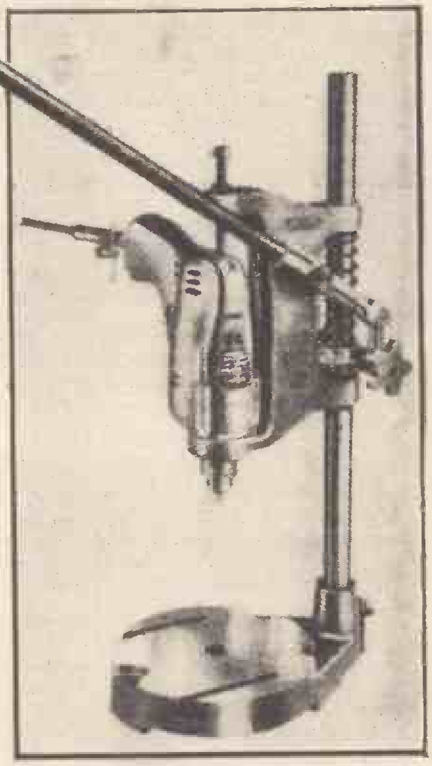
The appearance of the new lightweight soldering iron can be seen in the sketch above.

Multi-purpose File

SPECIALLY designed for the handyman, this file can be used on plastics, formica, bakelite or metal. It is produced by John Peace (Steel & Tools) Ltd., Algoma Works, Sheffield, 3, and is available from most tool stockists.

Extra Heavy Drill Stand

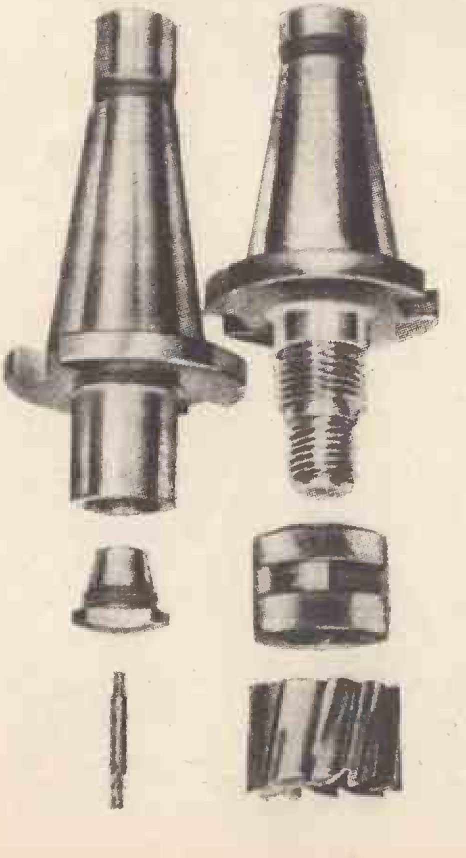
FOR those Wolf "Quartermaster" or Wolf Cub owners who require a heavy duty drill stand, a special adaptor collar is now available to enable the use of the Wolf "ESO" Drill Stand.



The Wolf drill stand.

Robust in design, this stand will enable the user to drill to a maximum depth of 3in. with complete accuracy. The base table is 7in. in dia., the maximum distance from chuck to base table is 10in. and maximum distance from pillar to twist drill centre, 4¾in. The power unit has free vertical and radial movement, operation being by means of a lever feed. The price of the "ESO" Drill Stand is £5 10s. The special adaptor collar, Part No. 13061, retails at 2s. 6d.

Screw-locked Milling Holders and Arbors



MADE by the Sheffield Twist Drill & Steel Co., Ltd., Summerfield Street, Sheffield 11, and marketed under the trade name "Dormer," this holder and arbor are available together with a comprehensive range of cutting tools.

As shown in illustration, the Dormer Heli-matic holder is very simply assembled. Two types are available; the one shown, with a solid nut for general slotting and milling, where both sides of the cutter are in contact with the work, and another, with a split nut for profiling, etc., where only one side of the tool contacts the work. Three sizes are available to accommodate screwed shank end mills, slot drills, Woodruff keyseating cutters and T-slot cutters from 1/16in. to 2in. dia., with shanks from ¼in. to 1¼in. dia. The complete holders range in price, according to size, from 47s. to £11 2s.

The Dormer Heli-matic arbor comprises two parts only (see photo) and is available in four sizes. Shell end mills up to 6in. dia., solid face mills up to 6in. dia. and inserted tooth face mills up to 9in. dia. can be accommodated. Prices range from 78s. 6d. to £12 14s., according to size.

The holders, arbors, screwed shank tools and screwed bore cutters are available from the usual engineers' tool suppliers.

