Practical MECHANICS

MARCH 1961

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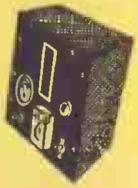
A SCRAPYARD CULTIVATOR

FOR THE PHOTOGRAPHER

REMOTE CONTROL FOR CAMERAS

FOR THE GARAGE

A HOME MADE BATTERY CHARGER



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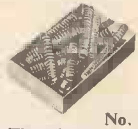

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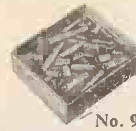

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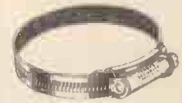

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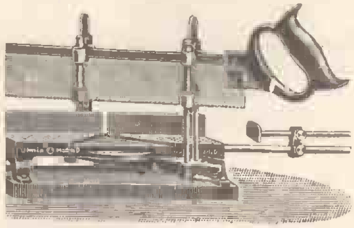

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CONTENTS

CONTRIBUTIONS

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

FAIR COMMENT

SCIENCE AND "PRACTICAL MECHANICS"

THIS is the Machine Age, the Age of Science, and man is continually reaching out for improvements in every field. As the tempo of living increases, he requires faster, smoother and safer transport, he requires quicker, cheaper and more reliable means of communication. His need for power and energy is ever increasing and there is a greater call today than ever before to end hunger, poverty and disease throughout the world. In spite of all this progress we have only just started to scratch the surface of knowledge of the world in which we live, and in this field too scientists are continually working and making new discoveries.

The speed of scientific discovery and development has been increasing since man first stood upright, and it is still increasing, and it is obvious that indirectly the results of all this increased knowledge are going to be passed on to the ordinary citizen in the form of a more complicated existence. More automatic machinery in the factory may eliminate a great deal of physical work, but it makes the job of the machine hand far more complex. Even if he is not expected to understand the new and complicated installation which he tends, a new band of maintenance engineers must be able to do so. In every technical field work is becoming more complicated: once any schoolboy could build the latest radio set but today an extensive course of instruction is required to be able even to maintain the mass of modern radio and television receivers. Today's car, though still working on the same basic principle as its early predecessors, would utterly confuse a 1910 garage mechanic. One needs only to mention electronic computers, jet aircraft and modern medical equipment to illustrate the point even further. Almost every aspect of modern life is rapidly becoming part of the province of the specialist.

All this means that science and technological progress are rapidly approaching the importance of politics as news and soon they will have caught it up and passed it. The present-day drive to recruit more young scientists and technicians will result in a much higher-educated community and a community whose prime interests will be centred on science. Somehow the thirst for technical knowledge and news will have to be satisfied. The present isolation of the scientist will have to end and he will find that he has a duty to the community—a duty to report his work in language the community can understand. It may even be that new periodicals and other types of publication will be introduced to provide the means of communication. The beginning of the trend can already be seen in the ever-increasing number of feature articles on scientific subjects being carried by the more thoughtful newspapers and also by the increase in the number of programmes with a scientific background being produced for radio and television. Our readers may have noticed the trend too in PRACTICAL MECHANICS where more articles of a scientific nature have been appearing of late on subjects ranging from satellites to submarines. As the deluge of discovery increases, we shall continue, as in the past, to keep our readers informed and up to date.

INDEXES FOR VOL. 27

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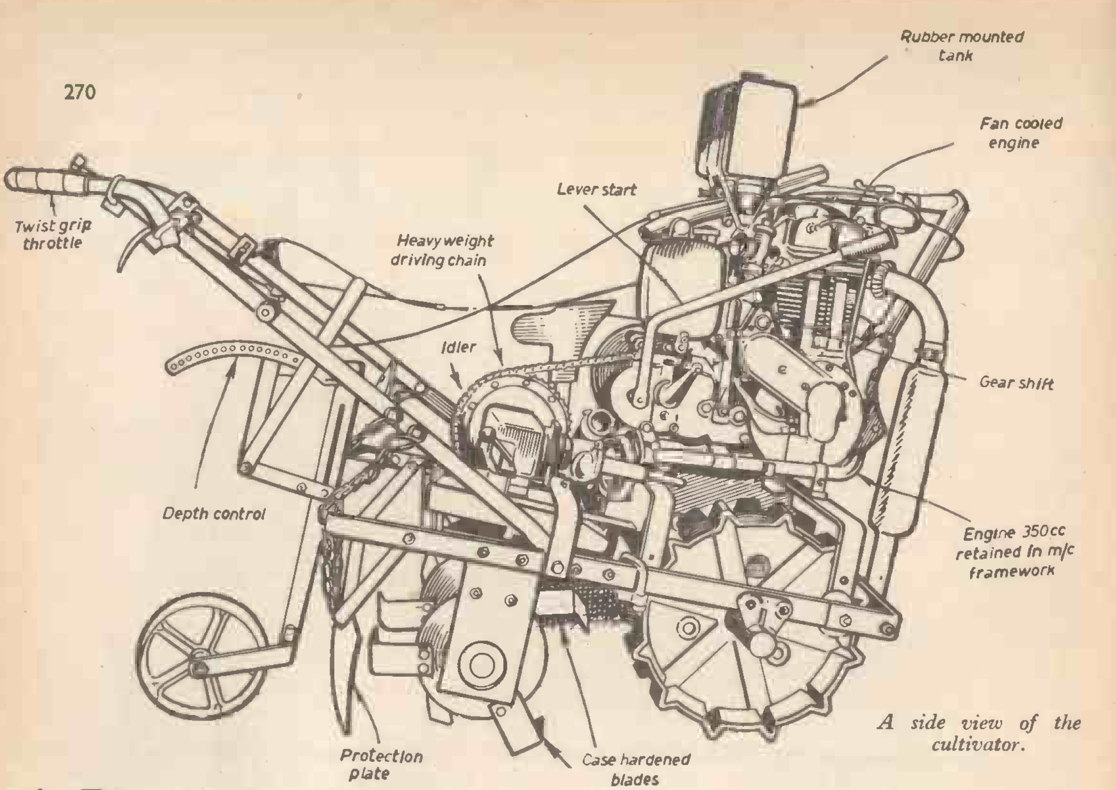


A side view of the cultivator.

A Scrapyard CULTIVATOR

By Peter Pentelow

THERE must be many mechanically minded nurserymen and smallholders who have use for a small rotary cultivator. All the wet weather experienced this year has left ample time to make such an implement.

Power Unit

Having a large garden, I soon explored the possibility of cultivating this mechanically. For a power unit the obvious answer lay in a motor-cycle air-cooled dry sump engine. The size should be fairly large, thus allowing good pulling power at low r.p.m. The original intention of a twin (500c.c.) cylinder engine had to be ruled out, for the whole idea was to keep the overall cost low (below £10) and the 500c.c. twin units were priced at £20/£30.

Eventually, a 350c.c. o.h.v. Ariel was purchased for £4, this representing the largest single cash outlay. During my travels there appeared to be a very large selection of motor-cycles at scrap prices. There were also several large scrap merchants in the area and regular visits were paid to these over the ensuing

Three views of the engine installation.

Drive to gear box, water pump and idler.

Under-side showing cutters.

weeks. Various chains, sprockets, steel wheels and other oddments were purchased, including several original items from an early type cultivator.

Building

To keep the power unit and gear-box in one unit, the frame of the motor-cycle was cut in such a way as to keep all the original strengthening tubes but still allowing a small compact power unit to be attached to the frame by " U " bolts.

The shaft to which a pair of steel wheels was fixed indicated a spinner width of 24in. This is slightly larger than the current largest 20in. model at present marketed in this country.

It was decided to mount the spinner in long 1in. dia. roller bearings that had been found attached to suitable housings during my travels (Fig. 3). The cutters would be attached to 10in. dia. discs that were added to the spinner shaft (Fig. 8). Backlash would be taken up by washers placed between the end discs and the bearing housings (Fig. 1).

The cutters were made from 2in. × ¼in. strip, 12 of them 9in. long. They were, firstly, " beaten out " blacksmith fashion, bent and sharpened. As if they could be kept sharp, it would make easier work for the motor, they were hardened. This consisted of heating, dipping in some case hardening compound and quenching, giving a case depth of 1/64-1/32in. which was considered adequate.

The spinner and cutters were finally assembled and installed in such a way as to allow, when working, an " even " condition of the implement.

Driving Chains

It became apparent early on in the project that the larger the chains that could be used the better. In view of this, the current large motor-cycle driving chain was chosen (⅝in. × ⅜in.).

An idler with tapered bearings was picked up at the scrap yard (Fig. 2), this being primary to give a means of reduction as it would have been impossible to drive direct from gear-box to spinner (even using first gear).

The final system giving the required amount of gearing down, had gear-box 17 teeth sprocket to idler input 57 teeth (this being the rear sprocket from the motor-cycle). The output sprocket was 18 teeth down to a 17 teeth on the spinner drive.

Chain adjustment to the idler was obtained by tilting the whole assembly but as this arrangement could not be utilised for the remaining driving chain a tensioner was incorporated in the final drive casing.

The tensioner was a 1in. roller bearing with an eccentric centre (Fig. 7).

This final chain drive was encased in an aluminium covering and allowed the chains to be covered in grease but at the same time being completely free of dust.

The non-driving end of the spinner was packed in grease and sealed up. Both end bearings had oil seals on the inner edge.

Cooling

As the motor would be working fairly hard yet lacking the air stream naturally found under its normal working conditions, means of assistance had to be arranged.

The crankshaft provided the required speed of the proposed fan and an adaptor was made up to take a normal " V " pulley (Fig. 6).

The normal car fans that were obtainable, combined with the only means of rotation made it impossible to " blow " air over the engine but, nevertheless, " drawing " the air over and around the power unit gives adequate cooling under all conditions.

The fan itself was mounted on a small shaft with roller bearings on either side of the " V " pulley (Fig. 5).

To provide maximum air flow around the cylinder barrel a cover for the fan was made up from thin alloy sheeting (see photograph overleaf).

Fuel and Oil

The lubrication system was left in its original state but filled much higher than recommended. All chains were packed with either grease or gear oil. The original fuel tank was dispensed with as too cumbersome. In its place was substituted a one-gallon can located by rubber bands to rubber feet, thereby relieving the problem of leaks through vibration.

Means of Driving

It was felt that, apart from having means of forward motion, for safety a neutral gear should be incorporated and, due to being rather heavy, a means of reverse. This was easily overcome by procuring a small dog clutch which was fitted between the driving sprocket (the larger sprocket on the input idler) and

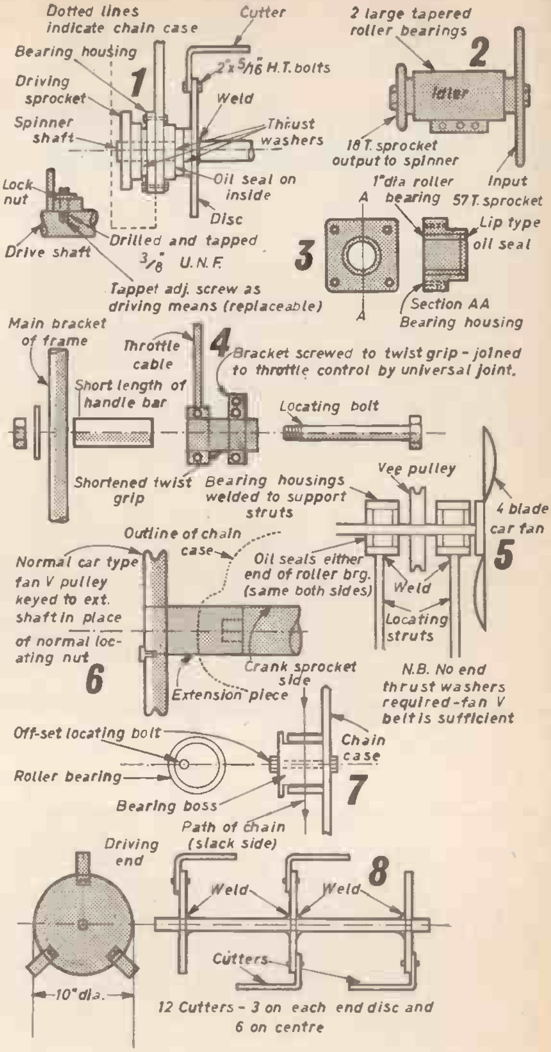


Fig. 1.—Spinner end thrust and driving device. Fig. 2—The idler. Fig. 3.—Spinner end bearings. Fig. 4.—Throttle twist grip installation. Fig. 5.—The fan drive. Fig. 6.—Fan drive pulley from crank shaft. Fig. 7.—Spinner drive chain adjustment. Fig. 8.—Spinner discs and cutters.

the driving wheels. The reduction then gave 4:1 between spinner speed and driving wheel speed. With normal work the first gear is engaged on the motor-cycle box, but the second or third gear gives adequate means of " grass cutting " or very light cultivating. For every rotation of the driving wheel there are " 12 cuts " of the cutters.

Shields

A large shield fitted at the rear covers the rear of the spinner, at the bottom of which is attached a piece of rubber sheeting giving the operator adequate protection (see heading illustration). Other shields covered the driving chain and gear to the driving wheels.

Depth Control

Although the original intention was to fit a skid with variable depth, I had the good fortune to locate on a scrap heap a castor wheel and depth control from an early type cultivator. This was easily fitted to our implement and allowed adjustment variations of one inch.

Cost

The whole project cost just under £8, in actual cash, also nearly four months of spare time. During this spell, there was also two weeks' solid turning and lathe work on various machines that were borrowed.

Trailer

As the machine could not easily be transported the two wheels from the motor-cycle were made into a low loading trailer for attaching to a light car, the trailer being made from small section angle iron. Even the mudguards of the motor-cycle were utilised; weight being under 2½ cwt. no brakes were fitted. The draw bar was made up from a scaffolding pole.

Starting

The machine starts very easily, the normal kick start having an extension arm welded to shaft and the footplate being removed, allowing use by hand operation.

The standard twist grip was utilised and operated by an extended arm. (See Fig. 4.)

All other controls had handles attached by fabricated " U " bolts.

Water Pump

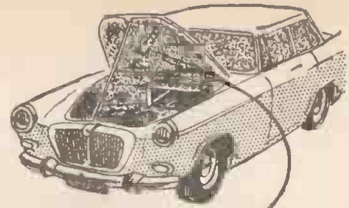
It was also intended to use the power unit to drive a water pump to fulfil the greenhouse requirements. A positive displacement pump was found on a large stationary engine on one of our various visits to the scrap merchants. This was driven by a normal " V " pulley from the shaft driving the steel wheels. For use of this, the chain has to be first disconnected and then the " V " belt connected. The output of this pump at a 4ft. head has been measured at 1,500 gallons per hour with a pressure of 5lb. sq. in. and a pump speed of 1,000 r.p.m. This can be increased slightly if higher gearing is engaged but for our present requirements this is adequate.

Results

Considering the amount of work the machine can complete, the cash outlay could have been increased and still given satisfaction. When other units on the market have a purchase price of nearly £200 and, considering the cash outlay was only £8 for a unit that will do comparable work, plus pump water, I am extremely satisfied. Plans are already in hand for fitting a compressor motor.

The cultivator mounted on a trailer.

Pep up the battery with this Home made CHARGER



By B. C. Macdonald

THIS charger is especially designed for home construction. It will charge 6 or 12V. batteries at up to 3A. The charging rate is fully adjustable by means of a variable resistor. Almost zero voltage is possible, thus enabling flat batteries to be charged without risk to the charger. An on/off switch is fitted and voltage change-over is also effected by means of a switch. Both the high tension and low tension circuits are fused and the fuses are mounted on the front of the panel for easy access. A red indicator lamp shows when the charger is switched on; this is provided in order to help avoid the charger being left " on " when the clips are removed from the battery. A further refinement is an ambient temperature cut-out. In common with all electrical equipment, radio and television sets and so on, there is the remote possibility of a fault developing which may cause a fire. Chargers are often in use for long periods unattended, and though the charger is fused in both circuits, the thermal cut-out provides additional protection; it will automatically disconnect the mains should the temperature rise exceed 160 deg. F., even if the fuses remain intact, and excessive current is not present.

Ex-service components have not been used, even when suitable, because these are often not readily obtainable.

Fig. 1.—The completed charger.

The Transformer

The transformer is a 4A. 0·9·15V. type, the higher current rating being necessary to suit the rectifier, and is recommended by the manufacturers. All the leads are colour coded and easily recognisable. The mains or H.T. winding is tapped to suit different mains voltages. The black lead is common and is used in every case. Great care must be taken not to confuse the L.T. and H.T. windings; it should be noted that the latter are much thinner than the former. The L.T. leads are coloured black, yellow, red, orange and white. The white and orange leads are not used. Black is common, black and yellow giving 9V. and black and red giving 15V.

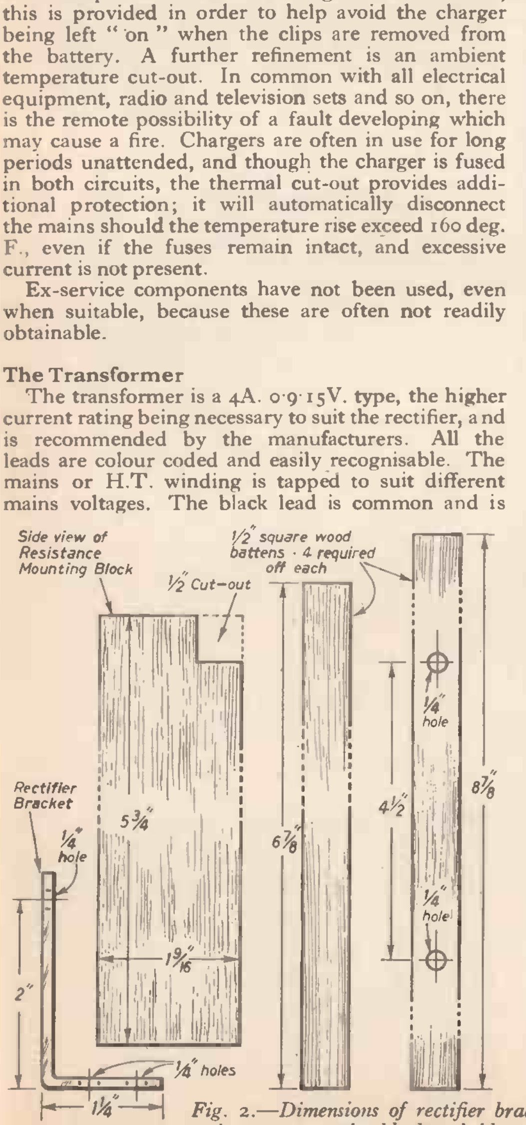


Fig. 2.—Dimensions of rectifier bracket, resistance supporting block and side woods.

The Rectifier

The rectifier is a full wave bridge type, 3A. rating. There are five projections on the rectifier; these are the input and output leads and they are coded by coloured paint on the ends. The two projections with the green ends are the low tension A.C. input from the transformer; the projection with the red end is the positive rectified output. The two black-ended projections, which must be joined, together form the negative rectified output. The rectifier is mounted on an L-shaped metal bracket by means of the screw and nut provided.

After cutting the ⅜in. plywood to size, smooth with glass paper. Mark out the positions of the components as shown in Fig. 3 and then screw the square wood moulding along the edges, using ⅜in. × No. 4 screws. The screw holes should be countersunk with a ¼in. drill. Place the components in the marked positions and mark the position of each screw with a pencil, then drill the holes, but be careful not to drill right through the wood. Paint the board all over with black paint, if too much paint is not used a good semi-matt finish will result. Paint the remaining wood parts in this way.