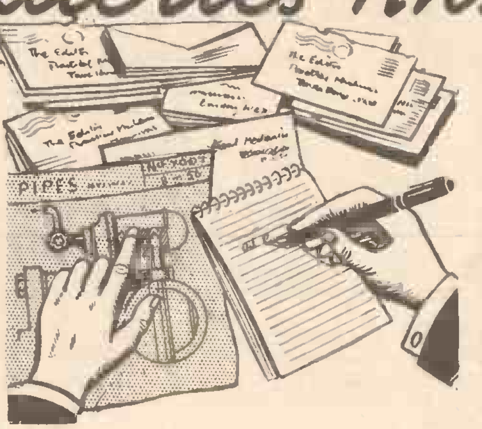
(Left).—The Dormer Heli-matic holder and arbor.

"Eclipse" Tools

FROM James Neill & Co. (Sheffield) Ltd. we have received a catalogue of the "Eclipse" tools manufactured by them.

The tools described and illustrated therein include hacksaw blades and frames, saw sets, trammel heads, bit gauges, many types of saws, scribers, surface gauges, tap wrenches, pin tongs and vices, vee blocks and clamps, angle plates, tool bit holders, and many others.

Your Queries Answered



Duplicator Fluid

IN using a full colour duplicator, there is a fluid one has to use on the pad which damps the paper that is pressed on the prepared master sheet. This fluid dissolves a little of the coloured ink that has been pressed on to the master sheet from the impregnated coloured sheets provided and so reproduces the drawing or writing.

Can you please tell me the nature of this fluid, so that I can mix my own ?—Rev. W. E. Dalling (Barry).

THE paper-damping fluid which you describe can be imitated by the following formula: water, 10 parts (by vol.), industrial, methylated or surgical spirit, 3 parts (by vol.), glycerine, ½ part (by vol.), Lysol, a few drops. The ingredients can be purchased from a local pharmacy.

Resilvering Mirror Painting

I HAVE a mirror with an oil painting on the glass but the silvering is in bad condition. Is it possible to remove the silver and have it resilvered without damaging the oil painting ?—G. Daniels (Sunderland).

TO protect the painting during the process of re-silvering the whole of the painted side of the glass may be coated heavily with Brunswick Black. After resilvering, the black may be redissolved and entirely cleared away by washing with cotton wool and turpentine freely applied.

If you have the mirror resilvered you can leave the removal of the old silver to the firm to whom you take it.

Capacitor Flash

I HAVE a battery-operated flash-gun using 2-unit cells (giving 3 volts). I would like to convert this to capacitor-type. Can you give me the circuit ?—J. Parkin (Edinburgh).

A RESISTOR of roughly 5,000Ω is required, and a condenser of 25v. working, 25μF, if space is important, or 50v. working, 50μF, if this is not important. These parts may be obtained from radio shops or Coventry Radio, 189, Dunstable Road, Luton, Beds. A 22½v. deaf-aid type battery is usual. Connections are: positive on battery to one end of 5,000Ω resistor. Second tag of resistor to positive on condenser and one synchro-flash contact. Negative tag of condenser to one point on flash-bulb holder. Second flash-bulb contact to negative on battery and remaining synchro-flash contact. The bulb should only be inserted shortly before it is to be fired.

A 50μF condenser will usually fire two bulbs in series, if required to do so.

QUERY SERVICE RULES

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

Replating Batteries

PLEASE tell me how to extract the plates of a car battery, also the address of firms who would supply new plates and components for replating 12-volt batteries.—J. Turnbull (Stockton-on-Tees).

IN order to remove the plates from a car battery the cells should first be emptied and the lead bars which connect the cells in series should then be removed. The latter operation will entail drilling down with a ⅜in. drill into each terminal post, making sure that the hole is dead central with the terminal post. The lead bars can then be prised off. The pitch sealing compound round the edges of the lids should then be cut or melted out. The plates can then usually be prised out of their cells by means of a lever under the bridge between the plates, the lever resting on a piece of wood on the edge of the cell.

We would advise you to apply to the makers of the batteries, if known, for new plates and links, etc.

Sealing compound may be obtained from one of the following firms:

Berry Wiggins & Co. Ltd., Field House, Bream's Buildings, London, E.C.4.

J. F. Craddock & Co. Ltd., 47, Vincent Parade, Balsall Heath, Birmingham.

Wood Glue

I AM proposing to face two old-type panelled doors with mahogany-faced plywood. I have decided to polish the wood in its natural state without using any stain.

I do not wish to use panel pins for fixing because they will look unsightly.

Could you recommend a strong adhesive which would be suitable for the purpose? The doors are inside and will not be subject to weather conditions. — J. Holt (Accrington).

A POWERFUL glue for wood is "Aero-glue," obtainable at hardware shops. It is a glue containing plastic, and requires warming before use. Apply a thin, fluid coat to each surface, then allow to become tacky. Press the faces together and hold firmly in position until the glue is partially set. You can improvise a clamp for each panel, using a stout piece of wood of about the same size as the panel to distribute the load evenly between clamp arm and plywood.

Dirt and Damp-proofing Charts

I HAVE a number of instructional wall charts which I am mounting for use in a school technical department. How can I finish the surface so that they will not be stained by dust and fumes ?—A. Armstrong (Fife).

THERE are two alternative materials and methods of rendering your charts dirt and damp proof. The more simple of them is to give the whole surface two coats of strong size (very thin glue) allowing the first to dry before applying the second. Then, when the second is thoroughly dry, give a single coat of spirit varnish.

The second method is more costly and a little more trouble, but it is more permanent. Instead of the size use celluloid dope. This can be purchased but it can be made by dissolving transparent colourless celluloid in amyl acetate so that it becomes a viscous lacquer, like thin treacle. One coat of this will be sufficient if you wish to finish with spirit varnish, or two coats may be given and the varnish dispensed with. The very best results may be obtained with the cellulose dope by spraying it on to the charts and we recommend this if spraying apparatus is available.

Rust Remover

I AM intending to treat the underside of my car with protective paint, but first require to use a rust remover of the "Jenolite" type.

I have been told that phosphoric acid is the main base of these liquids. Could you please inform me what is the correct dilu-

tion for this and if any further additives are required ?—G. E. Patchett (Isleworth).

MAKE up your rust remover as follows: Orthophosphoric acid 35 per cent., water 30 per cent., ethyl methyl ketone 10 per cent., ethylene glycol 25 per cent.

The two last named ingredients can be obtained from Griffin & Tatlock, Ltd., Kemble St., W.C.2. After treatment and clearance of rust wash down with water and allow to dry, and then apply bituminous paint.

Redrawing Missing Boat Plans

I WISH to resume the building of a ship model after a lapse of time, and have discovered that of my set of plans I possess now only the "body" or "section" plan.

Please tell me how to draw from this plan the remaining "half-breadth" or "waterline" and "sheer" or "profile" plans.

I understand that the body plan is the master one, all other dimensions being calculated.—V. A. Cooper (S.W.12).

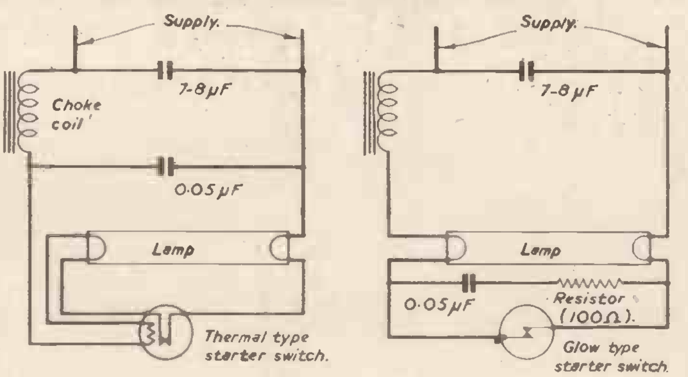
ALTHOUGH the body plan of a vessel gives all the lines of a hull in end elevation and cross section it does not give the length, and there is no means of calculating this from a body plan. If you can find out the length of the prototype, either on the load waterline or overall, then you can set out the sheer plan and half-breadth. On the body plan, the body lines are probably numbered or if not they ought to be. Suppose there are 20 lines, 10 forward and 10 aft, then having laid out the length in the sheer and half-breadth you must divide up the length into, say, 20 equal parts and draw cross lines at each division ; these will be the body lines, in side elevation and plan. Now, taking body line No. 1 first, with a compass or dividers, measure the distance from the hull centre line to the point where the body line cuts through the deck line and mark it off on the plan. Next drop to the top waterline and do the same with this ; do the same with the second waterline and again with the third, and so on down to the bottom waterline. Then go to the second body line and mark off on this all the intersections of the body line with each waterline ; then to the third body line, and so on, until all the body lines in the plan have little cross marks, which represent the intersections of the waterlines. Now with long curves or a flexible spline you must connect up all these intersecting lines on each separate waterline of the half-breadth plan. The only lines which will appear on the sheer plan will be the same waterlines, and these will be perfectly straight and horizontal. Over them will be laid the buttock lines, and these must be laid out by measuring up or down from the deck or keel on each of the waterlines on the body plan. These also will have to be completed on the sheer plan by curves.