The Paxolin Panel

This is the same size as the wood board and should have the hole centres carefully marked in accordance with the measurements shown in Fig. 6. This applies also to the centre slot, which should be out-

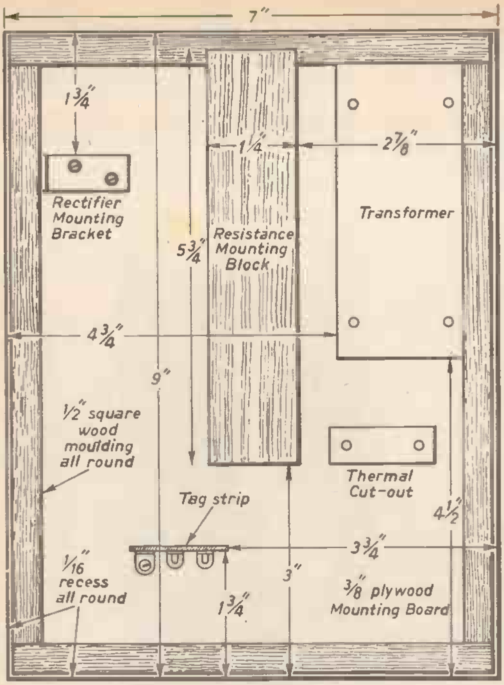


Fig. 3.—Rear mounting board showing positions of various components.

lined. A sharp-pointed pencil may be used for marking, but when it is sure that the marking is correct a scriber or any sharp-pointed tool should be used to go over the pencil markings, since these tend to get rubbed off in handling. The three ½in. holes can be made initially with a ¼in. or $\frac{5}{16}$in. drill and widened to size with a file or reamer. Drill from the front of the panel while it is supported on a piece of wood in order to avoid damage to the hole edges due to the exit of the drill. The ammeter hole and the slot are made by drilling a series of ⅛in. or ¼in. holes close together so that their edges nearly but not quite touch the perimeter of the final hole required. The centre piece, released by the holes, is removed and the edges carefully smoothed and the hole increased to the correct size. When filing, always move the file away from the front of the panel in order to avoid possible chipping. The eight panel fixing holes should be made with a $\frac{3}{32}$in. clearing drill. For cutting the panel to size a fine-tooth wood saw is suitable, and the edges of the paxolin may be smoothed with glass paper, but be careful not to scratch the front.

The ½in. square woods may now be fitted to the edges of the panel by means of ⅜in. × No. 2 brass wood screws. When fitted, the woods will form a rectangle $\frac{1}{16}$in. all round smaller than the panel. Here we may draw attention for the need for care in making and measuring the ¼in. dowel holes. These must be accurately positioned or the front of the charger will not be in alignment with the back.

Fit the toggle switches and on/off switch on the right-hand side of the panel and the voltage change switch below the ammeter. Fit the indicator lamp above the on/off switch. Place the ammeter in position, and hold the panel face down on a table, so as to press the ammeter firmly in position, then bend the fixing tabs on the ammeter outwards until they are close against the panel. Now fit the fuse box. This is a Bulgin type No. F.19 and measures 1⅞in. × 1¼in. × 1$\frac{1}{32}$in. The box used in the prototype charger illustrated was an ex-service component, but the Bulgin or a similar type is recommended since it is then impossible accidentally to interchange the L.T. and H.T. fuses by replacing the fuse cover the wrong way round. The fuse box is held in position by two 6 BA screws at $\frac{9}{16}$in. centres. The fixing holes and entry holes for the connections are best marked on the panel for drilling by inserting the point of a pencil through each hole in turn while the fuse box is held in position.

Rear Mounting Board

We now come back to the rear mounting board. Fit the rectifier bracket and rectifier, transformer, thermal cut-out and three tag strip. The positions of these components are not critical, although the transformer needs to be as near the left hand side as possible and the variable resistance and its mounting block must be accurately fixed so that the slider is correctly positioned in the slot in the panel when the latter is fitted. The measurements shown in Fig. 3 for the position of this part are only approximate, and to determine the correct place for the slider and its supporting block fit the panel temporarily and visually find the correct position for the block. This is then marked, the slider removed and the block fixed in the marked position by means of two screws at the rear. This procedure is necessary because small errors in the marking out or drilling may need to be corrected. (See Fig. 4.)

In order that the slider on the resistance may be as close to the panel as possible, the two projecting parts at the top of the fixing brackets must be cut off. This may be done quite easily while holding the resistance in the hand, by means of a pair of tin

PARTS AND COMPONENTS

3A. bridge rectifier.
4A. 0-9-15V. charger transformer.
3A. meter.
These are obtainable from R.S.C. Ltd., 29-31 Moorfield Road, Leeds, 12.
Paxolin sheet, $\frac{1}{16}$in. × 10in. × 8in. from Post Radio Supplies, 33 Bourne Gardens, London, E.4.
Variable resistor, 6 Ω, 3·16A. 60W. No. MV7.
Toggle switch, two way, No. S369.
Toggle switch, two pole, on/off, No. S277.
Fuse holder, No. F.19.
Thermal cut-out, No. FS.11.
Signal lamp, No. D. 187/Red.
The numbers quoted are Bulgin list numbers. These parts may be obtained from most radio component shops or direct from A. F. Bulgin & Co. Ltd., By-pass Road, Barking, Essex. The perforated metal, screws, etc., may be obtained from hardware merchants.

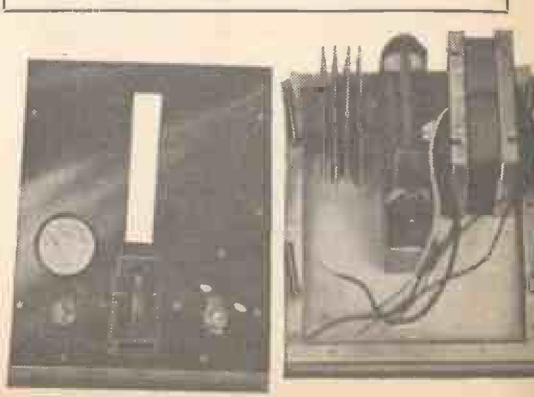


Fig. 4.—Rear mounting board with components temporarily in place.

snips or even an old pair of scissors. When the variable resistance is finally in position, part of the wiring may be carried out.

Lighting flex may be used for wiring but solid plastic-covered wire is best, not less than 19 s.w.g. In making the connections it is best, where possible, to wind the bared end of the wire round the solder tag so that it holds itself in position for soldering; otherwise it will be found that where more than one connection has to be made to one point, making the second connection will release the first, and it is difficult to solder the two on together. Cored solder is best for this work; soldering fluid or killed spirits must not be used.

Before fixing the panel the two tags on the voltage change switch should be strapped together. One of the transformer mains leads is connected to the thermal cut-out. The two black coded projections on the rectifier should be connected together, and the red coded projection on the rectifier connected to the screw terminal on the resistance. This is best done by means of a tag rather than by simply winding the wire on to the terminal before tightening it down. The top solder tag in the resistance is connected to the tag strip.

To fix the panel in position cut four 3$\frac{3}{8}$in. lengths of $\frac{1}{4}$in. round wood moulding, put glue on the ends and tap them into the holes prepared for them in the side woods on the mounting board. Now place the panel in position, again entering the round woods into the holes in the side woods on the panel, and pressing down. The panel should be close to, or touching the variable resistance, but not pressing upon it. It is a good plan to cut a piece of wood of just sufficient length to go between the mounting board and the panel. By inserting this as a gauge at several points, and pressing the panel down, or lifting it, as required, even fitting can be ensured. The wiring may be completed when the glue has set (Fig. 5).

Any terminal on the thermal cut-out is connected to any of the two inner terminals on the on/off switch. The other inner switch terminal is connected to the fuse box. The remaining terminal on the thermal cut-out is connected to the black mains lead on the transformer. The second transformer lead is connected to the fuse box, but the colour of the lead used depends upon the mains voltage. For 200/210V. mains use the brown lead, 220/230 the green lead, 240/250 the blue lead. Unused leads should have the ends taped with insulating tape and coiled out of the way. The selected lead is connected to the fuse box terminal opposite to the one already used, upper or

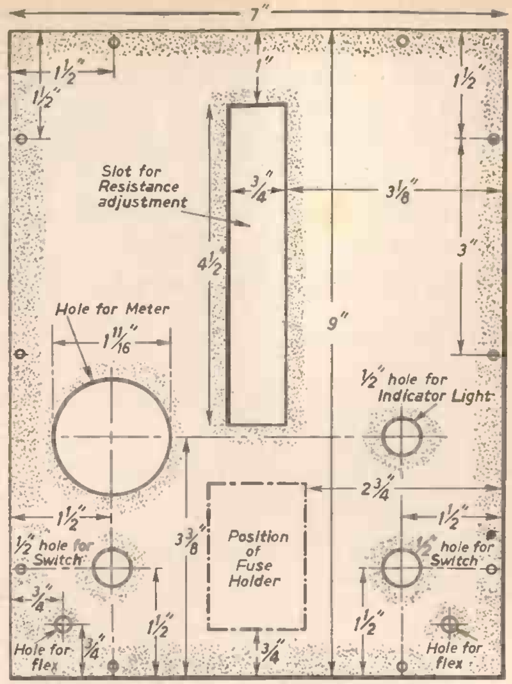
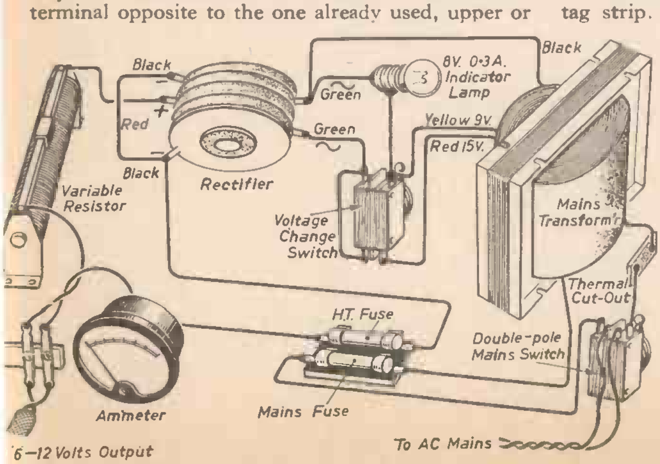


Fig. 6.—Dimensions for the paxolin panel.

lower, as the case may be. The red L.T. lead on the transformer is connected to the lower vacant voltage change switch terminal, the yellow L.T. lead on the transformer is connected to the upper terminal on this switch. The black L.T. lead is connected to one of the green coded projections on the rectifier; connect to the same point one of the indicator lamp holder terminals. Connect the remaining terminal on the lamp holder to the upper terminal on the voltage change switch. Connect the strapped change switch terminals to the vacant green-coded rectifier projection. Connect the red-coded rectifier projection to the screw terminal on the variable resistance. Connect the top terminal on the resistance to one of the solder tags on the tag strip. Join the strapped rectifier terminals to one of the two vacant fuse terminals and connect the right hand ammeter lead (looking from the front) to the vacant fuse terminal. Remember carefully that the fuse box terminals are in pairs, upper and lower, and take care not to connect an H.T. lead to the L.T. pair, or vice versa. Connect the remaining ammeter lead to the vacant tag on the tag strip.



Plastic covered lighting flex is recommended for the battery leads and one strand must be coloured black and the other red. Thread the flex through the left hand grommet and connect the red flex wire to the tag on the tag strip which carries the connection to the sliding resistance. The black coloured flex wire goes to the other tag on the tag strip. The mains flex is best plastic covered (any colour) and the two wires are connected to the vacant terminals on the on/off switch, in any order. If the charger is to be used in a garage then three-core appliance flex, rubber covered, should be used for the mains lead,

(Concluded on page 301)

Fig. 5.—Wiring diagram.

L.B.S.C's

EVENING STAR

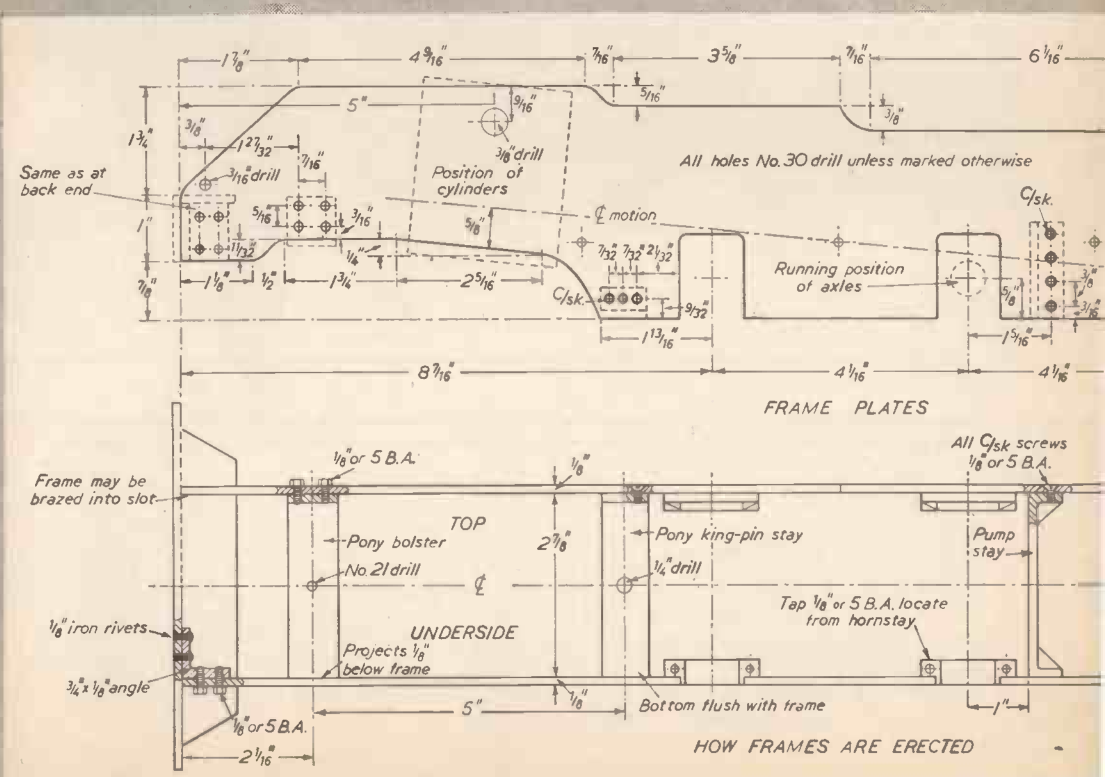
1. Cutting and erecting frames and buffer and drag beams

THE first job in building a locomotive is to cut out the frame plates, and for these we shall need two pieces of ⅛in. mild steel, 30in. long and 3¾in. wide. Either the bright or blue kind may be used, as long as it is soft and ductile. Hard-rolled material is unsuitable; though it may be flat to start with, it warps and twists as soon as it is cut and drilled. Make sure that each sheet is perfectly flat, then mark out one of them as shown in Fig. 1.

Bright steel should be given a coating of marking-out fluid, easily made by dissolving some shellac in methylated spirit, and adding a little blue or violet aniline dye. Most chemists will make up a small quantity. If applied with a soft brush it dries in a few seconds, and scriber-marks made on it stand out like railway lines in bright sunshine. Blue steel, if clean, requires no treatment, as the scriber-marks usually show up bright.

Used gramophone needles make nobby scribers. Drill a suitable hole in the end of a piece of round rod about 4in. long and about 3/16in. dia. Drive in the needle, and as soon as it gets blunt, pull it out and put in a fresh one. Saves muckle bawbees, ye ken!

Make sure that one edge of the plate is perfectly straight, and on this, set out the five openings for the horn-blocks. First mark off the centre-lines, starting from the front edge of the plate; then on these centre-lines, set out the openings, using a try-square to get them exactly at right angles to the edge of the frame. The outline of the frame can then be very carefully marked out, checking every measurement as the job proceeds. I very strongly recommend all beginners and other inexperienced workers, to obtain a full-size print of the frame, because it is much easier to work from this, than to take the measurements from a small drawing. Tell it not in Gath, but I once had a friend, an engine-driver now deceased, who used to buy the full-size print, stick it on the sheet of metal, and cut out his frame like a kiddy doing a fretsaw job in wood. The catch in this



was that prints usually shrunk in the making, and the frames weren't exactly true to measurements. Slight allowances had to be made in the motion work, etc., easy enough when you know the job upside down and backwards, but baffling to a raw tyro.

Mark off all the screwholes to the given measurements, and make a fairly deep centrepop at each location. The exact position of the $\frac{3}{16}$ in. hole at the front end of the frame, doesn't matter much, as it only represents the hole in the full-size engine's frame where the crane hook goes in when the engine is lifted. The others should be as shown; but if any experienced worker likes to braze the frames into the slots in the buffer and drag beams, instead of the fixing method shown, the four holes at each extreme end of the frame may be left out.

How to Cut Out the Frames

As the two plates must be exactly alike, they are cut out together. Drill any one of the screwholes at each end of the marked plate, file off any burring, then temporarily clamp the plates together, and drill two holes in the unmarked plate, using those in the marked one as guides. Put a couple of rivets through the holes, and burr them over, so that the two plates are firmly held together.

Drill all the rest of the holes through both plates at once. Countersink those shown in the drawing with a ring round them, using a $\frac{7}{32}$ in. or No. 2 drill, on both sides. The countersinks then indicate which is the outside of each frame plate, one right-hand and one left-hand.

Much of the surplus metal around the outline of the frames, can be cut away with a hacksaw. Don't use a blade with less than 22 teeth per inch, or it will soon look as though it had paid a visit to the dentist. Also never use a dry blade to cut steel. Lubricate it with the same cutting fluid used for turning steel in the lathe. Any good cutting oil will do. Some kinds are mixed with water, forming an emulsion like milk (frequently named " mystic " in engineering shops) but my favourite is a brand called " Cutmax " to which I add half its bulk of paraffin. Applied with a brush, this enables the saw to walk through the steel like nobody's business, and makes the blades last ever so much longer—vot you tink, eh? When used for turning steel in the lathe, it doesn't leave a sticky mess, like water-diluted oil, but keeps the machine in new condition.

When sawing along the straight lines, use the top of the vice jaws for a guide wherever possible, setting the marked line level with the jaw tops, and sawing along with the blade resting on them. The blade can be set sideways in the saw frame for this purpose. When cutting the hornblock openings, drill a row of holes, using No. 40 drill, just below the marked line at the top of each opening. Put the frames upside down in the bench vice, with the row of holes just showing above the jaws. Saw down to them, keeping just inside the marked lines each side. Grab the metal between the sawcuts with a big pair of pliers, and waggle them back and forth

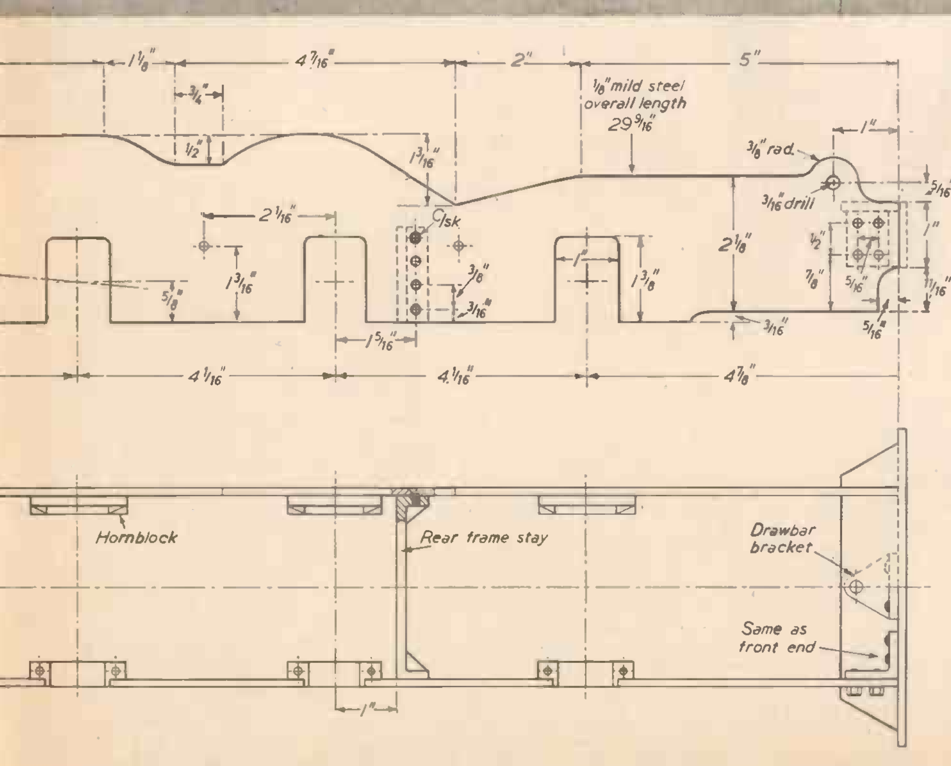


Fig. 1.—Details and dimensions of the frame plates and how they are erected.

like a dentist trying to pull out a troublesome tooth. The metal will break away along the line of holes. Trim the ragged opening to shape and size with a flat file, plus a small round one for the corners, using a gauge to get all the openings "spot on." This is just a short length of 1in. × $\frac{1}{4}$in. flat bar (brass or steel) with one end rounded off to the shape of the openings, as shown on the drawing. File the opening until the gauge will just slide in without any shake. Finally trim off any raggedness along the sawn outer edges of the frame, so that it conforms to the drawing; knock out the rivets, part the two plates, smooth off any burring along the edges and around the rivet holes, and stage one is completed.

Buffer and Drag Beams

The beams can be made from 1in. × $\frac{1}{8}$in. steel angle, or from castings. If angle is used, two pieces are needed, one 5$\frac{3}{4}$in. long, and one 5in. after the ends have been filed off square. Bright soft angle should be used, though common black stuff would serve at a pinch. Coat one member of the longer piece with marking-off fluid, and carefully mark it out as shown in Fig. 2. Centrepop and drill all the holes first with No. 30 drill; then open out the large ones with $\frac{5}{16}$in. drill. Countersink the rivet holes with $\frac{7}{32}$in. or No. 2 drill, and file the middle one square, with a clockmaker's square file, until a piece of $\frac{1}{8}$in. square silver-steel will slide easily into it. The ends are scalloped out with a half-round file, as shown in the drawing. This, on the full-size engine, is for platform clearance.

The other member, which forms the top of the beam, has to be slotted to take the ends of the frame plates—and this is where you want to watch your step; so much depends upon true slots. If they aren't true, the frame plates won't be square with the beams, and when assembled, the whole bag of tricks will assume a rhomboidal shape—"all wonky" as the kids would say. If a $\frac{1}{8}$in. saw-type milling-cutter is available, the job is a piece of cake. Just after the Kaiser's war, I bought one (Govt. surplus) for a shilling, and mounted it on an arbor made from an old $\frac{1}{2}$in. bolt. The bolt-head was sawn off, and the cutter, which was 3in. dia., clamped between two nuts on the screwed part.

The beam was clamped under the slide-rest tool-holder, parallel with the centreline of the lathe, and set with the marked location of the slot, exactly opposite the cutter, the improvised arbor being held in the chuck With the lathe running at slow speed, the beam was fed carefully on to the cutter, cutting oil being applied with a brush. The result was a perfect slot. (See Fig. 3.)

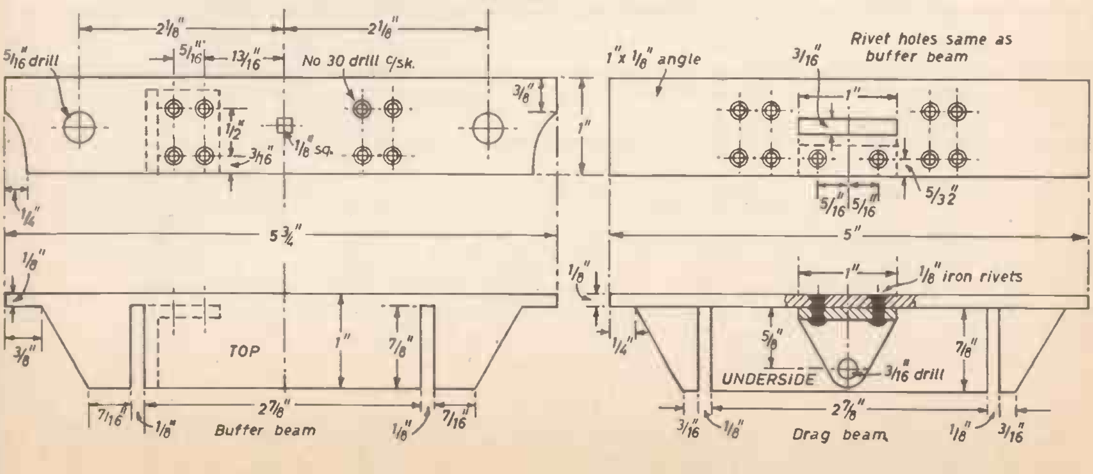
The slots can be cut by hand, if a cutter isn't available. Put the beam vertically in the bench vice, with the marked edge of one of the slots level with the top of the vice jaws, and saw along the line, using the jaw top to guide the sawblade. Ditto repeato with the other edge of the slot, then clean the ragged edges with a thin flat file, such as a keycutter's warding file, until a piece of $\frac{1}{8}$in. steel plate will fit tightly. I used to do the job this way, in the far-off days of long ago when I was "'ard-up-'n'-'appy." Experience teaches! Thank goodness I now have a milling-machine. Each end of the top of the beam is sawn to the shape shown.

The face of the 5in. drag beam has eight countersunk rivet holes drilled in it, to the same spacing as those in the face of the buffer beam. In addition there are two more, for the attachment of the bracket which carries the drawbar. The slot for the drawbar is 1in. long and $\frac{3}{16}$in. wide. Drill a row of $\frac{5}{32}$in. holes along the marked-out oblong, then run them into a slot with a rat-tail file, finishing off to correct size with a thin flat file. The bracket itself is filed up from a piece of the same kind of steel angle used for the beam, to the shape shown in the drawing. Drill a $\frac{3}{16}$in. hole in the apex of the triangle, as shown, for the drawbar pin. Clamp the bracket to the inner side of the beam, with the triangular part level with the bottom of the drawbar slot. A toolmaker's cramp put over bracket and beam between the rivet holes, will hold it firmly. Poke the No. 30 drill through the rivet holes in the beam, carrying on right through the bracket; file off any burring, and rivet the bracket to the beam with a couple of $\frac{1}{8}$in. iron rivets. Hammer the shanks well into the countersinks, and file off flush. Finally put the $\frac{3}{16}$in. drill through the hole in the bracket, and drill a corresponding hole through the beam, using the hole in the bracket as guide, so that the holes line up.

Brackets for Attaching Frames

Take a look at the drawing of the frame assembly (Fig. 1) and you'll see that the frame plates are jammed

Fig. 2.—Buffer beam and drag beam details.



tightly into the slots in the tops of the beams, and screwed to pieces of angle which are riveted to the beams. Four pieces of $\frac{3}{4}$in. × $\frac{1}{8}$in. angle are needed, each $\frac{7}{8}$in. long. To locate them correctly, jam any odd bit of frame steel left over from the frame cutting, into one of the slots. Set the piece of angle right close to it, as shown in Fig. 1 and clamp it tightly with a toolmaker's cramp. Put a No. 30 drill through two of the holes in the beam, and carry on right through the angle. Remove the cramp, put two $\frac{1}{8}$in. iron rivets in the holes, hammer the shanks well down into the countersinks on the face of the beam, drill the other two holes and repeat the riveting job. File the rivet heads flush with the face of the beam. Repeat operations with the other three pieces of angle, attaching them to the beams flush with the inner edges of the slots.

Note: if cast beams are used, lugs for attachment of frame plates will be integral with the casting, and there will be no need to fit the pieces of angle as described above. The only job will be to cut the four slots in which the frame plates are fitted, and this is done in exactly the same manner as those in beams made from angle. The bracket for supporting the drawbar will also be cast on, and will only need drilling for the drawbar pin.

How to Erect the Frames

Erection of the frames is a very important job; everything depends on it. If the frame assembly is out of true, the whole engine will be affected. The frame plates and beams must form a true rectangle. Like every other job, it's easy *when you know how.* All I use, are four small cramps, a try-square, and the lathe bed, and this is how the trick is done. First push the ends of the frames into the slots in the beams, as shown on the plan drawing, setting the lot square, as near as you can " by eye." Next stand the assembly on the lathe bed, right way up, with the bottom edges—where the hornblock openings are—resting on the bed. The tailstock will probably have to be taken off the bed for this job, and the saddle run up as close to the headstock as possible, to make enough room.

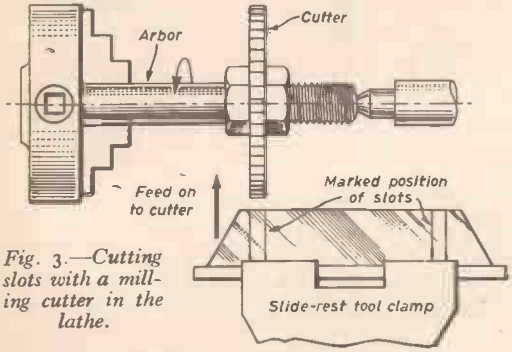


Fig. 3.—Cutting slots with a milling cutter in the lathe.

Adjust the frames until they sit on the lathe bed without shake, both frames resting on the bed for their full contact length. Next, set the buffer beam so that the bottom edge of it is exactly $\frac{7}{8}$in. above the bed, for the full width of the beam. For a gauge, I use a piece of steel bar of correct width; but both ends of the beam can be checked by inside calipers, or by a scribing-block, otherwise known as a surface gauge, or even by measuring from bed to beam with a steel rule. Now put a cramp tightly over the frame and piece of angle on the beam, at each end. Turn the frame end-for-end on the lathe bed, and repeat operations on the drag beam. See that all the cramps are tight, then apply the try-square to beam and frame at each end. You will see at a glance whether the frames and beams are square with each other; if not, adjust until they are. Then, with the frames touching the bed for full contact length, and the bottom of the beams exactly $\frac{7}{8}$in. above it for full width, the assembly is " spot on."

The cramps shouldn't be applied so that they cover all four holes at each end of the frame; they will hold tight enough if two holes at each end are left open. Run a No. 30 drill into each hole, and make countersinks with it on the pieces of angle attached to the beams. Follow through with No. 40 drill, going right through the angles. Tap either $\frac{1}{8}$in. or 5 BA, and put temporary screws in. When all four corners are done, remove cramps and repeat the countersinking, drilling and tapping through the holes previously covered by the cramps. There is no need to put screws in these yet, as the frames have to be taken apart again to fit the hornblocks; but put the frame assembly, held by the temporary screws, on the lathe bed again, and recheck to make quite sure that nothing has shifted during the drilling and tapping process. Should the frames rock slightly on the bed, or the beams be slightly out of line, slacken the screws slightly, set the assembly true again, and then re-tighten the screws.

Hornblocks and frame stays will be dealt with in the next instalment.

PUZZLE CORNER

And then there were none!

A LADY was given a box of chocolates which she refrained from opening for three days. On the fourth day she could resist no longer and ate $\frac{1}{10}$ of the contents. On the following day she ate $\frac{1}{9}$ of the remainder, and on the next day $\frac{1}{8}$, and so on. On the last day she ate $\frac{1}{5}$ of the original contents and the box was empty.

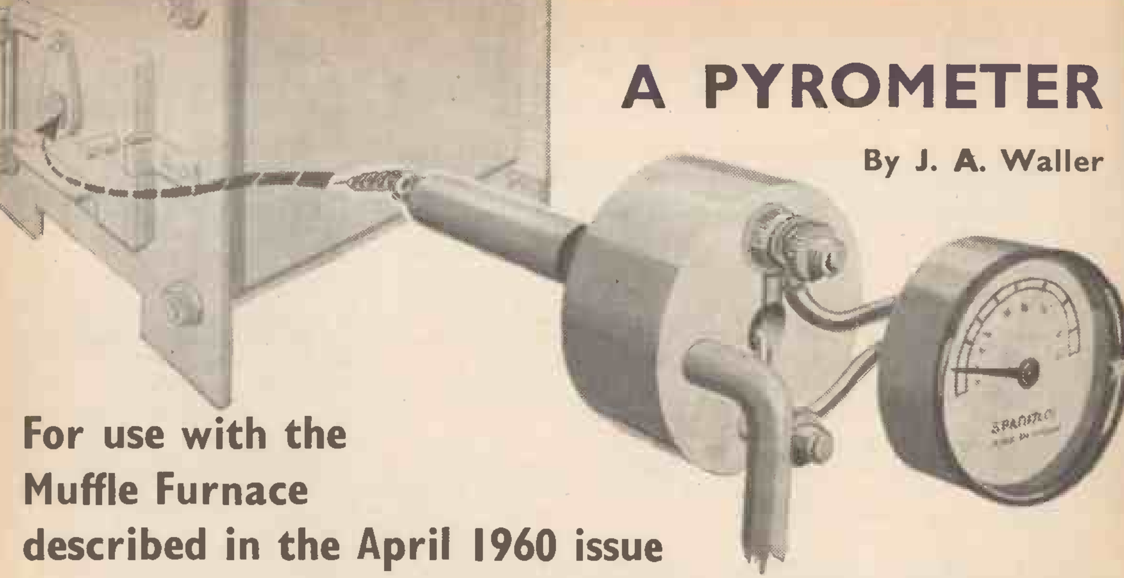
For how many days had she the box of chocolates in her possession?

Answer

12 days. On the 4th day she ate $\frac{1}{10}$ leaving $\frac{9}{10}$, and on the fifth day $\frac{1}{9}$ leaving $\frac{8}{10}$ and so on until the 11th day when she ate $\frac{1}{3}$ leaving $\frac{2}{10}$ = $\frac{1}{5}$, and on the 12th day she ate this $\frac{1}{5}$ and the box was empty.

A PYROMETER

By J. A. Waller



For use with the Muffle Furnace described in the April 1960 issue

AN additional and essential piece of equipment for the Electric Furnace described in PRACTICAL MECHANICS in April 1960, is a pyrometer for checking the temperature of the muffle prior to inserting a steel detail for heat treatment. The use of such a piece of apparatus eliminates the guesswork of judging the temperature of an article by its colour. This technique requires the heating of a part until the material reaches a certain colour (ranging from a dark cherry red to a brilliant light orange or white according to the temperature required) before plunging the detail into the quenching water. Despite the greatest care, with high temperatures of this nature, only a comparatively rough and ready check on the all important temperature is possible. As modern steels demand strict adherence to the steelmaker's specifications the colour test is now considered in the engineering workshops as being obsolete and reliance is placed on accurate scale reading before withdrawing the steel from the furnace.

Fig. 1 illustrates the general particulars of the suggested pyrometer for this furnace and the design follows the usual principle of these instruments in that when the joining ends of two dissimilar metals are heated a difference in the electrical potential is created in the connecting leads, and if the pyrometer is connected to a sensitive meter a very accurate reading is possible. The inclusion of a thermostat allows a close control of the temperature to be made and it is possible to build up and hold a temperature for a given period in order to allow the steel "soak" for the necessary length of time.

A piece of thick heat resisting material—Bakelite, Tufnol or similar plastic material is drilled to receive the two terminals—the actual shape of this base "A" is immaterial, but consider the shape of available material before attempting to finish the piece. A recess is cut in the top surface with the aid of a small chisel as a means of sinking the two wires beneath the surface and so give a better appearance, and finally a hole is drilled to provide a location for the tube "C." Despite the fact a flange is brazed on the latter and three screws used for securing it to the base, a tight fit is preferable as this overcomes any tendency for the screws to be torn from their holes.

The tube "C" is faced to length—it need not reach to the back of the furnace and a piece of material about 9in. long is sufficient. Braze on a steel disc cut from an oddment of $\frac{3}{32}$in. plate but make sure the holes are drilled and countersunk prior to brazing it in position otherwise the making of the countersinks is impossible unless a special tool is available.

Both terminals "D" are similar though one has a longer thread in order to accommodate the locknut, and though a blind nut is not essential for holding the wires connecting the instrument to the meter, they are made in this manner to improve their appearance. Fig. 2 gives the necessary dimensions.

A piece of Nichrome V 80/20 nickel wire is bent to shape as shown and the lower end is twisted in conjunction with a piece of copper strip. A close contact is essential and a gentle squeeze in the bench vice will assist in ensuring this degree of contact. About 24g. is recommended as being suitable for this pyrometer and this wire is a stock size. Before bending the nickel wire to fit underneath the terminal, encase this item in insulated beads—a slight kink in the wire at the lower end will hold them securely.

The introduction of a handle at "H" is a refinement well worth adding as this makes insertion into the furnace an easy matter, but do not tap the hole for the threaded end completely through the base member as the exposed end will become hot and make it uncomfortable if not impossible to use. Setting the handle at right angles to the position indicated in this drawing is perhaps the best way of assembling this detail but as the final site of the furnace may influence this decision the choice is left with the reader. The thin guard round the base is useful in preventing to some extent, too much heat from impinging on the wires connecting the pyrometer to the meter. It is secured to the base by six screws.

The Meter

The purchase of a new meter is unnecessary as most electrical repair shops will have an old voltmeter which will make an admirable reading unit for this pyrometer. Another source of supply is the Government surplus store.

This work of calibrating the meter requires some experimentation before an accurate reading is secured besides a fair amount of preparation, so set

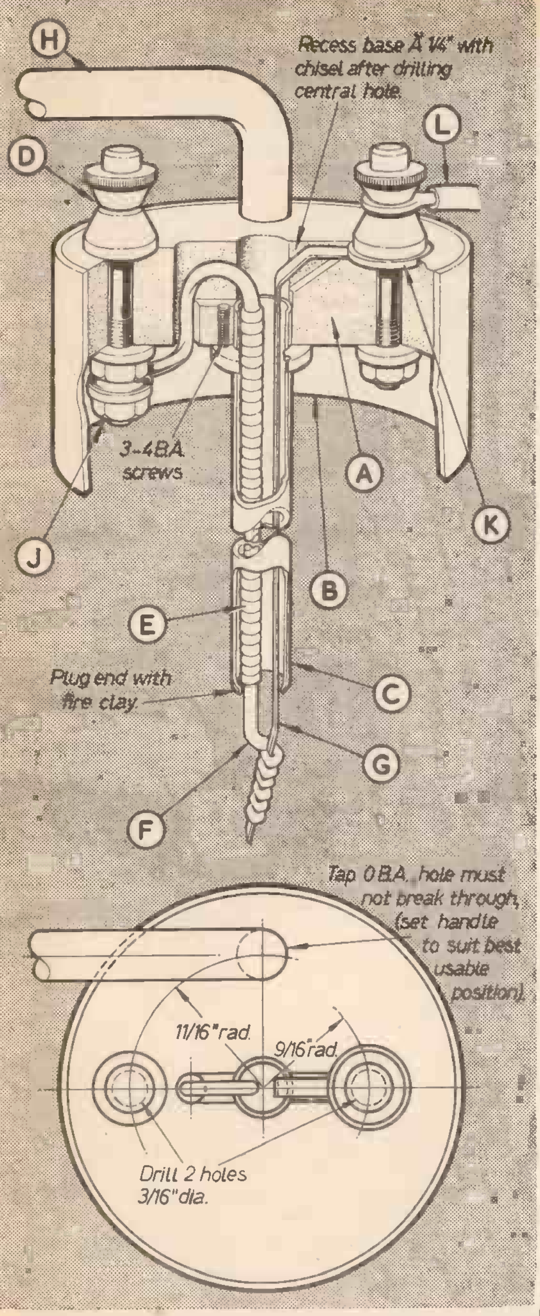


Fig. 1.—Pyrometer assembly. A-base; B-cover; C-tube; D-terminal; E-insulating beads; F-24G Nichrome wire; G-copper strip; H-handle; J-clamping nut.

aside a whole day for the work and check each reading as the job proceeds.

A meter reading to about 150 or 200V. D.C. with a resistance somewhere in the region of 3,000Ω appears the ideal unit for this work, so remove the resistance and see exactly what happens when the pyrometer is gently heated in the flame of a Bunsen burner or over the gas stove. It will probably swing through the complete range of the scale. However, before commencing any work a reader should obtain a good supply of Seger cones—these particular details are made from a special material and you can purchase them quite cheaply in various cone numbers for different temperatures, and those ranging from cone numbers 022 to 05a are sufficient to give 600 to 1000 deg. C. in various steps.