We have said that the length may be divided up into, say, 20 parts. Actually the number of divisions, and they must, of course, be equal divisions, can be found by counting the number of lines in the body plan. There may be more than 20 or less. But there is one thing to look out for carefully: there may be a parallel interval in the length of the hull ; if there is there will be a gap in the numbering of the body lines. For instance, if the numbers run from 1 to 8 forward and 12 to 20 aft, then the portion from 8 to 12 will be straight and parallel amidship. Probably there will be no parallel part, and then it is a case of simple counting of the number of body lines. The body lines must be equally spaced in the sheer and half-breadth plans. If there is any sheer on the deck line this will be transferred to the side elevation of the hull (the sheer plan) with compasses transferring the measurements up from the top waterline at each body line.

Operating Fluorescent Tubes

I HAVE in my possession some 5ft. fluorescent tubes ; could you give me any details as to construction of chokes or equipment necessary to operate these tubes ? —F. C. Drawbridge (Wisbech).

WE presume that you refer to the 80-watt fluorescent discharge lamps. For each lamp you could construct a choke coil having a core built of Stalloy stampings approx. 0.014in. thick, the stampings being lightly insulated on one side. The core should have three limbs, the centre limb built up to a cross sectional area of 1.5 sq. in., whilst the cross sectional area of each of the two outer limbs should not be less than 0.75 sq. in. For use on a 240-volt 50-cycle supply, the centre limb should be wound with 1,200 turns of 25 s.w.g. enamelled wire, a layer of thin paper being wound over each layer of the wire ; tappings can be brought out from the coil for use on lower voltages if required. Air gaps should be left in each limb of the core. These air gaps should preferably be adjusted to give 115 volts across the lamp with a lamp current of 0.8 amp, starting with minimum air gap. The correct gap will probably be 0.02 to 0.025in.



Circuits using two types of switch.

A capacitor of 7 to 8μF should be connected in circuit to improve the power factor ; with another small capacitor of about 0.05μF to by-pass unwanted radiations generated within the lamp, which might otherwise cause radio interference. The lamps should be provided with either a thermal starter or a glow starter switch. The respective circuits are shown above.

Brass Lacquer

I MAKE brass vases, pots, etc. as a hobby, and on completion of manufacture buff and polish them to a high degree. I have not, however, been able to lacquer them with any success. I have sprayed on various lacquers both cold and thermal setting.

Is there some method of preparation after polishing, such as pickling ?—H. T. Altham (Bedford).

THE first and important thing to do before lacquering polished brass is to remove every trace of grease. Most metal polishes contain in their make up an oil or grease, especially those for buffing purposes. After polishing with ordinary metal polish apply Goddard's plate powder with water, rubbing well in. Allow to dry and then remove with clean, dry rags. For lacquer, a hot spirit lacquer may be used of the kind employed by optical instrument makers. The brass may be only warmed to a little above blood heat, say to 110 deg., and the lacquer applied with a large camel hair mop brush. This is the best treatment, but one which is easier to apply is a cold cellulose solution made by dissolving clear transparent celluloid in amyl acetate. This also is better applied with a brush than by spraying, but care must be taken that every part of the object is covered.

Renewing White Etched Lettering

THE depth of focus scale on my telephoto camera lens is engraved in white, which is beginning to wear. The background is black, and I would be grateful if you could suggest a method of renovating that could be attempted by myself.—F. S. Thomson (Mansfield).

THE engraved scales and lettering on such lenses are filled with white or black pigment, according to the colour of the ground, and the surplus beyond the engraving wiped off with a solvent after the pigment is dry. In your case we suggest that you paint the scale heavily, sufficiently to fill the engraving with artist's process white. It is made by Winsor and Newton, Ltd., sold in little glass pots by artists' colourmen and is a stiff body water colour. As carefully as you can, paint the engraving with this, using a very fine water colour brush. Allow the colour to dry thoroughly and then slightly moisten a piece of chamois wash leather, or the ball of your thumb, and wipe away any colour which you may have got on the surface outside of the figures or other parts of the engraving. The wiping material must be smooth, without fluffiness: even a clean handkerchief will not do and that is why we suggest the ball of the thumb. If the engraving is on metal breathing on it will provide enough moisture and a dry thumb will remove surplus white.

A flat oil colour can be used and would be more permanent, but if that is used turpentine would have to be applied to the thumb or to a wash leather.

BOSTIC D.I.Y. COMPETITION RESULTS

The competition set by the proprietors of Bostic 252 adhesive was judged by Mr. Peter Heard and Mr. F. J. Camm. The competitors had to make a list of new uses for this famous adhesive and large prizes provided the incentive. A large number of entries was received and in the result. prizes were awarded to the following :

1st Prize £400.—J. Stewart (Aberdeen).