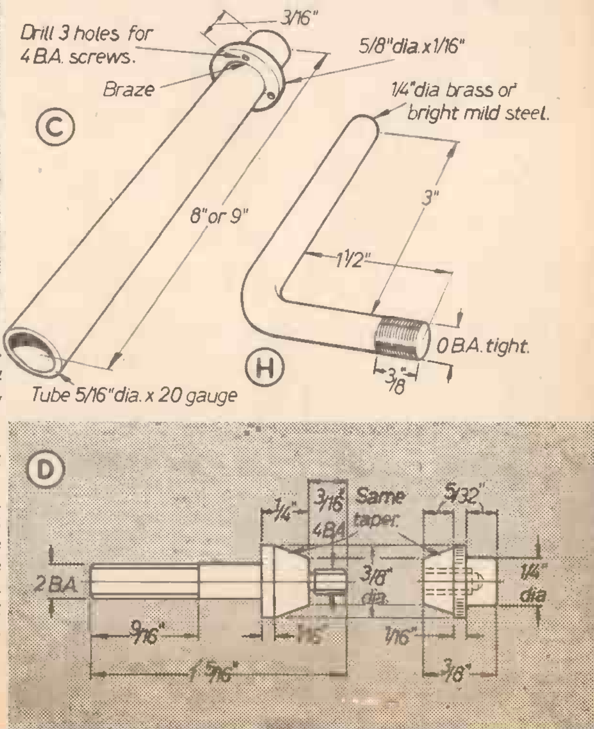
Briefly these cones are inserted in the furnace—for a temperature of 740 deg. C. cones which give 710, 730 and 750 deg. would be placed on the hearth and as the furnace approaches the desired heat, the 710 cone will bend over signifying that the furnace had reached that temperature, and as the 730 cone also follows suit the thermostat is checked to prevent the final cone from also observing the same fate. Now it follows that with two known temperatures the scale on the meter can be marked—a new scale is not difficult to make once the initial readings are obtained, and a further check is possible by melting down a few soft metals. Lead is obviously a typical example together with tinman's solder and perhaps zinc and again marking these on the scale. From the data collected the making of a fresh scale is simple if accurate drawing is possible and fine lines made with Indian ink marked on the scale, and it should be possible to control the furnace temperature to within 10 deg. C. in conjunction with the thermostat. A little practice, cross checking as you go along plus patience is all that is necessary for this latter work.

The Final Details

The pyrometer is inserted through the sighting hole in the front of the furnacé as the temperatûre is raised. With the thermostat set to control the required temperature the only care necessary is to

(*Concluded on page* 289)

Fig. 2.—The simplicity of construction is shown in these drawings of the tube, handle and terminals.



A MAKE IT YOURSELF

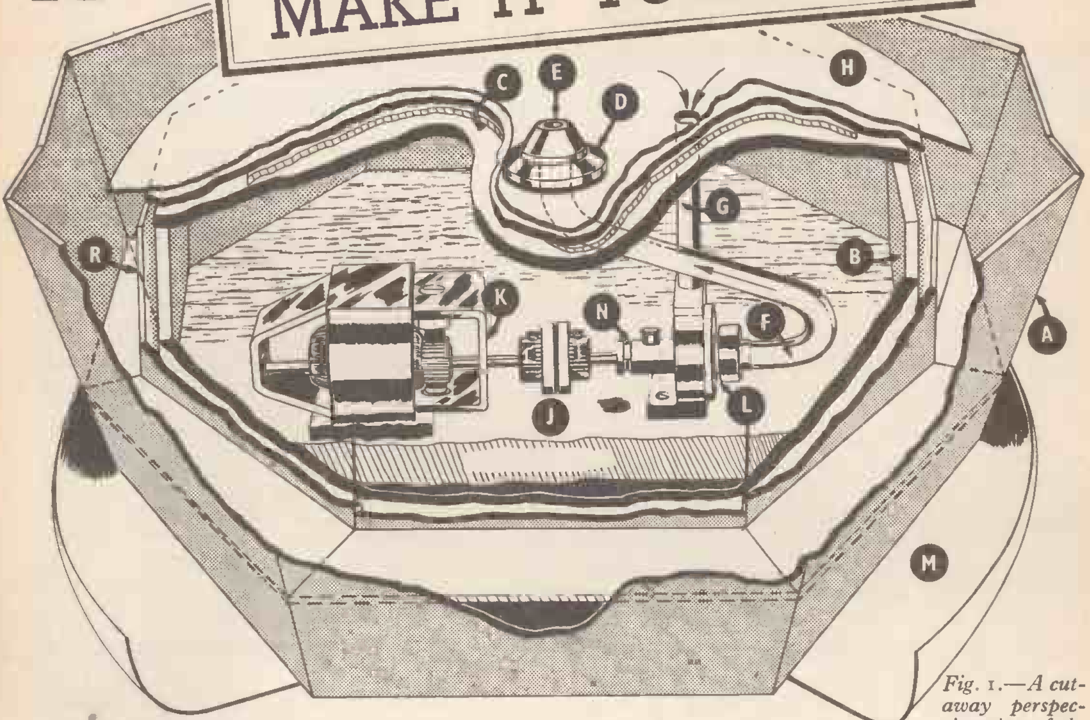


Fig. 1.—A cutaway perspective view of the completed fountain.

THE design consists basically of a small pump, driven by a motor which, though arrangements can be made to run it off the mains, the makers, Stuart Turner Ltd., Henley on Thames, Surrey, claim will operate from ordinary torch batteries. Described as an S.T. electric motor, it weighs 6 oz. and costs 25s. This is mounted in a plastic bowl.

The making of the octagonal bowl (Figs. 1 and 4) requires eight pieces of plastic—clear or coloured according to whether you wish to use the bowl merely as a fountain or for keeping fish. Remember when choosing the colours to keep in mind the surrounding furnishings and endeavour to match the latter rather than to introduce contrasting shades. Cut the pieces to size and shape as shown in Fig. 4—these will give you a finished bowl about 18½in. across the corners which is considered large enough for the average table decoration. Cut one piece and use this as a template in order to make all the others exactly the same size. The edge decoration is simply two angles running from the corners to the centre of the facet and a distance of about ⅝in. is sufficient. Any alternative shape can be employed.

Setting these sections to the required shape needs patience, and one method is to use a ring of putty into which the pieces are inserted while the cementing process takes place. There is no point in allowing the putty to harden as this material is merely a holding medium and with the edges pressed close together a spot top and bottom is sufficient to hold each piece securely for a while to enable a final examination to be made before completely sealing each joint. An additional refinement is to use small shoe brads driven into the base board in the form of an octagon against which the sections will contact before the edges are buried in the putty. A further check can be made with a cardboard template cut to the shape of the bottom of the bowl.

Key

A	Octagonal bowl	J	Coupling
B	Inner cover	K	Motor
C	Rubber pad	L	Pump
D	Nut	M	Lower bowl
E	Jet	N	Coupling
F	Delivery pipe	P	Rotor
G	Inlet pipe	R	Outer cover
H	Splash disc		

Adhesive

Use a mixture of cellulose nitrate or cellulose acetate chips and acetone for holding these details together. This is a good all purpose adhesive, but keep in mind that acetone is especially volatile and must be kept sealed when not in use. Clean the edges where the joints occur but as dirt and grease are seldom associated with plastic, there does not appear many problems from this direction. Each joint will require pressure until the cement sets, so proceed slowly and a perfectly shaped bowl should result. Once the desired octagon is achieved the closing of all the seams is carried out and then these are carefully dressed in order to remove any jagged corners.. A smooth file is ideal for this work and a brief polish with fine sandpaper will soon take out any marks left by the file.

The shaping of the disc on to which the water falls is easily done. A circle is drawn with the aid of a compass on a piece of paper and this glued on to the plastic. Sawing and filing round this circle is a

TABLE FOUNTAIN

simple matter. Centre pop the centre point made by the compass and open out the hole until it fits the jet. Radius the edge of this disc with a very fine grade sandpaper.

Similar tactics are used when cutting out the octagonal floor of the bowl and a paper template will give a close approximate size leaving just enough for a few final rubs with a file to ensure it fits over the inner member and to the side walls of the bowl. Small triangular pieces of plastic—there are eight of these, fit into the corners as shown in Fig. 4 and these adequately support the floor and the inside cover over the working parts. They are secured in the same manner as the bowl.

The Pump

This is of simple rotary design as can be seen in Figs. 1 and 2 and it has the added advantage of being constructed from scrap materials. The pump casing is a slice from a short end of bronze bar. Brass will give long service despite the soft nature of this metal, and aluminium is yet another alternative though its use will mean installing bushes as bearings for the shaft as this material is too soft for continued working in this manner. Do not use ferrous metal.

The machining of the outside diameter of the casing is perhaps advisable in order to provide a clean and true diameter of the inlet port and the base detail which secures the pump to the base board. An important point concerns the height of the pump shaft and the motor spindle, as these must correspond to each other. Do not attempt to drill the tapping holes in the casing until the cover is drilled as the latter will do duty as a jig for this operation. Simply spot through the cover using the same drill as was applied for the drilling of that item—only a small dimple is necessary and this is then opened out with the tapping drill. If the drills are not changed the casing holes will be too large for the taps.

The Rotor

Draw the profile on a piece of paper, using fine lines. Glue it to the metal and lightly centre punch

By J. A. Waller

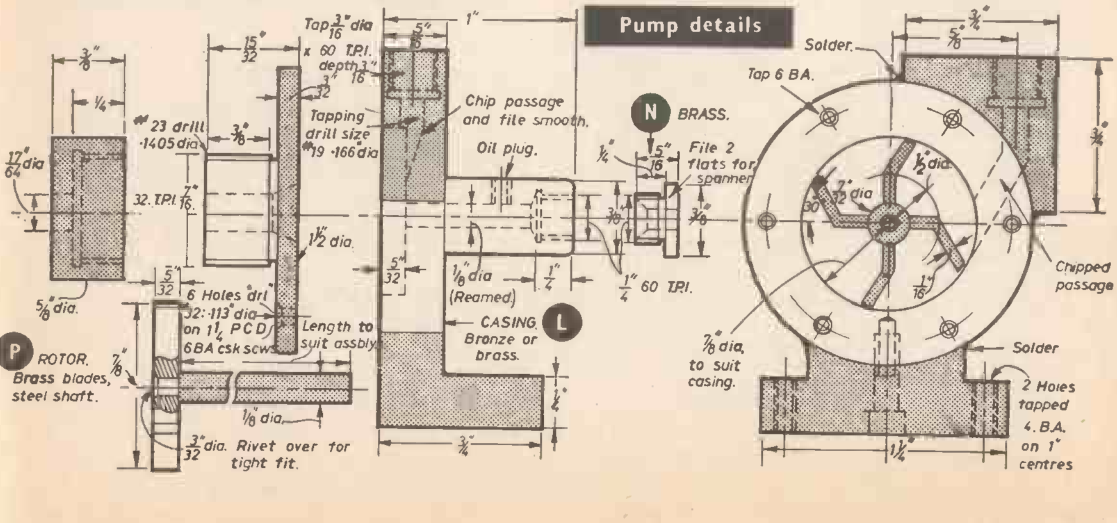
round the marked profile to transfer the shape to the rotor blank. Use a saw and file to remove the excess material. The rotor shaft is made from a piece of silver steel—for the uninitiated this is material accurately finished to size and it will not need reducing on the end to fit tightly into the rotor.

A block to receive the water inlet pipe is attached to the upper portion of this casing, but prior to this operation it is necessary to drill a 0·166in. dia. hole and then chip a water way into the main chamber. A reference to Fig. 2 will reveal this passage and an effort should be made not to restrict the passage of the water to the rotor. The block could be attached by screws but as a watertight joint here is essential, tinning the faces which eventually make contact and then sweating them together by applying the heat from a blow lamp, is the easiest way of holding them and at the same time securing a perfectly watertight joint. If a weep of water does appear round the edge when the pump is on trial, run a further fillet of solder round the two parts and this effectly seals the tiny crack.

A serious leakage of water is obviously not possible with a pump of this nature due to the close proximity of the electric motor, so the careful machining of the hole in which the rotor shaft rotates is essential. A perfect run fit is required—if the shaft rotates by an easy turning action of the fingers without a vestige of shake between the parts, this will do much to prevent water leaking through this bearing. The addition of a gland will also assist in preventing this problem. Exercise care and see that the packing material in the gland does not grip the shaft too tightly. The rotor must revolve in the casing without side movement, so first bore the recess in the casing and finally face the rotor to thickness; a clearance of 0·0005in. between the faces and 0·001in. on the diameter of the recess is ample clearance for these details.

The remaining items are simple turning jobs—the coupling details " J " have a disc of leather interposed between them, and three small bolts provide

Fig. 2.—Details and dimensions of the pump.



the necessary drive between the parts. Whether the jet " E " and the clamping nut " D " are made from either brass or plastic is a matter of choice. The latter material looks much better in designs of this description especially if one of the pastel shades is used, and with care the fine thread should not cause a serious problem (see Fig. 3).

Copper or Brass Tubes Can be Used

Cut them when the final stages are reached and the bowl, inner cover, pump and motor have been temporarily assembled. A length of lead covered electric cable is ideal for determining the correct shape as this bends easily and is subsequently straightened out to the required length of pipe. Never attempt to make a sharp bend. In the first place the pipe will kink unless filled beforehand, and what is more important such bends restrict the water flow and so affect the jet height. Easy bends are essential so keep the tubes reasonably short.

side to provide the required moisture for a few water plants or flowers. The addition of plastic flowers is another suggestion as a decorative medium in both the upper and lower bowls. This design is for a single jet but if a cone is made with three or four holes about $\frac{1}{32}$in. dia., then this will give a multi-jet that is pleasing though perhaps not quite so spectacular as the single higher stream of water.

Hiding the cable is not a difficult problem to overcome; a suitable flower is useful as camouflage in this respect.

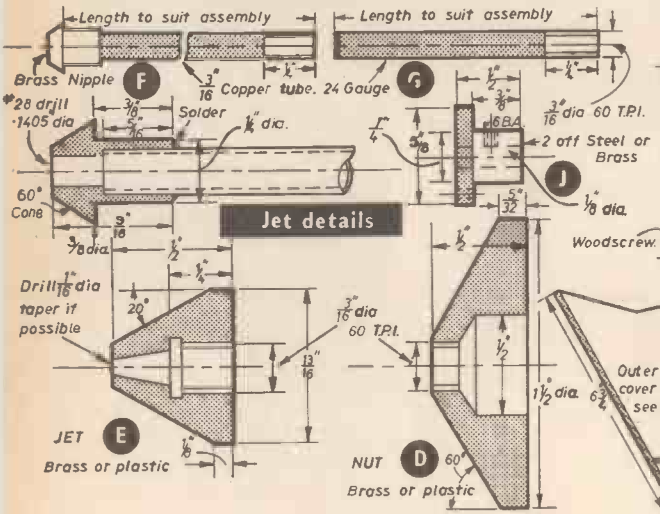


Fig. 3.—Details for making the jet.

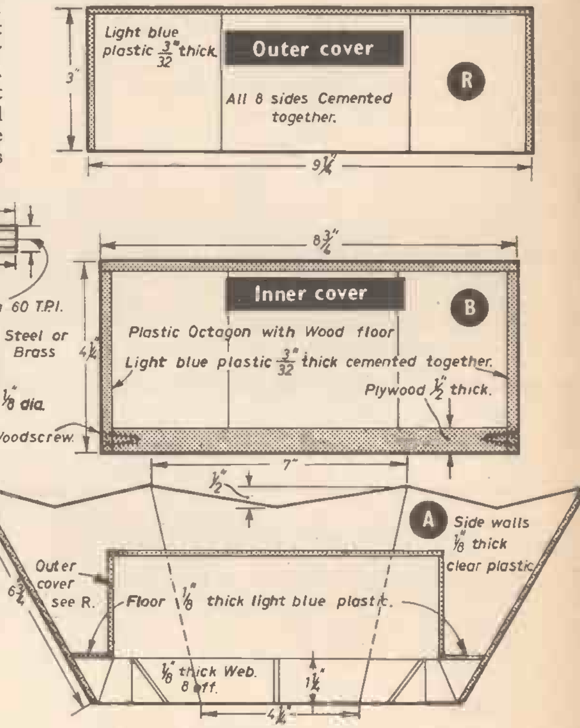


Fig. 4.—The bowl and inner and outer covers.

The inner cover shown in Fig. 4 is made of plastic but a plywood board was added to form the base for The pump and motor. If a transformer is included in the design to allow the pump to operate off the mains, this can also be housed in the inner cover. Make the pipes a tight fit in the plastic cover and see that the rubber joint also fits securely. Once the pump is operating it is only necessary to make an annual inspection, so these details are seldom disturbed.

Drill half a dozen ¼in. holes through the plywood to act as an escape route for any sudden rush of water—the possibility is remote, but they allow the water to run away, rather than to cause trouble with the electrical gear underneath the fountain.

A shallow bowl " M " is an additional feature—it solves the problem of any water drops falling on the surface of a table, and it also makes an attractive contrast to the octagonal shape of a bowl. On the other hand if a plastic bowl is made, the centre portion in which the octagonal member stands can be left dry, by including an inner wall to keep out the water, while the latter can be poured round the out-

While this bowl is a comparatively simple regular octagon, other more elaborate ideas suggest themselves once the pump is made and the motor is available. Water cascading down a miniature waterfall, though the latter is but a few inches high, is always attractive if the drop and surrounding scenery are made to match. For instance a plastic sheet overhanging in much the same way as the plastic disc used in this example to give the effect of a fall will look delightful if the water is pumped into a channel eventually to drop over the edge on to a collection of tiny rocks. A stream running into a fish tank is yet a further suggestion; a great deal of water is not necessary if the width of the stream is restricted to about 1in. Finally, there remains the colouring of the water or installing a series of coloured lights which change their colour every few seconds.

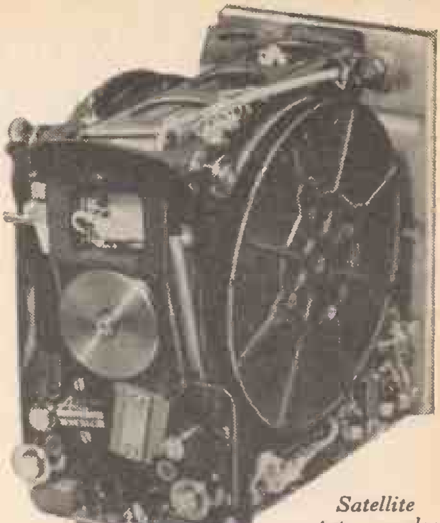
It is recommended that a few rocks are placed on the floor of the fountain whether fish are allowed in the fountain or otherwise as this gives the impression of looking down into a pool rather than on the plain bottom of a bowl.

SCIENCE NOTES

The Hawker P.1127

Sir Sydney Camm, designer of the famous Hurricane and Hunter fighters is responsible for Hawker's latest design shown in the photograph below. Information is still classified but the basic dimensions of the aircraft are length 41ft. 2in.; span 24ft. 4in.; height 10ft. 3in. Power for both VTO and forward flight is provided by a Bristol Siddeley BS53 engine via movable jet nozzles. The P.1127 is not merely a research aircraft but is intended as a fighter.

Two views of the Hawker P.1127.



Satellite tape recorder

Satellite Tape Recorders

Five tape recorders like the one shown above are orbiting the earth at 20,000 miles per hour in the U.S. communications satellite Courier 1B. When in range of a ground station, Courier can receive 340,000 words in a five-minute period. The tape recorders store the information until it is later relayed to the next station on the command "transmit."

The tape units are each about the size of a transistor radio and can each record, reproduce and erase. In spite of the small size the prime design factor is reliability in extreme environmental conditions of altitude, temperature, humidity, vibration and shock. The units were developed by Consolidated Electrodynamics Corp. and the tape produced by Minnesota Mining and Manufacturing Co.

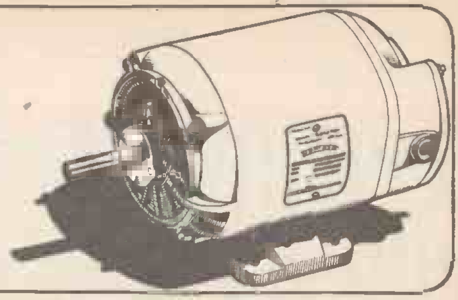
G.E.C. Research

Many large firms in all branches of industry have permanent research departments and one of the foremost of these is run by G.E.C. The two photographs on the right show two widely divergent types of research at present being investigated. On the far right a crystal of ruby is shown being grown from a small seed up to a maximum of 1½in. in an oxy-hydrogen flame at about 2,000 deg. C. The ruby is for a MASER which is a weakly magnetic crystal into which energy can be fed at one wavelength and extracted at another. A microwave signal incident upon the crystal can be amplified by the transfer of energy from an independent source of shorter wavelength radiation. Research is aimed at providing an improved crystal.