2nd Prize £100.—J. E. Green (Malvern).

3rd Prize £50.—C. P. Abbott (North Leigh).

£5 Consolation Prize winners :

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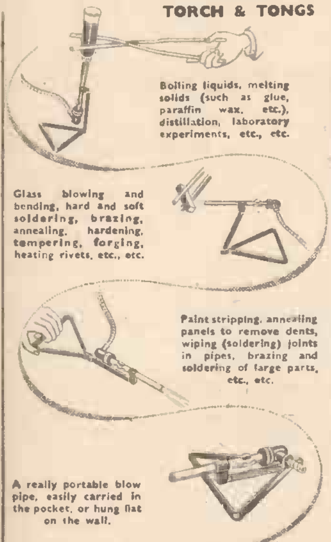

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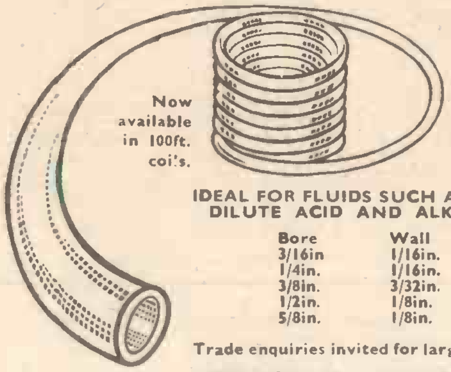

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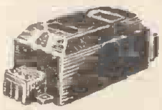

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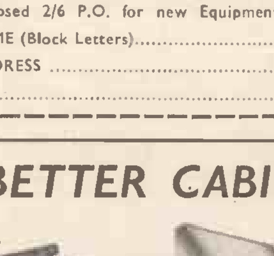

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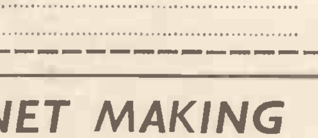

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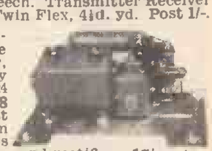

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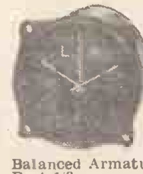

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Editor : F. J. CAMM

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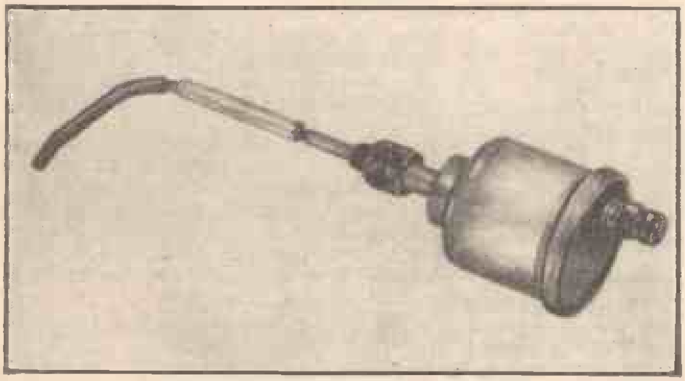
WHAT I THINK By F. J. C.

Automatic Tyre Pumps

IN the early days of pneumatic tyres punctures and bursts were frequent. You could not repair them yourself and they had to go back to the makers. This, of course, was before the days of beaded and wired edge tyres, even before the cycle valve had been invented by Woods. The covers were stuck to the rims and they were inflated through a small rubber tube and a football pump. There were many suggestions for inflating the tyre whilst the machine was in motion so that small punctures, which in those days were frequent, were not apparent until you stopped. Many patents were taken out, but none of them proved successful. Readers will remember that I tackled the problem a few years ago and finally produced an automatic pump which would inflate the tyre from zero to full pressure. It was at the time described in this Journal, and was also exhibited and demonstrated at various National Exhibitions. It consisted of a pump attached to the spokes, the upper end of the pump barrel being connected to the valve whilst the pump plunger was pushed up and down by a stationary cam attached to the wheel spindle. It was a pump weighing only 1¾oz. but was remarkably efficient. Many of you may have noticed demonstrations on the News Reels. It incorporated a pressure relief valve which could be adjusted so that when the right pressure was released in the tube the pump was cut out of action. That pump was tested by many well-known cyclists over thousands of miles and no trouble was experienced. This set other minds to work on the problem, and one of the designs marketed was the Nopal which you see illustrated on this page. This was attached to the valve and the plunger which was placed inside the tube and which had a flexible end was operated by the deflection of the outer cover at its point of contact with the road. Several thousands of these pumps were sold, but the makers withdrew it from the market because it was found that it would not inflate the tyre to full pressure and the very short stroke permissible in the design would not inject air to sufficient pressure to build up a safe riding pressure in the tyre. It would, of course, prevent the tyre from going dead flat, but it became inoperative once a few pounds pressure had been inserted. To inflate a tyre with an ordinary cycle pump can be quite an exhausting business. You have to build up in the body of the pump a pressure in excess of that in the tyre in order to force the valve rubber from its seating. You have probably noticed that a considerable part of a stroke of the cycle pump is used to build up this pressure and it is only during the last inch or so that air is injected into the tyre. With a short stroke pump such as the Nopal which is approximately ½in., more than half the stroke is wasted, so to speak, before sufficient pressure is built up to make the pump effective. In my tests of this pump I affixed a pressure gauge to the tyre and was able then to get a visible reading of the pressure obtained. With 5lb. pressure in the tyre it took over half a mile to build up a pressure of 10lb. and I was quite unable to inflate the tyre beyond that point. Therefore, if a cyclist has a puncture the tyre will deflate to below 10lb. pressure before the pump commences to inject air and in my view this is insufficient for safe riding and is certainly bad for the tyre. Remember also that the pump is continuously in action whether you have a puncture or not. The worst feature, however, was a very rapid local wear at the point where the cover operated the plunger. You may have noticed that the cover of a tyre wears at those points where ordinary patches or gaiters are fixed, but it is some thousands of miles before this becomes noticeable. With the tyre-operated pump, however, the wear is most rapid. It is for this reason, the makers inform me, that they withdrew it from the market and did not pursue it further. It is quite impossible for a pump of this type to deal with a puncture on the high pressure tyres now popular (70/90lb. per square inch).



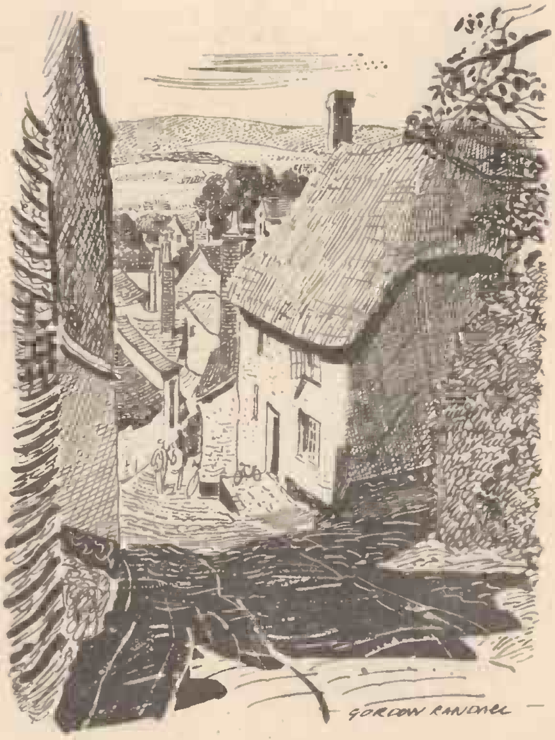
The Nopal automatic cycle tyre pump.

The fact is that the tyres to-day are most reliable and roads are so good that a puncture is comparatively rare, and when it does occur it is quite easily and quickly dealt with by means of the repair outfit which every wise cyclist should carry.

I am reminded of this matter by an article in a contemporary which shows readers how to make one of these automatic pumps, working on exactly the same principle as the Nopal. The author of the article claims that the pump will deal with small punctures quite satisfactorily, but I should welcome the opportunity of submitting it to a precise test and to report upon it.

More Cycle Lighting Legislation?

The Bill, which at the time of writing is before Parliament, intends to amend the Road Transport Lighting Act, 1957, and its main clause is to permit cyclists to fit amber reflectors on to the pedals. As far as I am aware it always has been legal to fit such reflectors and, indeed, such have been on the market for a long time. Surely it should not be necessary to make legislation "permitting cyclists to use them." The State has messed about with cycle lighting for so many years that I wonder what particular point now arises; as far as I can trace there is nothing in any of the Acts debarring a cyclist from fitting them. These permissive clauses need to be carefully watched for they have a nasty habit of finally being made compulsory and providing the police with further opportunities for pin-pricking prosecution. Of course, it is possible to read into existing legislation a meaning not intended by the architect of the Act, which does say that lights on vehicles, apart from dipping headlights, shall not be moved by swivelling, deflecting or otherwise whilst the vehicle is in motion. Perhaps when the act was framed pedal reflectors had been overlooked and the new clause is intended to put the matter right. No prosecutions have ever been brought on this score.