The other photograph shows a critical light distribution test being carried out on a prototype lantern, using a photometer with a large rotating mirror. The lantern has been developed for a high pressure mercury vapour fluorescent lamp.

(Above) Light distribution test. (Right) Growing rubies.

DIAGNOSING SINGLE-PHASE MOTOR FAULTS



BY J. L. WATTS

A SMALL electric motor (under 1 h.p.) may fail to start if it is too heavily loaded at starting; check this by seeing if the motor will start up unloaded, after removing the belt or otherwise uncoupling it from its load.

The obvious cause of a motor failing to start when unloaded is that there is no supply at the motor terminals. This might be due to a faulty contact at the switch, plug, socket-outlet or other point, a melted fuse, broken or disconnected wire, or even due to the supply being cut off.

In case of doubt it is useful to apply a mains-voltage 15W. test lamp to the motor terminals, as in Fig. 1. If the test lamp fails to light at the motor terminals, it should next be applied to the socket outlet.

If the test lamp again fails to light probably one of the circuit fuses has melted. If all the fuses are intact, and the contacts and connections of the fuses and main switch are sound, it is possible that one of the sealed service fuses belonging to the supply authority has melted. In this case, of course the supply authority should be advised. Should the test lamp light at the socket outlet, but not at the motor terminals, an open circuit between the plug and motor is indicated. In most cases the cause will be found by careful inspection of all the connections.

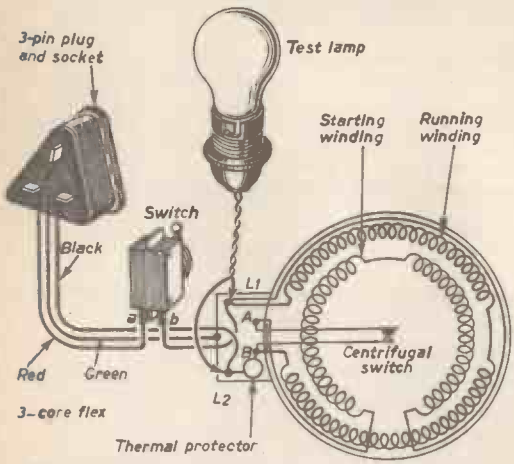


Fig. 1.—Supply testing a 1-phase induction motor.

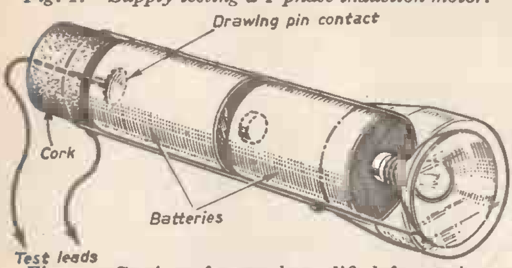
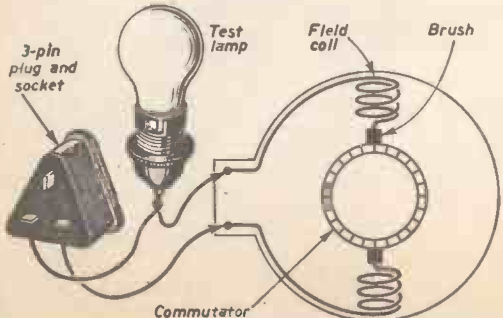


Fig. 2.—Section of a torch modified for testing.

Fig. 3. (Below)—Testing for an open circuit in a series motor.



Open Circuit Testing

Some tests may be necessary, however, to detect such an open circuit. In the case of the motor circuit shown in Fig. 1, the motor may be switched on and plugged in, and the leads of the test lamp applied to the terminals a and b of the switch. If the lamp lights this indicates that the switch contacts are not closing properly. The test lamp may be similarly applied to the ends of any part of the circuit which should be directly connected together, e.g. between L and a, b and L_2, L_1 and N. In each case the test lamp should not light, if it does it indicates there is an open circuit in the cable between the test points, and a new cable may be required. This test will give reliable results provided there is only one open circuit.

Some types of induction and capacitor motors have a thermal protective device incorporated, as connected between terminals L_2 and B in Fig. 1, and an open circuit may occur in this device due to faulty contacts or connections, or due to the device requiring to be reset by hand after it has opened its contacts due to the motor having overheated. An open circuit in this device would be indicated if the test lamp lights when applied between terminals L_1 and L_2, but not when applied between L_1 and B.

A Modified Torch for Testing

An ordinary torch can be used also for testing for open-circuits when modified as in Fig. 2. When the torch is switched on the bulb will light if the test leads are applied to two ends of a circuit between which there is a resistance of less than about 5Ω. The motor should be completely isolated from the supply before using this device. The test leads may then be applied to two points between which an open circuit is suspected, such as the ends of a cable conductor. The bulb will light if there is no open circuit; but will fail to light if there is an open circuit, or the device is being used to test a part of the circuit between which there is a high resistance.

Testing for an Open-circuited Motor

If, after checking the points already detailed, the motor refuses to start; there is a defect in the motor. Check that the motor is not jammed, due to a seized bearing; dirt, varnish or foreign matter in the radial air gap between the rotor and stator; the motor being incorrectly assembled;

bearings out of line; or the rotor rubbing on the stator due to a worn bearing.

If free, the most likely cause for non-starting is an open circuit in the motor, particularly with a single-circuit motor, such as a series, universal or repulsion type. This can be checked by connecting the small mains-voltage test lamp in series with the motor and switching on, as in Fig. 3. The test lamp should light if the motor is not open-circuited. In a series or universal motor the most likely cause is that one of the brushes is not making contact with the commutator, as might occur due to the brush sticking in its holder, being worn, or not having sufficient pressure. Alternatively the commutator may be rough or dirty, and require smoothing with fine sandpaper. The intersegment micas may be projecting above the surface of the copper segments in the commutator; in which case the micas should be carefully cut down about $\frac{1}{64}$in. with a hacksaw blade.

Another possibility is an open circuit in one of the series field coils, which are usually connected between the motor terminals and the brush holders, as in Fig. 3. To check, apply the supply to each individual field coil in turn through the small mains-voltage test lamp, as in Fig. 4. If the lamp fails to light an open circuit in the field coil is indicated, and the coil will need rewinding.

The repulsion type of motor has its stator windings connected directly between the motor terminals; together with a wound armature and commutator on which are brush holders which are short circuited together and usually not insulated from the frame of the motor. If such a motor sounds quite dead when switched on, and the small mains-voltage test lamp fails to light when connected in series with the motor as in Fig. 3, an open circuit in the stator windings is indicated. If the fault is not at one of the stator connections in the machine it will need some rewinding. Similar remarks apply to shaded-pole induction motors, which have a squirrel-cage rotor.

Induction and Capacitor-Start Motors

In the case of a single-phase induction and capacitor types of motors there should be two parallel circuits between the motor terminals when it is at a standstill. The main stator windings, usually having leads of the same colour are connected between the motor terminals. The starting winding, also usually having leads of another colour, is connected in series with a centrifugal switch in most cases, this starting circuit being connected directly across the motor terminals in a single-phase induction motor, as in Fig. 1; and connected to the motor terminals through a capacitor in a capacitor-start motor. The centrifugal switch should open to cut out the starting winding (and capacitor if fitted) after the motor has accelerated to about three-quarters of its normal speed at starting.

If such a motor is switched on with an open circuit in one of its parallel windings it will hum but will not be self-starting, even when unloaded. However it will accelerate in whichever direction it is rapidly spun round before switching on. No motor should be allowed to remain stalled whilst switched on or it is likely to burn out. If there is an open circuit in the running winding the motor will slow down again slightly after reaching the operating speed of its centrifugal switch, and then accelerate again slightly as the centrifugal switch recloses, the motor continuing to fluctuate about three-quarters of its normal speed. It should not be allowed to continue running like this. If the connections to the main stator windings are sound some rewinding will be necessary.

If the motor runs up to its normal speed when thus started by hand, an open circuit in the starting circuit is indicated. The centrifugal switch should then be checked to make sure

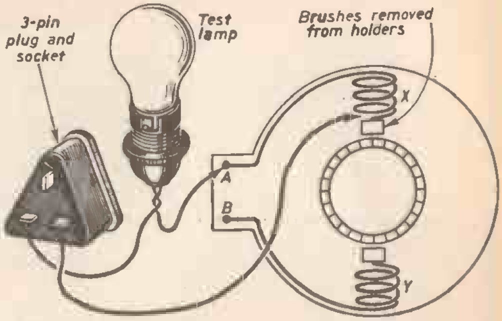


Fig. 4.—Testing for an open-circuited field coil in a series motor.

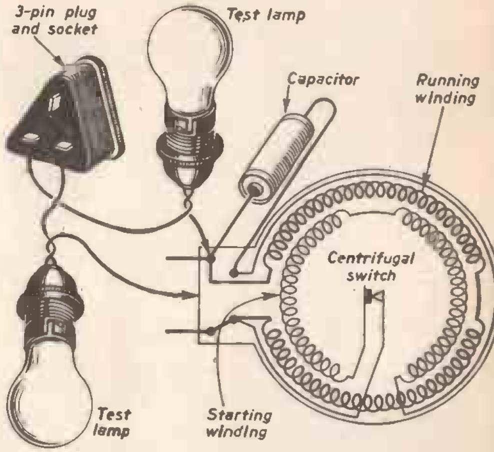


Fig. 5.—Testing for an earth fault on a capacitor start induction motor.

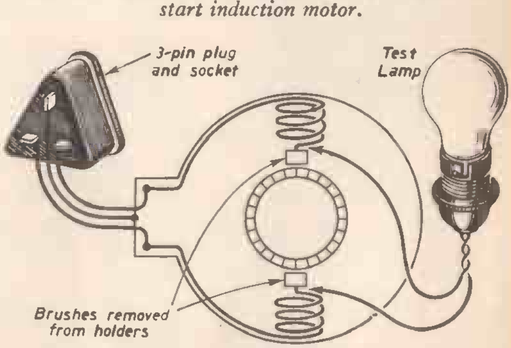
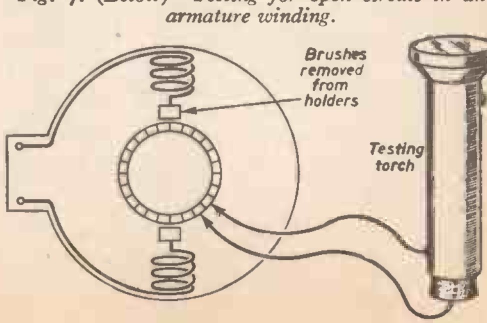


Fig. 6.—Testing a series model for short circuited armature.

Fig. 7. (Below)—Testing for open circuit in an armature winding.



that its connections are sound, its contacts in good condition, and that its contacts are closed when the motor is at rest. If the centrifugal switch is in order, the fault may be in the capacitor (if fitted). Try connecting a mains-voltage lamp across the capacitor terminals and switching on the motor at rest. Various sizes of mains-voltage lamp may be tried for no more than a second or two in each case. If the motor then starts up unloaded, possibly in the opposite direction to normal, and especially if a test lamp then lights during starting, it is likely that the capacitor is faulty, and a new capacitor should be fitted. If even a small test lamp fails to light when thus connected across the capacitor it is likely that the starting windings are open-circuited and may need rewinding.

Testing for an Earth Fault

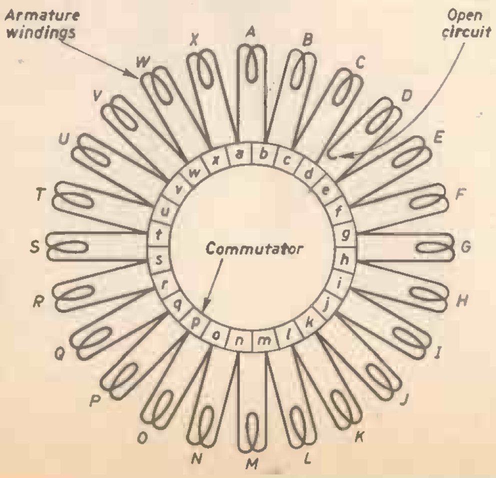
Another fault which may cause a motor to hum but not start, when switched on to the supply unloaded, and cause a fuse to melt, is an earth fault, i.e. failure of insulation between a conductor and the earthed motor case. This may be checked by connecting a small mains-voltage test lamp in each pole of the supply with one lead applied to the motor case, and the other lead to each motor terminal in turn, as in Fig. 5. The motor case should not be touched whilst thus testing, and the motor must not be connected to the supply except through the test lamps as shown. If there is an earth fault, one or both test lamps should light.

In this event the various parts of the motor, i.e. the individual stator windings, or field coils, the centrifugal switch, brush holders, armature windings, etc., may be completely disconnected from each other and the supply applied through the test lamps to each part and the motor case. The part which then causes the test lamp, or lamps, to light is the one on which the earth fault exists.

Short Circuits

Another cause of fuses melting is a short circuit on the windings and this is often difficult to check without being able to measure the resistance of the windings. Such a fault may or may not prevent a motor starting and is usually accompanied by a smell of burning and overheating of part of the motor, often with the emission of smoke. If an ammeter is available this may be connected in series with the motor. Should the motor take more than about half its rated full-load current when running unloaded, with overheating of some distinct part of the motor, a short circuit or an earth fault is likely, necessitating some rewinding. Table 1 gives the approximate full-load current of typical 240V. single-phase A.C. motors, which may be taken as a guide where the current is not marked on the motor, although some rather inefficient motors may take more current. The full-load current of a motor of given horse power is approximately inversely proportional to its rated voltage.

Fig. 8. (Below)—Effect of an open circuit in the armature winding of a series motor or a repulsion motor.



Horse Power	Watts output on full-load	Approximate full-load current on 240 volts A.C.
1/30	25	0.4 amps
1/20	37	0.47 ,,
1/16	47	0.56 ,,
1/12	62	0.7 ,,
1/10	75	0.8 ,,
1/8	93	0.9 ,,
1/6	124	1.25 ,,
1/4	186	1.6 ,,
1/2	373	3 ,,
1	746	5.5 ,,

Table 1.—Approximate full-load current of typical 240V. A.C. motors.

Short-Circuit Tests on Armatures

A short-circuit on the armature windings of a repulsion or series type of motor may also cause difficulty at starting and may cause the fuse to melt. To test for a short-circuit on a repulsion type the brushes should be removed from their holders and the unloaded motor switched on to the supply. The motor should then hum but not start and the rotor should be free so that it can be turned either way. If, on the other hand, the rotor pulls into a certain position, and resists being turned from that position, the rotor is short-circuited. The short-circuited coil is likely to overheat. The short-circuit may be in the rotor windings, necessitating a rewind; or it may be in the intersegment micas, in which case the carbonised insulation may be scraped away. In the case of a repulsion-start induction motor, such a short-circuit might possibly be due to the commutator short-circuiting contacts sticking in contact with the commutator while the motor is at rest. This device should not move into contact with the commutator until the motor has accelerated to a fairly high speed.

The same indications of a short-circuit in the armature of a series or universal motor will be given if the motor is switched on to the supply unloaded, after removing the brushes from their holders and connecting the brush holders through a mains-voltage lamp or radiator, as in Fig. 6. The Watts rating of the lamp or radiator should be in the region of half the Watts equivalent of the motor output, the approximate value of which is given in column 2 of Table 1.

Other Causes of Fuses Melting

A universal or series type of motor may fail to start properly, possibly with melting of the fuse, if the brush holders are not in their correct position. The effect of slight shifts of the brushes may be tried, if possible, after marking the original brush position. Such a fault may also cause a motor to run at the wrong speed.

Fuses may also melt at starting if the field coils of a series or a universal type of motor are connected so that they create poles of the same magnetic polarity, instead of opposite polarity; or if the two sets of stator windings of a dual-voltage motor are connected with one set in reverse. Similarly the fuse may melt if the two sections of the stator windings of a dual-voltage motor are connected in series, instead of parallel, for use on the lower voltage; or are connected in parallel, instead of series, for use on the higher voltage.

A motor normally takes a much higher current to start it than it takes when running on full load, thus a fairly large fuse is often required for a single-phase motor, in spite of the fact that the current rapidly falls as the motor accelerates from rest. Some motors take up to as much as eight times the full-load current at the instant of switching on, and may need a fuse having a current rating of as much as three or four times the full-load current, or sometimes even greater if the starting load is such that the motor starts up slowly.

Tests for an Open-Circuited Armature

Sparking at the brushes of a repulsion motor or a series type of motor may occur due to the brushes being in the wrong position, or due to there being a short-circuit on the armature. Methods of testing an armature for short-circuit have been described previously. Sparking at the brushes may also be due to an open circuit in the armature windings, which fault usually results in burning of two adjacent commutator segments connected to the faulty coil. It is quite often possible to test an armature for open circuit by means of the modified torch shown in Fig. 2. To do this the motor should be isolated from the supply and the brushes removed from their holders. The testing leads may then be applied, as in Fig. 7, to each pair of adjacent commutator segments, repeating the tests right round the commutator. If the torch lights when connected to all pairs of segments except one; or lights less brightly when connected between one pair of adjacent segments than when connected between the other pairs, an open circuit in one coil is indicated.

For instance if there is an open circuit in the coil D connected between segments d and e in Fig. 8; when the torch is connected between d and e the current will have to pass through all the other coils E to C in series, the high resistance of which will reduce the light of the bulb or prevent it lighting at all. When connected between any other adjacent segments the current will have to pass through one coil only and the bulb will light.

It may be that the commutator connections need re-soldering, a broken wire re-connecting, or a coil or the armature rewinding. In any event it is advisable to check whether any of the intersegment micas of the commutator are carbonised, and, if so, to scrape out the carbonised mica and fill the resultant hole in with a paste of powdered mica and shellac varnish.

Low Starting Torque

If a motor starts up satisfactorily when unloaded but fails to start against load, it is probable that the starting load is too high, possibly due to a tight belt or lack of lubricant. Otherwise it may be possible to assist the motor by hand during starting, or to reduce the starting load by fitting fast and loose pulleys or a friction clutch, or by fitting pulleys of different ratio to drive the load at a reduced speed. The latter alteration will, of course, reduce the running load also. Alternatively it may be advisable to fit a larger motor, or a type of motor which has a higher $\frac{\text{Starting torque}}{\text{Full-load torque}}$ ratio.

Causes of Overheating

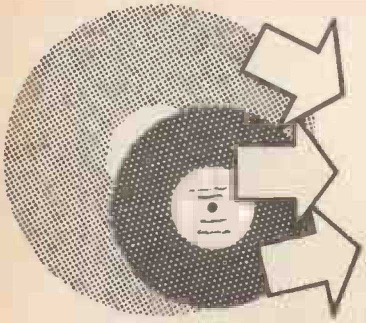
If, however, the motor overheats when running on its rated voltage it is possible that it is too small, driving the load at too high a speed, the brush position is wrong or there is a short-circuit or an earth fault on the motor. The motor current would then exceed the normal value, as would also be the case if the motor was wrongly connected. Overheating will also occur if a centrifugal switch fails to open after the motor has speeded up. This could be checked by switching on the motor in the usual way, but with a small mains-voltage lamp connected across the centrifugal switch terminals. The lamp should light, if it is sufficiently small, after the motor has accelerated. An auxiliary switch might be connected in series with the centrifugal switch, this being opened by hand after the motor has accelerated. If the motor then operates normally the centrifugal switch should be suspected. If a motor overheats on normal voltage whilst taking no more than its rated full load current, it is likely that its ventilation is being impeded by dirt or foreign matter in or on the motor or by the motor being in a small enclosure from which the heated air cannot escape.

It should, however, be noted that a motor may appear quite warm to the hand even when it is in no danger. Generally speaking it is satisfactory if the measured temperature of the motor windings does not exceed about 90 deg. F. more than that of the surrounding atmosphere.

A PYROMETER (*Conc. from page* 281).

watch the needle rise. If the thermostat is not fitted, the pyrometer is pushed through the door after a suitable interval and the temperature observed on the meter scale. There is no need to leave the pyrometer permanently in place as this can cause damage to the ends. Once the parts already in the furnace have reached the required heat they are withdrawn for quenching purposes. So turn off the furnace immediately the pieces are quenched and place the pyrometer on a sheet of asbestos while it cools down.

The meter and thermostat are best placed alongside the furnace and adjacent to the controlling switch as this keeps all the controls in sight and makes working conditions easier. A board with each part screwed on is much better than having each as a separate unit, and a chart above with various temperatures for the tools which are being treated is yet a further useful addition to this equipment. Check the pyrometer against a commercial thermocouple if possible. Anyone who can undertake this will find that results obtained with the method described above are surprisingly accurate.



Cut your own RECORD HOLDERS

Jameson Erroll gives details of a device for cutting holes and discs from all soft materials

ALTHOUGH primarily intended for cutting thick paper record holders for subsequent binding into album form, this machine has proved extremely useful for cutting paper and cardboard discs and for cutting circles in various materials (including soft metals)—and for large washers.

Figs. 1 and 6 show the completed machine. It will be seen that the silver steel rod attached to the pivot carries a cutting wheel and that, upon pressure being applied and the rod moved round, the extremely sharp and hardened edge of the wheel cuts into the paper or other reasonably soft material.

The Baseboard

Fig. 1 is a close-up of the assembled cutting mechanism of which Fig. 3 is a side view in detail. The lower pivot is mounted centrally on a perfectly flat, smooth board of hardwood, preferably oak about $\frac{1}{2}$in. thick. This should first be prepared and be of a size suitable for the largest job likely to be undertaken; a useful size is 15in. square. Underneath, across the grain, it can be strengthened by 2in. × 1in. battens at each end. See that all the sides make accurate right-angles as they will frequently be used as guides. Bore a $\frac{1}{4}$in. hole in the centre and put on one side for the time being.

The Pivots

The upper and lower pivots are the next job and Fig. 4 furnishes all the necessary detail. The upper pivot is prepared from a piece of 1in. round steel 2$\frac{3}{16}$in. long. One inch from the top, and completely through it, a $\frac{3}{8}$in. dia. hole is bored. This must be carefully done, since if it cants the silver steel rod will not be parallel with the top of the baseboard and, when pressure is applied, a severe strain will be imposed on the pivot. Similarly, if the hole is not dead central, the wheel will not cut a true circle. When this is done, a $\frac{5}{16}$in. hole is bored downwards from the top—dead central, of course—until it meets the first hole. This second hole is tapped $\frac{3}{8}$in. Whit. thread to carry the hexagon-headed bolt which holds the rod firmly in the desired position. Next to be drilled is another $\frac{3}{8}$in. hole centrally from the bottom end of the pivot; this is bored to a depth of $\frac{5}{8}$in. and its end finished flat with a milling tool. A $\frac{1}{4}$in. half sphere is now sunk as shown, this carries half the $\frac{1}{4}$in. ball bearing.

The lower half of the pivot, the foot, is somewhat easier to make and consists of a 1$\frac{7}{16}$in. length of $\frac{3}{8}$in. round steel which should be just a sliding fit into the head. This is cupped at the top with a similar half sphere but it should be the tiniest fraction under $\frac{1}{4}$in. deep so that the steel ball takes the pressure. At $\frac{5}{8}$in. from the top end the pivot is reduced to $\frac{1}{4}$in. dia. for the remainder of its length, about $\frac{1}{2}$in. of which is threaded $\frac{1}{4}$in. Whit. This is the portion which occupies the hole already bored in the baseboard, and is fixed underneath with a washer and nut.

The Cutting Wheel

This is shown in detail in Fig. 2, and for a really first-class job should be turned from the solid. It must withstand considerable pressure when cutting thick cardboard, etc.—and, while revolving freely on the rod, must otherwise be a solid, chatter-free fitting. Its depth of 1in. provides ample bearing surface, and its minimum width, also 1in., is strong enough to accommodate the $\frac{3}{8}$in. dia. central hole by which it is threaded over the rod. After the various shoulders have been cut, the gradual slope towards the maximum width (2$\frac{3}{8}$in.) furnishes the keen cutting edge. When the wheel is complete it should be taken to an engineer's shop to have the cutting edge case-hardened; it will quickly become blunt if this is not done, and an extremely fine but hard edge must at all times be maintained.

Two large hexagon nuts, with threads stripped and grub screws fitted, are required to complete the apparatus (see Fig. 6).

Making Record Holders

Since, as previously mentioned, the machine was intended to cut these, a few details as to size, etc., may not come amiss at this stage. Fig. 5, left and right, give necessary details. The cases are cut from flat pieces of suitably strong paper, 28in. long and 13in. wide, the extra $\frac{3}{4}$in. allowing for a flap to be cut as shown and later folded over and glued. The 3$\frac{1}{2}$in. hole is, of course, central, and allows the name of the record to be visible. The top finger hole can also be cut in the machine with proper positioning. Two fences at right angles should be clamped to the baseboard to serve as guides for the edges of the covers when folded and ready to be cut.

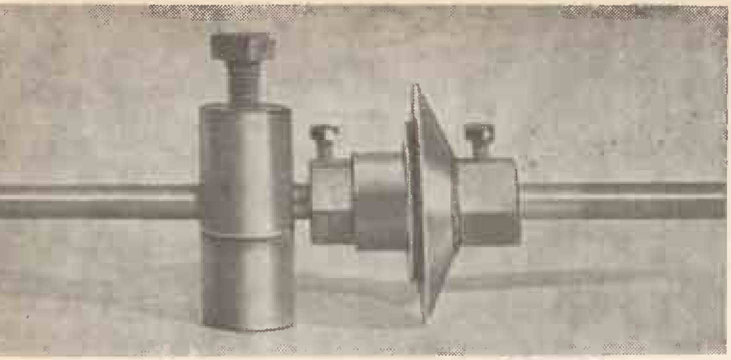


Fig. 1.—A close-up view of the main parts, i.e. pivots and cutting wheel.

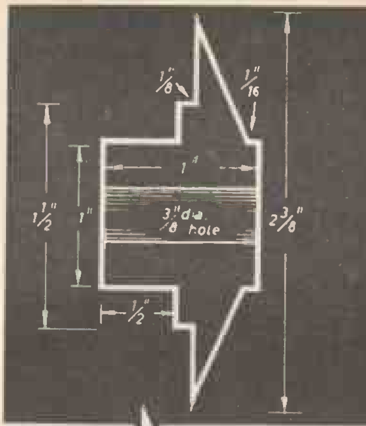


Fig. 2. (Top right)—Details and dimensions of the cutting wheel. This needs to be turned from the solid on a lathe.

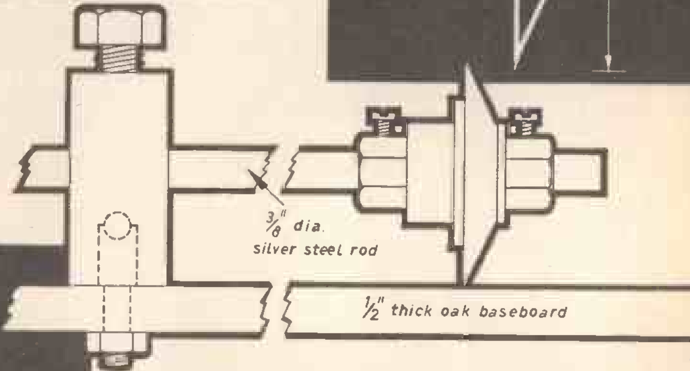


Fig. 3.—Side view of the cutter set up ready for use.

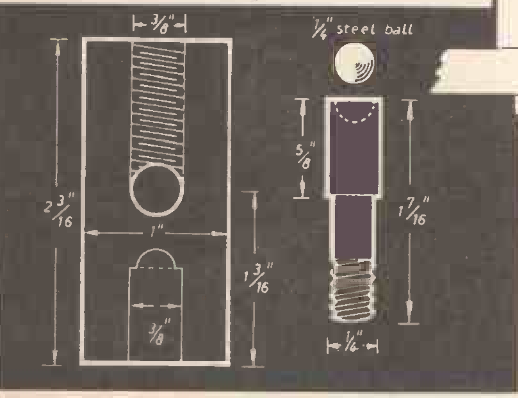


Fig. 4. (Left)—Half sections of the pivot head, ball bearing and pivot foot.

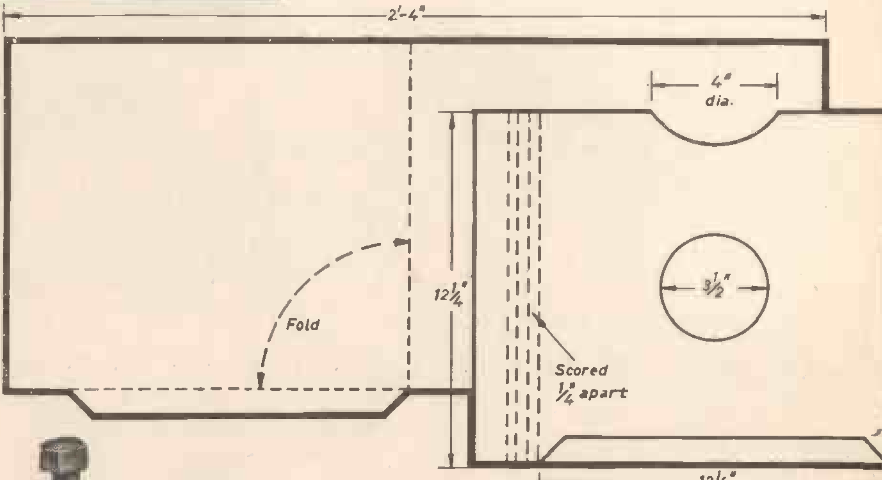


Fig. 5. (Right)—Details and measurements for cutting thick paper record holders for subsequent binding. One cover is shown folded, glued and cut and then scored for easy turning over.

Fig. 6. (Below)—A view of the completed cutting device.

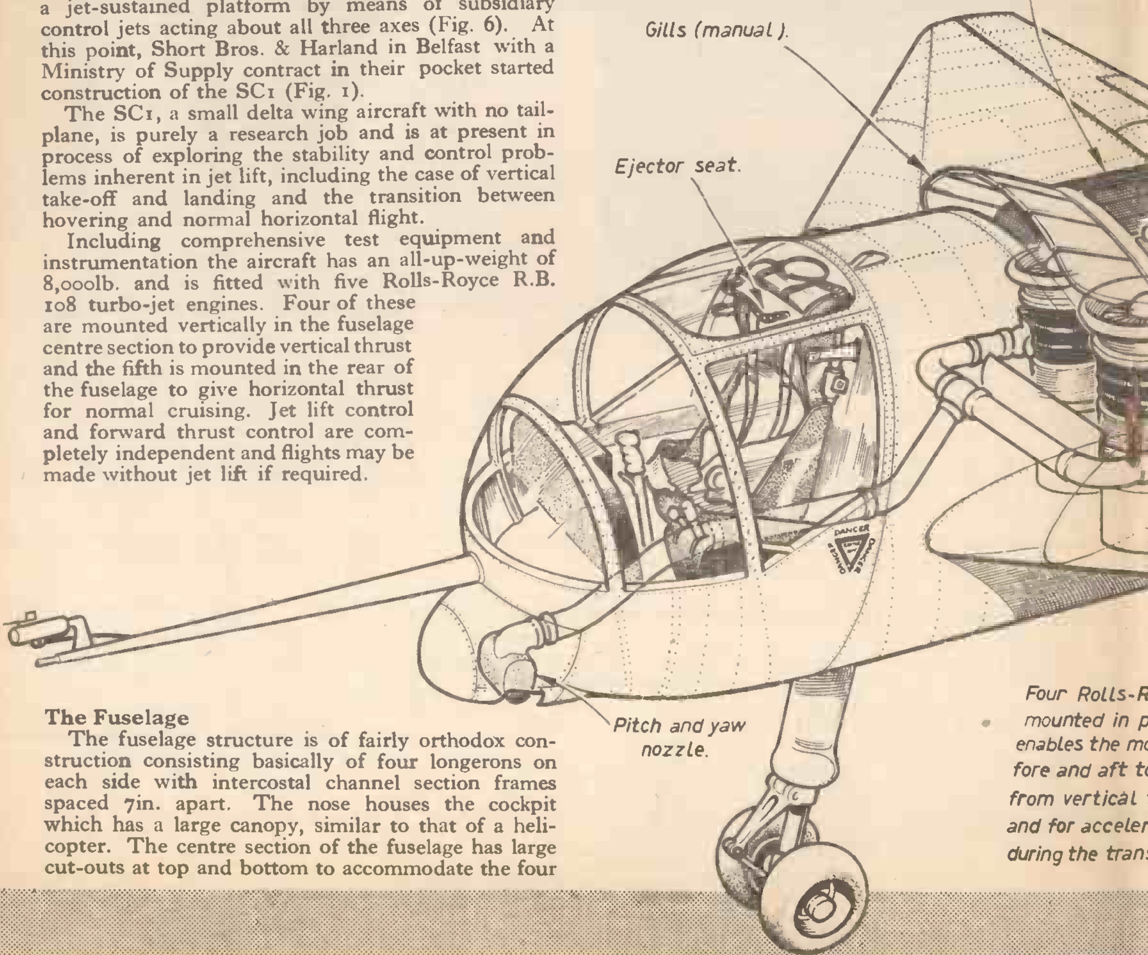
the Sh

Fig. 1.—Up she goes; The Short S.C.1 at a recent demonstration. Photo.—Reuter.

THE phrase " vertical take-off and landing " is already so well known that it has been cut down to an abbreviation. It is generally accepted as being the essential characteristic of the aircraft of the future. VTOL received its first practical support in August 1954 when the Rolls-Royce " Flying Bedstead " demonstrated that it was possible to stabilise a jet-sustained platform by means of subsidiary control jets acting about all three axes (Fig. 6). At this point, Short Bros. & Harland in Belfast with a Ministry of Supply contract in their pocket started construction of the SC1 (Fig. 1).

The SC1, a small delta wing aircraft with no tailplane, is purely a research job and is at present in process of exploring the stability and control problems inherent in jet lift, including the case of vertical take-off and landing and the transition between hovering and normal horizontal flight.

Including comprehensive test equipment and instrumentation the aircraft has an all-up-weight of 8,000lb. and is fitted with five Rolls-Royce R.B. 108 turbo-jet engines. Four of these are mounted vertically in the fuselage centre section to provide vertical thrust and the fifth is mounted in the rear of the fuselage to give horizontal thrust for normal cruising. Jet lift control and forward thrust control are completely independent and flights may be made without jet lift if required.



The Fuselage

The fuselage structure is of fairly orthodox construction consisting basically of four longerons on each side with intercostal channel section frames spaced 7in. apart. The nose houses the cockpit which has a large canopy, similar to that of a helicopter. The centre section of the fuselage has large cut-outs at top and bottom to accommodate the four

ort S.C.1

PROTOTYPE PLANE OF THE FUTURE

lift engines. These cut-outs are bounded by Titanium-sheeted fireproof bulkheads. The upper cut-out is for the engine air intakes and is closed by a built-up guard frame shaped to the fuselage contours and covered with wire mesh; the frame is hinged to the upper longeron on the starboard side. Aft of the rear bulkhead of the engine bay the longerons continue to a sloping bulkhead which carries the fin main spar. The dorsal fin is integral with the rear fuselage as in the engine air intake, into the top of which it is faired (see Fig. 3). Main dimensions are shown in Fig. 7.

The Mainplane

The mainplane structure is of two-spar construction, the front spar being placed along the 30 per cent.

Fig. 2.—An artist's impression of the S.C.1 cockpit.

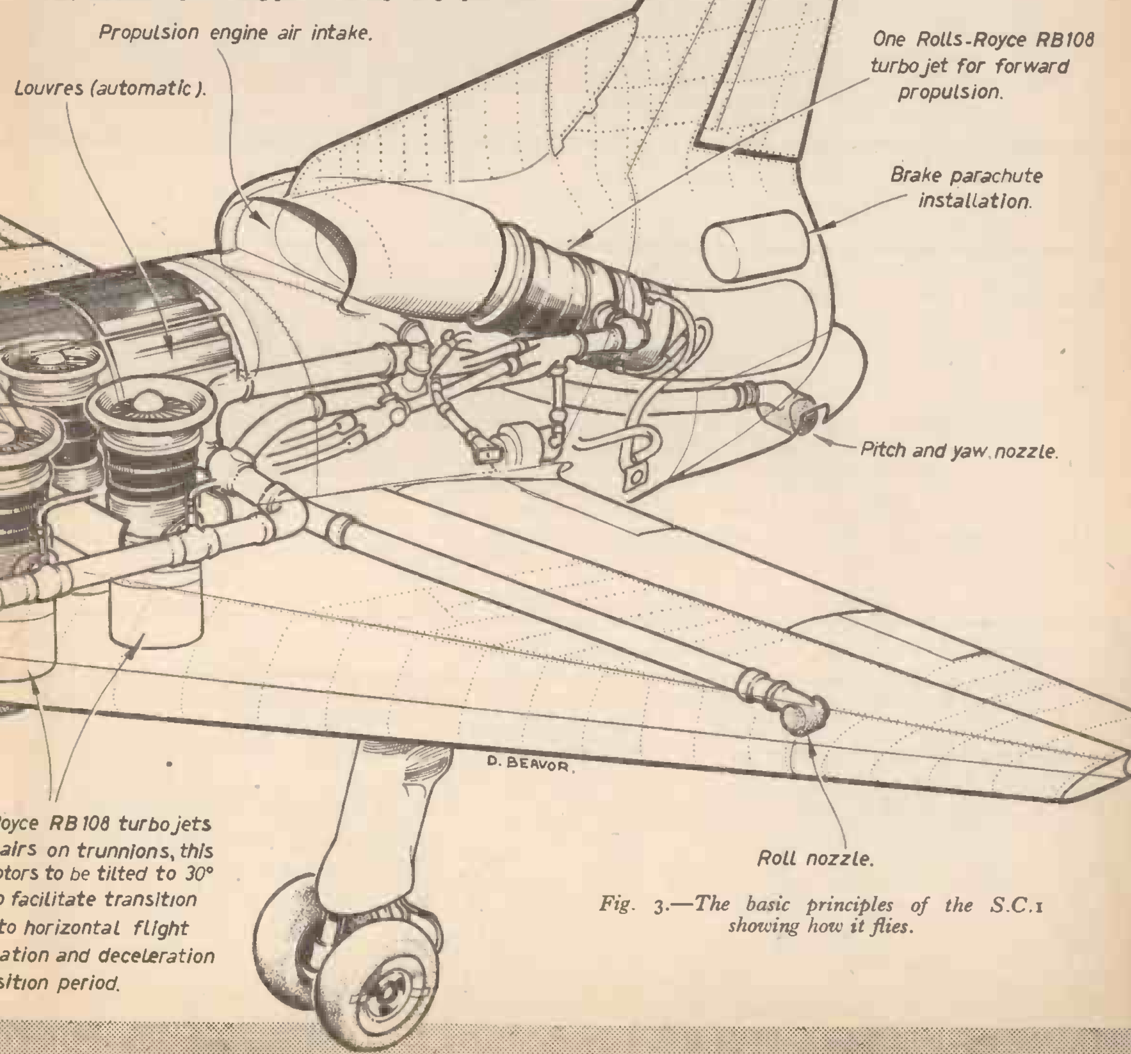


Fig. 3.—The basic principles of the S.C.1 showing how it flies.

Fig. 4.—Stabiliser jet nozzles (left to right) tail nozzle, nose nozzle and wingtip nozzle. Photos.—Short Bros. and Harland Ltd.

chord line, coinciding with the forward boundary of the engine bay, and the rear spar running in a true span-wise direction at the rear boundary of the engine bay. The major part of the leading edge is formed by a detachable fuel tank constructed of a series of flanged diaphragms with lightening holes. Outboard of the fuel tank the leading edge is formed by normal flanged nose ribs.

Normal flap-type elevators and ailerons are fitted to the trailing edge but no flaps are provided since a high maximum lift is not necessary in this case.