The old church steps, Minehead, Somerset.

Tandem Maintenance

Adjustable Bottom Bracket : Gearing : Tandem Wheels

MAINTAINING the tandem at home is no more difficult than looking after a solo machine, but there are a few tasks to be carried out which are not met with on the cycle. In addition there is the difference that a great deal of the equipment is heavier and more robust in view of the double weight to be carried.

The Adjustable Bottom Bracket

The drive is between the rear chainwheel and the rear wheel sprocket, the front chainwheel and cranks being linked to the rear by means of an extra chainwheel on the rear bottom bracket axle and a long chain, see Fig. 1. This long chain must have some means of adjustment to keep it taut, and this is by means of the front bottom bracket, which is shown in Fig. 2.

As can be seen, the bottom bracket assembly is set eccentrically in a larger diameter shell which, in turn, is clamped in the frame shell, this being adjustable by means of the two nuts and bolts underneath the bottom bracket.

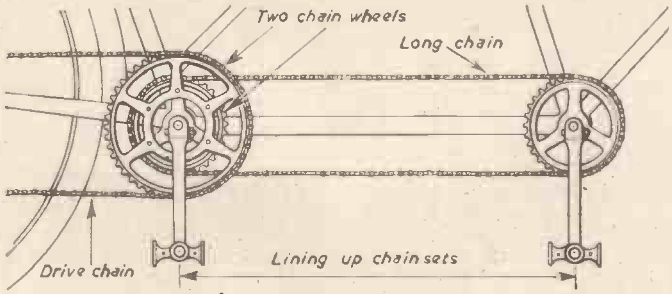


Fig. 1.—Arrangement of Chains and Chainwheels.

To tighten the chain, loosen the nuts on the clamping screws underneath the frame just sufficiently to allow the shell containing the bottom bracket assembly to be rotated in an anti-clockwise direction by means of a hammer and punch and the hole provided.

Fig. 2.—The adjustable Bottom Bracket.

The chain is loosened by inserting the punch and hammering the shell in a clockwise direction. When the correct adjustment has been obtained, the nuts underneath the frame are retightened.

Replacing the Long Chain

It will be obvious that this long chain is slightly longer than the 108-link length sold for normal cycle use and that an extra piece will have to be joined on. It should not be necessary to buy two chains if a good cycle dealer with a workshop on the premises is visited. In the course of his work he will have fitted a number of chains to ordinary cycles and is almost certain to have an odd length of new chain to extend the length of the chain purchased. Do not consider extending the length of the chain by means of a piece of old chain—it is never satisfactory. The two lengths of chain may be joined either by means of an extra spring link or a neater job may be made by means of riveting. When the chain is wrapped in place round the two chainwheels, make sure that the two sets of cranks are exactly in line. The easiest way to ensure this is to position both sets exactly vertical, as shown in Fig. 1.

Tension on this long chain should be about the same as is usual on a solo machine, i.e., about $\frac{3}{4}$in. play in the centre of each strand. It is worth taking a lot of trouble with this chain adjustment as if it jumps off at speed it has a tendency to jam between the two rear chainwheels, resulting possibly in their being buckled and the chain being broken.

Tandem Wheels

When having wheels built for a tandem, remember to obtain special tandem hubs. These are specially strengthened and are larger than the normal hubs; also a larger front spindle is used. The spoke holes too are designed to take tandem spokes, which should be of a larger gauge than usual. For a sporting tandem single-butted 12/14 gauge spokes can be employed, and on heavier machines plain 12 gauge. There is no need to use specially heavy rims for tandem wheels, unless it is proposed to carry a great deal of weight on the rear—pannier bags and saddlebag, etc. For normal riding and riders of average weight, 26in. or 27in. × $1\frac{1}{4}$in. Endricks are quite adequate. In the same way, heavy tyres are not necessary either, and the normal touring weight or slightly heavier tyre can be used, but not high pressure road racing tyres—tandem riding will wear them out very quickly!

Gearing

It is doubtful whether agreement will ever be reached between cyclists on the subject of gearing, but it is possible to make some very general observations about tandem gearing. A tandem, theoretically, has twice the power of a solo machine without twice the weight and road friction, which means that a higher gear is possible. This is true for a machine being ridden over a flat road or downhill, but uphill is a different story. The greater weight and longer wheelbase make a tandem harder to ride uphill than a solo machine. A compromise is therefore necessary and the gear which a great many riders find favourable is 72in. or 76in. The former is obtained by using a 48-tooth driving chainwheel and an 18-tooth rear sprocket, while a 76in. gear is obtained by using a 48in. chainwheel and a 17-tooth sprocket.

Wide-ratio variable gears are the most suitable for use on tandems, a very low gear being useful for hill climbing (something between 50in. and 60in.), and two others in

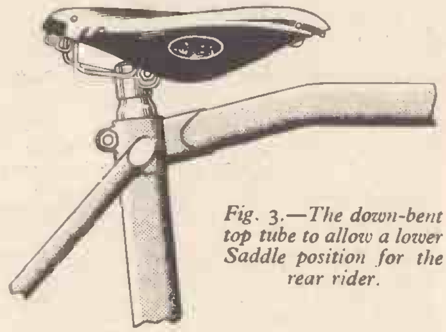


Fig. 3.—The down-bent top tube to allow a lower Saddle position for the rear rider.

the region of 75in. and 86in. for normal riding. When derailleur gears are used on short-based machines, it is not usually possible to obtain four gears. The chain length is too short to stand being bent so far out of line.

Frame Selection

Much depends upon the use to which a tandem is to be put. For long distance touring or club riding, in the author's opinion, only a "double-gent's" machine is suitable. The "lady back," owing to its design, has little rigidity. The different sizes of the front and rear riders can be allowed for by means of a down-bent top tube, as shown in Fig. 3. There are many frame designs all claiming their own advantages, and one feature frequently met with is the curved rear seat tube, to give a short wheelbase machine. The short base is useful for easy hill-climbing, racing or other fast riding, but tends to cause discomfort for the rear rider over a long distance. The "pottering" tourists will probably find themselves better suited with a longer wheelbase machine.

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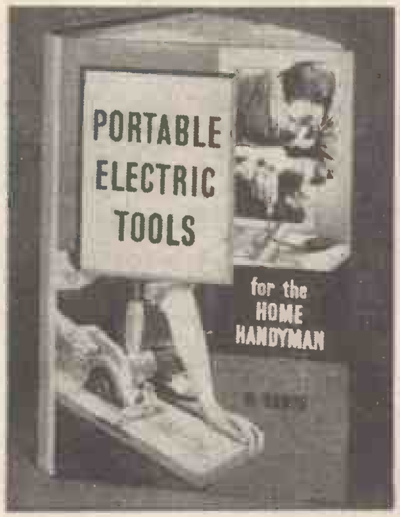

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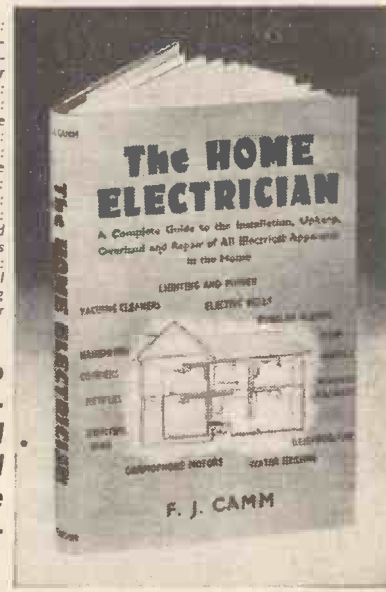

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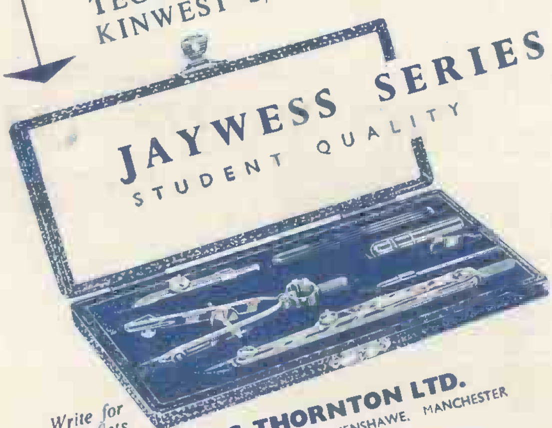

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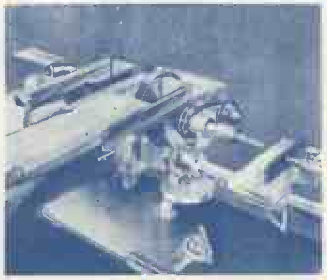

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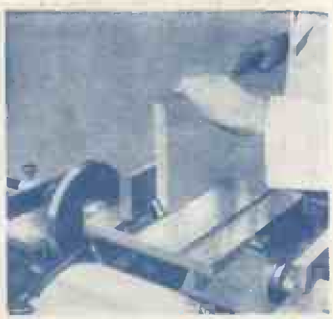

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