Undercarriage

A non-retracting undercarriage of the tricycle type is fitted and comprises two main units and a nose wheel unit each carrying fully castoring twin wheel assemblies. The main wheels are fitted with pneumatically operated disc brakes.

Because of the possibility of landing with a slight backward drift, the drag bracing of the main units is by means of hydraulic jacks which allow the wheels to be moved aft from the normal landing and take-off position. Long travel oleos are fitted to cater for the specified velocity of descent and allow adequate clearance between the jet nozzle and the ground.

Cockpit

The cockpit is similar to that of a helicopter, providing the best possible all round view particularly forward and downward. A conventional rudder bar and a pistol-grip type control column are used. The engine controls are positioned on a console at the port side of the cockpit and the majority of the electrical controls are grouped on a console at the starboard side. Engine and flying instruments are arranged on panels which are mounted comparatively low in front of the pilot to afford a good view forward and downward (see Fig. 2). An ejection seat is fitted.

The Power Unit

The Rolls-Royce R.B.108 rating engine is an axial-flow turbo-jet incorporating axial compressor directly coupled to a turbine.

There are two types, a lift engine to provide the lifting thrust and a propulsion engine for use in horizontal flight.

The lift engines are designed to be installed in pairs connected together by links at a point on the compressor outlet casing and supported on trunnions transversely in the aircraft fuselage centre section (Figs. 3 and 5).

The engine mounting is so designed that it can be tilted 30 deg. either way from the vertical axis, thus directing the gas stream either rearward or forward to allow the aircraft to be accelerated or decelerated in a forward direction during transition from hovering to horizontal flight and vice versa.

On this aircraft two pairs of lift engines are mounted vertically in the fuselage centre section, with an air intake in the top of the fuselage, and a propulsion engine is mounted in the tail end of the fuselage with an air intake in the top of the fuselage forward of the fin.

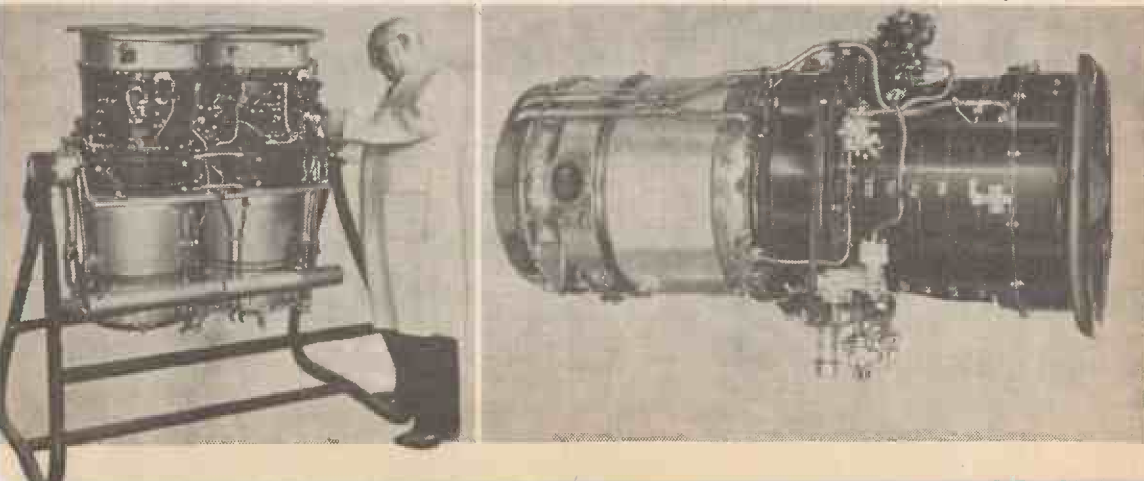
The two pairs of lift engines are linked together and coupled to a hydraulic jack anchored to the aircraft structure to tilt the engines forward or rearward.

Stabilisation System and Flying Controls

To stabilise the aircraft while hovering and during transition from hovering to forward flight, etc., air is bled from the compressor outlet casing of each engine and directed through the trunnion mountings and ducting to auxiliary jet nozzles at each wing tip and at the nose and tail ends of the fuselage (Fig. 4).

These are normally operated from an automatic

Fig. 5.—Two views of the Rolls-Royce R.B.108 axial-flow turbo-jet engine. Photos.—Rolls-Royce.



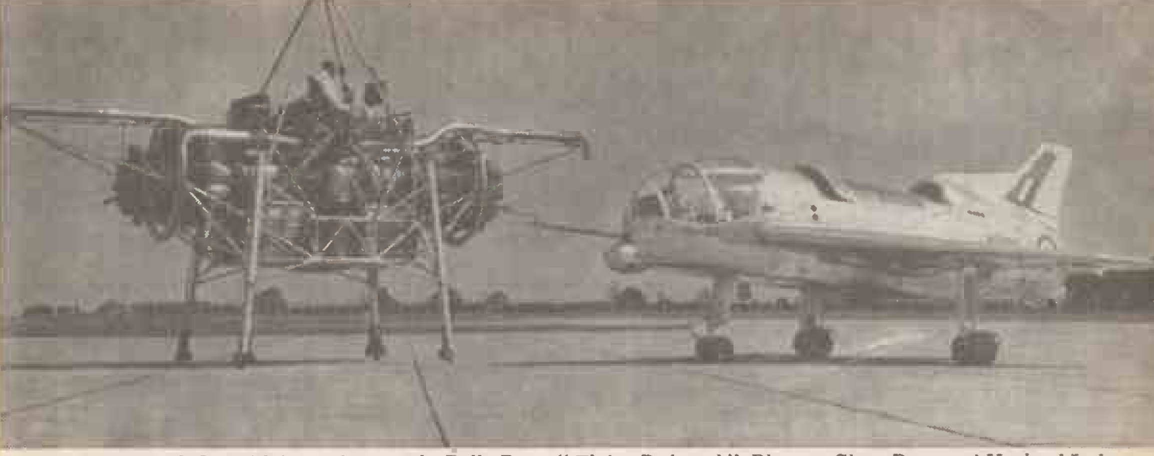


Fig. 6.—The S.C.1 with its predecessor the Rolls-Royce "Flying Bedstead." Photo.—Short Bros. and Harland Ltd.

stabiliser system, but may alternatively be controlled by the pilot.

Vertical Control

The ascent and descent lever in a vertical take-off aircraft is a primary flying control. In this aircraft the lift engine throttles are operated by a single lever gripped, in the manner of a helicopter collective pitch lever, by the pilot's left hand (lift to increase thrust). For forward flight with the propulsion engine, the pilot has a normal throttle on the left hand console; however, as he may wish to operate both throttles during transition from vertical to forward flight, a second (twist-grip) throttle has been provided on the end of the lift engines lever. These two throttles are coupled together, the twist-grip being electrical and motoring the main throttle, while the latter is directly coupled to the engine linkage but motion of the main throttle does not motor the twist-grip.

Normal Flying Controls

The flying control system has normal push-pull tubular rods to operate rudder, elevators and ailerons. There is a power control on the elevators, other controls being directly operated. The pilot's controls can also be made to operate the air nozzles; manual operation of these and/or the normal control surfaces can be selected through transition mechanisms operated by two levers, one for pitch and the other for roll.

Emergency Controls

A fire extinguisher system is provided for the propulsion engine. The extinguisher bottle is discharged either by push-button or, in the event of a crash landing, by emergency switches.

Should there be a failure of the main hydraulic system or the electrical control valve, a pilot-operated emergency control feeds hydraulic pressure to the engine tilt jack. The emergency system can move the jack to either of two positions, i.e. 5 deg. backward tilt or full forward tilt.

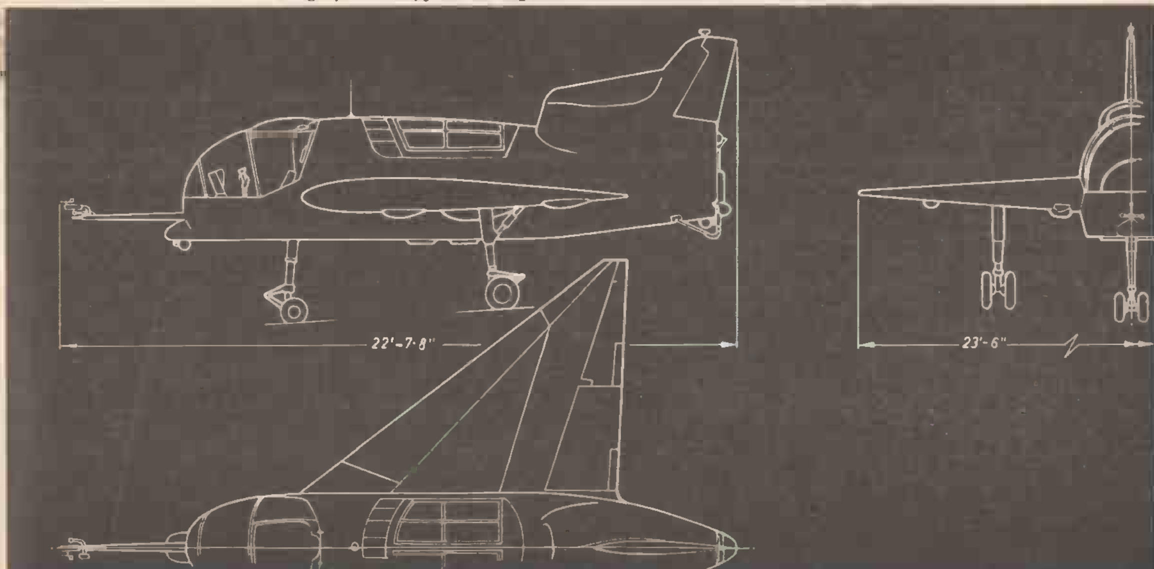
In the event of failure of the normal brake system pressure is supplied from the air bottle supplying emergency pressure to the transition mechanisms.

A braking parachute is installed in the tail end of the fuselage above the propulsion engine jet pipe.

Fuel is carried in two tanks in each wing, i.e. the rigid leading edge tank and the flexible bag tank between the spars.

Electrical power is supplied by an air-turbine driven 28V. D.C. generator and a 24V. 25 A.H. battery; a Venner 60 A.H. battery is provided for emergency use. Power supplies for flight instruments and auto-stabiliser system are provided through two type 100A. inverters with an additional inverter as standby.

Fig. 7.—Side, front and plan elevations giving main dimensions.



THE original table cost under 30s. and only the simplest tools were used to make it.

Make a start on the side pieces. These are made from ⅝in. wood and should be cut out together to ensure a perfect match. Fig. 2 gives the measurements. Drill the 3/16in. holes as shown, to take the bolts securing the legs. This done, mark off the angle "A" on to a length of 1¾in. × 9/16in. and cut off. Make a mark 3ft. 1½in. along and once again, using the side piece as a template, mark off the angle again and cut along the line. All four legs are identical so, using this first one as a pattern, make the other three. Next drill the holes for bolting to the side pieces. To remove any chance of a slip while doing this, lay the side piece over two of the legs and drill through the existing holes in the side piece.

The notches in the rear legs (to take the rear stretcher) should now be cut out. This is where the clamps come in useful. Clamp the two rear legs together and mark out and cut the notches in one operation. The legs can now be bolted to the side pieces using 3/16in. bolts, not forgetting washers.

The top piece (Figs. 1 and 3) should now be screwed in place. In the original this was made from ½in. solid wood, but only because it was to hand; ⅜in. plywood would do equally well. Drill pilot holes to guard against splitting and use 1¼in. screws.

Carefully lay the partly assembled "horse" upside down and screw the tray in place, once again using

AN ADJUSTABLE DR

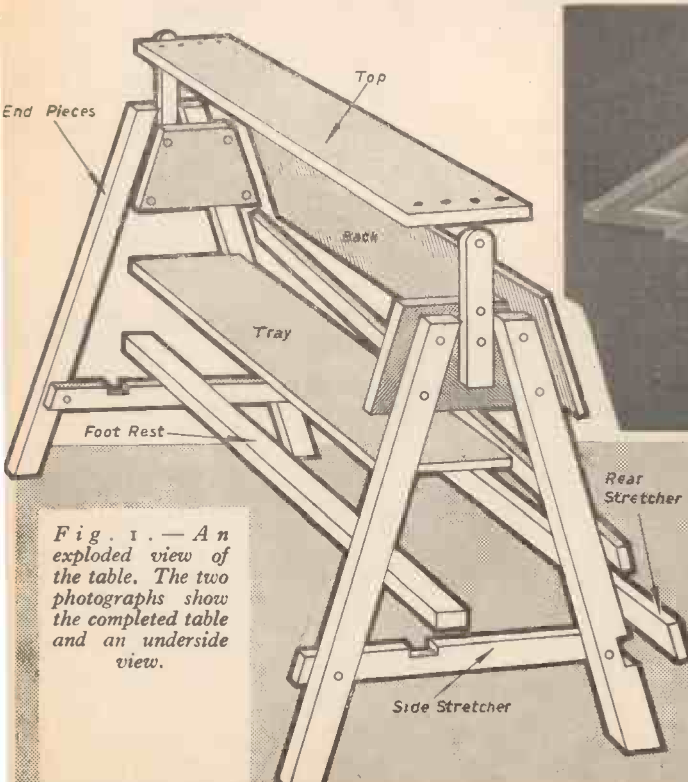
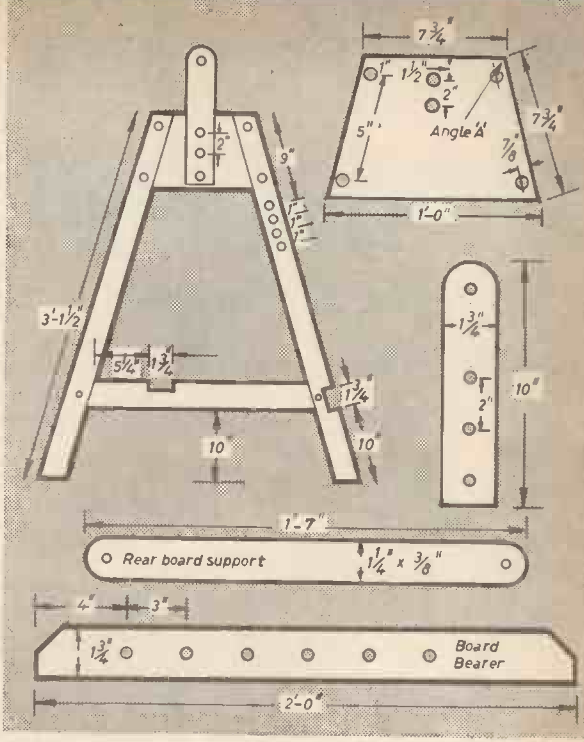


Fig. 1.—An exploded view of the table. The two photographs show the completed table and an underside view.

YOU WILL NEED

1¾in. × 9/16in. . . . . . . 40ft. 6in.
1¼in. × ⅜in. . . . . 4ft. 6in.
Plywood
One panel 2ft. × 1ft. × ¼in.
One panel 2ft. × 8½in. × ¼in. (Hardboard satisfactory).
One panel 2ft. × 7¾in. × ⅜in.
One panel 2ft. × 3ft. × ⅛in.
Two doz. 1½in. × 3/16in. bolts, nuts and washers.
Four wing nuts.
Assorted screws. (See text).

Fig. 2.—Measurements for the stand and positions of holes to be drilled.



1½in. screws in pre-drilled holes. The stand can now be put back on its legs while the back is fitted. It will be necessary to bevel the rear edge of the top piece to allow the back to sit flush. The back can either be ¼in. plywood or a good quality hardboard. It is secured using ½in. screws every 1½in. It only remains to bolt the board supports (see Fig. 1) to the side pieces before making a start on the stretchers.

The basic stand should now be quite steady and it only needs the addition of the stretchers and the rear diagonal brace to make it really sturdy. Fit the rear stretcher first. This goes into the notches already made in the rear legs and should be a snug fit. Nails or screws can be used to secure it.

Side Stretchers

To allow for any errors in construction so far, it is a wise plan to lay a length of 1¾in. × 9/16in. in position and mark off the angle made by the rear leg. Saw along this mark and then lay the stretcher in place. It lies behind the rear stretcher. Mark off the angle at the front and once again saw along the line. Repeat for the second stretcher. The stretchers are now the correct length. Make the notches to take the foot rest; Fig. 2 shows their position. Once again clamp the stretchers together to mark out and cut the notches. The stretchers are then bolted to the legs. Once again either nails or screws can be used to secure the footrest in place. The diagonal brace,

AWING TABLE

By A. B. Orr

which is made from 1½in. × ⅜in. wood, is located as shown in Fig. 1.

The drawing-board support (rear) should be made next. Fig. 2 gives the size. Drill a 3/16in. hole in each end. Fig. 2 shows the position of the 3/16in. holes drilled at 1in. centres in the right-hand-side rear leg to allow for adjustment of the slope of the board.

Drawing Board

In the original this was made from a 2ft. × 3ft. sheet of ⅛in. plywood battened with 1¾in. × 9/16in. Pirana pine. A similar sized sheet of ½in. or ⅝in. plywood would be better but this would cost considerably more. Fig. 4 shows the battening. It is very important that the sheet should be laid on a dead flat surface when glueing the battens in place. When the glue has dried on the battens, locate and glue the bearers as shown in Fig. 4 but do not forget to drill the adjustment holes first. These allow for the adjustment of the amount of overhang of the board.

If desired a 3ft. length of 1¼in. × 5/16in. can be glued to the lower edge of the drawing board, standing approximately ½in. proud of the top of the table to retain pencils, drawings, etc.

The board can now be bolted on to the board supports in a suitable position. Bolt the drawing board rear support in the last hole on the right hand bearer and select a hole in the rear leg that gives the board the desired slope. Use wing-nuts on all the adjusting bolts to facilitate ease of adjustment.

If an existing board is to be used then a cradle can be simply made as seen in Fig. 4. The original board bearers are made longer and a short piece of wood is attached to act as a stop (Fig. 3).

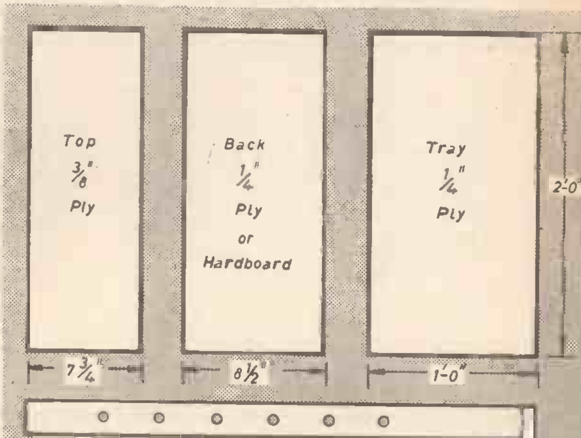


Fig. 3.—The three panels and alternative board bearer.

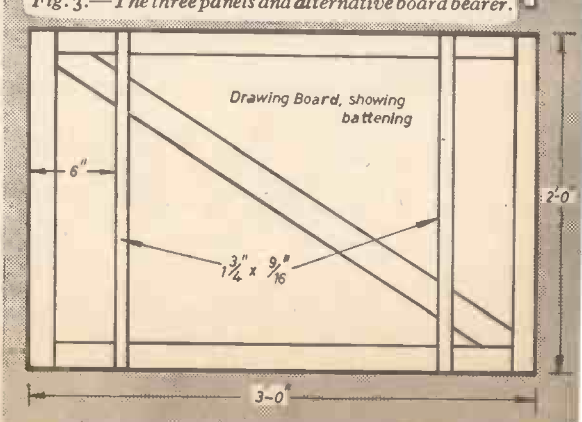


Fig. 4.—Drawing board details.

Now you've made the Adjustable Drawing Table on the previous two pages, why not try this

ADJUSTABLE LAMP

designed to use with it.

FIG. 1 shows the finished lamp. As will be seen, it is extremely simple to make and costs well under 10s. The dimensions given in Fig. 2 are those of the lamp illustrated and they can be altered if necessary.

Construction

The clamp used was bought in a local tool shop. Drill a $\frac{3}{16}$in. hole as shown, countersinking so that the head of a 3in. × $\frac{3}{16}$in. bolt lies flush with the under surface of the clamp.

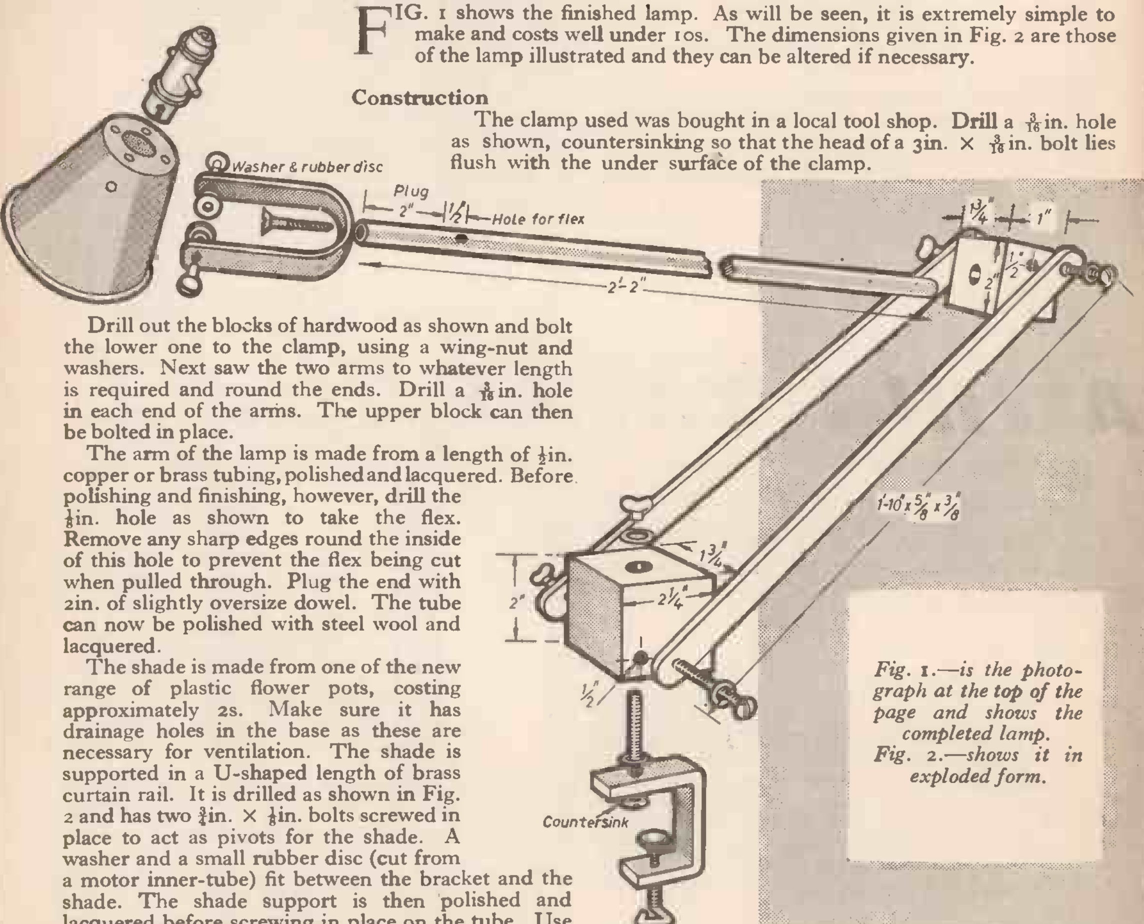


Fig. 1.—is the photograph at the top of the page and shows the completed lamp.
Fig. 2.—shows it in exploded form.

Drill out the blocks of hardwood as shown and bolt the lower one to the clamp, using a wing-nut and washers. Next saw the two arms to whatever length is required and round the ends. Drill a $\frac{3}{16}$in. hole in each end of the arms. The upper block can then be bolted in place.

The arm of the lamp is made from a length of $\frac{1}{2}$in. copper or brass tubing, polished and lacquered. Before polishing and finishing, however, drill the $\frac{1}{8}$in. hole as shown to take the flex. Remove any sharp edges round the inside of this hole to prevent the flex being cut when pulled through. Plug the end with 2in. of slightly oversize dowel. The tube can now be polished with steel wool and lacquered.

The shade is made from one of the new range of plastic flower pots, costing approximately 2s. Make sure it has drainage holes in the base as these are necessary for ventilation. The shade is supported in a U-shaped length of brass curtain rail. It is drilled as shown in Fig. 2 and has two $\frac{3}{4}$in. × $\frac{1}{8}$in. bolts screwed in place to act as pivots for the shade. A washer and a small rubber disc (cut from a motor inner-tube) fit between the bracket and the shade. The shade support is then polished and lacquered before screwing in place on the tube. Use a long screw, at least 2in., to screw the support into the dowel plug.

Cut out the hole in the shade carefully as the plastic is very brittle. Drill a series of small holes round a circle of sufficient diameter to take the fitting and then carefully cut away the webs between them and trim smooth with a file. When drilling the $\frac{1}{8}$in. holes in the side of the shade to take the pivot bolts, make distinct indents with the point of a pair of compasses to prevent the drill slipping and scoring the plastic. Once these holes have been drilled, carefully spring the U-shaped support in place.

Screw in the light fitting and take the flex down the inside of the tube and the light is finished.

YOU WILL NEED

- 2ft. 2in. length of $\frac{1}{2}$in. copper or brass tubing.
- A block of hardwood measuring $2\frac{1}{4}$in. × $1\frac{3}{4}$in. × 2in.
- A block of hardwood measuring $1\frac{3}{4}$in. × 1in. × 2in.
- 3ft. 8in. × $\frac{5}{8}$in. Pirana pine (or similar wood).
- A short length of flat section brass curtain rail.
- Three 3in. × $\frac{3}{16}$in. bolts, washers and wing nuts.
- $5\frac{1}{2}$in. plastic flower pot with drainage holes.
- Flex, light fitting, 60W. max. bulb and suitable clamp.

home-made

CHEMICAL LABORATORY APPARATUS

Part 7

By K. Given

This instalment deals mainly with Filtering Equipment

Experimental Preparation of Copper Sulphate

TO carry out this experiment using home-made equipment, copper oxide is placed in an evaporating dish and dilute sulphuric acid poured on it. The dish is gently warmed on a sand bath for some 15 minutes. If all the oxide disappears more must be added to neutralise the acid.

When cold the solution is filtered to remove the excess copper oxide and the filtrate is evaporated slowly until crystals begin to form. The solution is then left to crystallise.

Apparatus not so far described includes filtering gear, stirring rods and evaporating dishes and watch glasses.

Watch Glasses

Glass fronts to real watches, etc., may be used. Very good watch glasses may be made from the top portions of old radio valves having no top cap. The procedure of Fig. 38 (Feb.) is used, but no lip is formed. Lamp bulbs of about 15W. rating will also suit. When being heated all watch glasses must be treated with great care. A sand bath should be used and the heat increased only slowly.

Stirring Rods

Use ¼in. solid glass rod cut into 8in. lengths. Glass tubing of any kind can also be sealed by turning slowly just above the blue tip of a roaring bunsen flame. It is not advisable to use tubing without sealing it first.

Filtering Equipment

Filter funnels are cheap and can be purchased from any chemist. They must have a 60 deg. angle or the filter paper will not make an airtight fit.

The normal apparatus for filtering consists of a retort stand fitted with a ring, a funnel and a filter paper. A piece of wood drilled as shown in Fig. 41C may be used in lieu of the stand for some work. It is stood on top of a beaker or jam jar. If ¾in. wood is used the bottom hole should be ¼in. deep × just over ¼in. dia. The upper one should be ¾in. dia. If thicker wood is used it adds to stability and proportionately larger holes are needed so that the funnel is held vertically.

Preparation of Chrome Yellow Pigment

Obtain some lead acetate (poisonous) and potassium chromate from

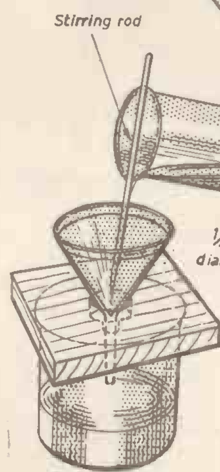


Fig. 42.—(Below) Pouring liquid into filter funnel.

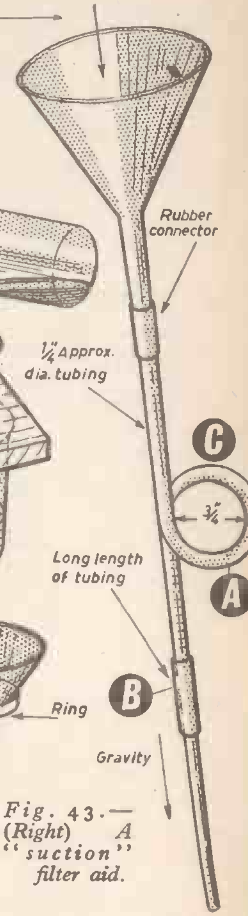
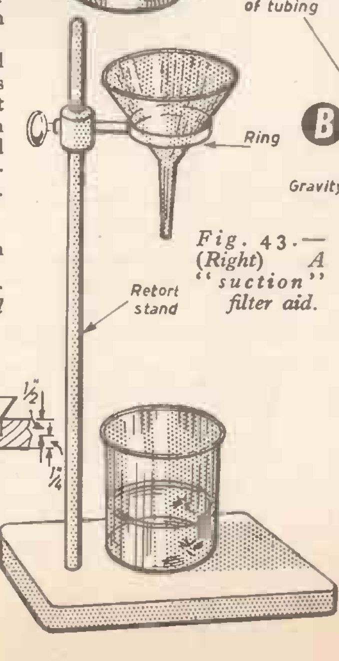
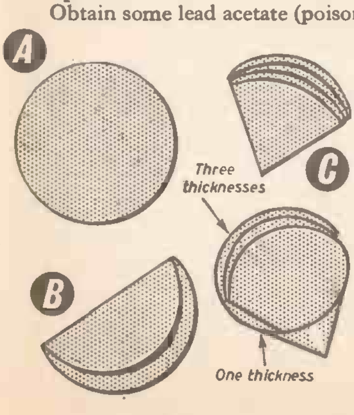


Fig. 43.—(Right) A "suction" filter aid.





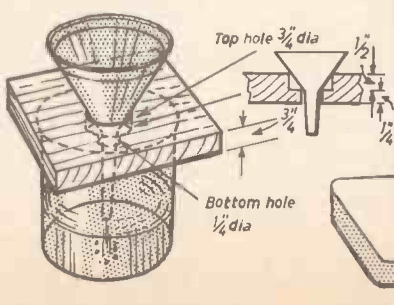


Fig. 41.—Basic filtering apparatus. A, B and C show how to fold a filter paper.

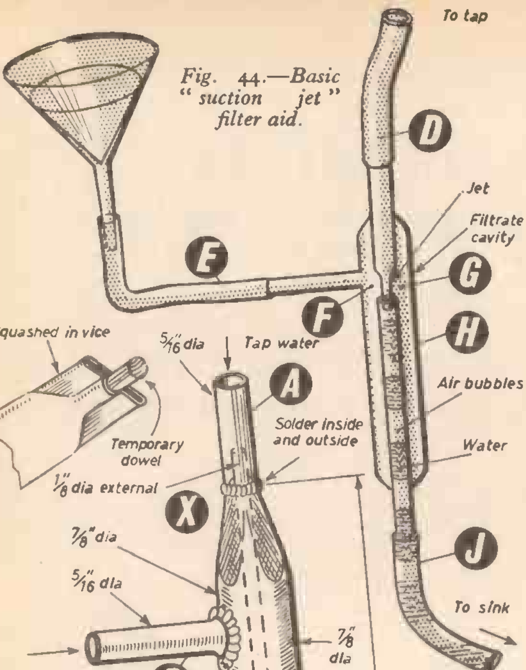


Fig. 44.—Basic "suction jet" filter aid.

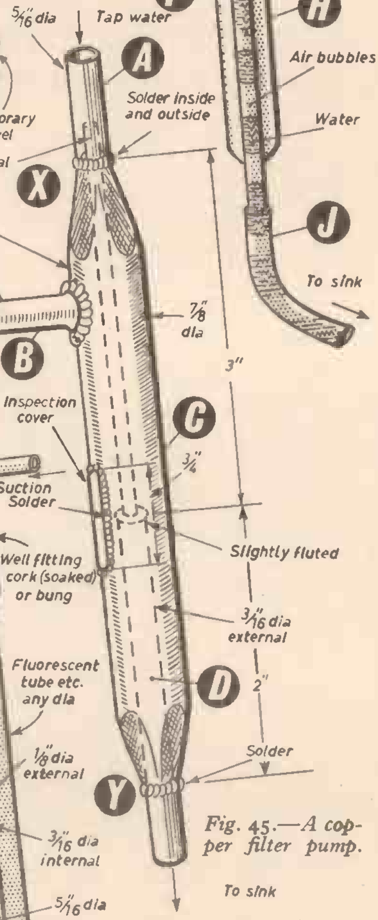


Fig. 45.—A copper filter pump.

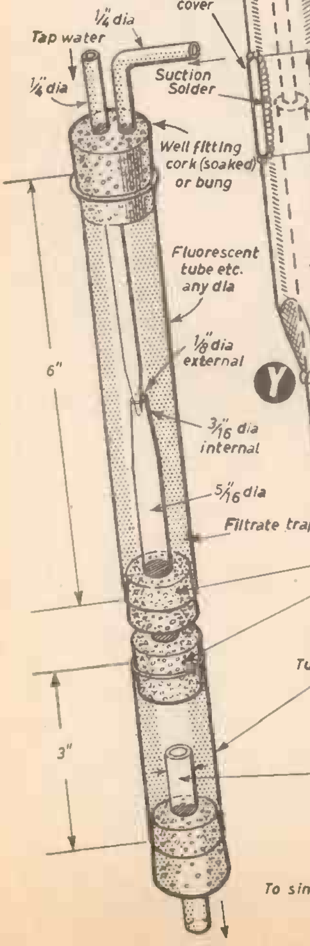


Fig. 46.—A glass and cork suction aid.

the chemist. Dissolve 3¼gm. of the acetate in distilled water and 2gm. of chromate separately in distilled water. Mix the two to obtain a brilliant orange yellow precipitate. Filter and wash. The filtrate, of potassium acetate solution, has no use. The lead chromate is poisonous and should be kept away from children. The correct method of pouring into a filter funnel is shown in Fig. 42.

Suction Filter Aid

To save time in filtering it is often helpful to apply a slight suction to the funnel. A small bore tube (about ⅛in. in bore) is heated in a bunsen flame and bit by bit coiled to a loop as shown. This loop is annealed in the yellow flame. The funnel is fixed in the top of a retort stand on a ring and the length of tube " B " in Fig. 43 is made about 18in.

Filtrate collects in the bottom of curve " A " and gradually goes over the top " C " when gravity pulls the column down along " B ". This pull causes a lowering of pressure within the tube and air pressure pushes liquid through the filter paper at an increased rate. This latter must be a perfect fit in the funnel or air will enter and destroy the suction.

Filter Pumps

Filtering may be quickened by using an adjustable suction. Too much suction will rupture the paper and only experience can tell one how much may be safely applied. Water pressure operated filter pumps are used for this work and they are quite easily made at home (Fig. 44).

Water from the tap enters at " D " and through the jet. Water thus gushes into the tube " G " and now and again takes a few bubbles of air with it, these are seen passing down the pipe " J " to the sink. Air is thus removed from the large cavity " F " and " G ". This causes a suction which is applied to the funnel via pipe " E ". If the water supply is adjusted so that none comes over the top of " G " the filtrate may be collected in the bottom of the large tube.

A Glass and Cork Filter Pump

The diameter of the large tube (Fig. 46) does not matter. Take an old fluorescent tube and with the hot wire apparatus already described crack it round in any convenient position. Leave the tube for half an hour and it will be found to have separated. It is unwise to pull the two pieces as fluorescent dust may do some harm when inhaled. Further cracks are made at suitable positions. The tube is washed in warm soapy water, the powder being kept away from hands and food.

The ends of the pieces cut must be examined to make sure there are no longitudinal cracks which would spread when corks were inserted.

The jet is made by heating a piece of ¼in. soda glass tubing somewhere along its length, turning all the time. Quickly remove from the flame and then pull out. Cut at a place where the jet is of the correct size.

The jet receiver is made of larger diameter tube which is treated in the same way. It is cut off so that the internal diameter is 3/16in. which will receive the ⅛in. external dia. jet made above.

Holes are carefully bored into well soaked corks and an extra hole made in the upper one to receive the suction pipe. The corks and their tubes must then be very carefully inserted so that they are perfectly airtight, the jet enters ¼in. approximately into the receiver and is central within it. The pump will now operate if sufficient pressure of water is available. Much better operation is however obtained by fitting an " air bubble trap " beneath.

The trap gives no difficulty and is made as shown in Fig. 46, the outlet going direct to the sink via a rubber pipe. A suction of over 3ft. of water was obtained and this is more than sufficient for filtering. After storage the pump must be soaked in water overnight to swell out the corks (or use rubber bungs).

A Copper Piping Filter Pump

A pump which is strong and always ready for use may be made from copper piping (Fig. 45).

The outer tube " C " is cut to length using a fine toothed hacksaw blade. Two old bits of dowel or bolts are required, one $\frac{3}{16}$in. and the other ¼in. dia. The large tube is heated to redness at one end and plunged into cold water. The tube is then pinched round the dowel using some mole grips, a small hammer and the vice. The other end is treated in a similar manner. (See inset Fig. 45.)

A small hole is cut or drilled in the side of the tube for an inspection cover. This hole is not used once the instrument is made and some readers may care to omit it. The fixing of the jet within the receiving tube is very difficult unless you can actually see it.

A piece of ¼in. o.d. tubing is then soldered into the prepared end. The end is also sealed with solder. Baker's Fluid or Killed Spirits should be used to make sure of a good air tight joint. The tube " A " is now tinned and soldered over the small tube. This is not strictly necessary, but it is easier to fit a pipe to this larger tube. The soldering must be done quickly, half at a time, or the small tube within will become unsoldered.

When these two tubes have been definitely and permanently fixed the receiving tube may be fixed. It is best to flute it a little at the top by softening and then using a taper punch. Viewing through the inspection hole it can be soldered perfectly as shown in Fig. 45. A small copper or brass sheet is then soldered over the inspection hole. The finished job is small, strong and very efficient, giving twice the suction of the glass prototype.

When in use turn on the tap pressure slowly until you estimate the suction is sufficient. The degree of suction may be ascertained by taking a long pipe down to the floor and dipping it into coloured water. The upper end is connected to the suction pipe. Inches of depression of water are then measured and can be converted into lb. per sq. in. (see any text book on physics or mechanics).

HOME MADE BATTERY CHARGER

(*Concluded from page* 275)

and in this case a 3-pin plug must be used. This completes the wiring. The wiring diagram (Fig. 5) clearly shows all the connections.

The sides of the charger are covered with perforated or expanded metal, of about $\frac{1}{16}$in. mesh. (See Fig. 1.) This gives good appearance and ventilation. If expanded metal is used, the flattened kind is best. A strip of the metal is cut of just the right width to fit between the panel and rear mounting board, in the recess provided; it may be in one or two parts and is held in position by ¼in. × No. 2 brass wood screws. If three core mains flex is used, the third core, the green-coded one, has the bared end connected to the perforated metal by passing it round one of the fixing screws, but under the metal. On each corner of the back and bottom is fixed a rubber headed tack, or rubber foot, those on the bottom to form feet on which the charger rests and those on the back to form rests should the charger be hung up on a wall. In this latter case a bracket will also be required on the back of the charger.

Fit the fuses to the fuse box. These are 1¼in. long fuse cartridges and the carrying capacities are 3A. for the L.T. and 0·75A. (750mA.) for the mains. For future reference, it is suggested that these values be marked on a piece of paper and this securely gummed inside the cover so as to indicate the correct position of each fuse. Finally, fit charging clips to the ends of the battery leads.

To use the charger, connect up to the mains, then fit the clip on the red lead to the + battery terminal and the clip on the black lead to the — battery terminal. Select the voltage required by means of the voltage selector switch, that is down for 12V. and up for 6V. Switch the charger on and adjust the rate of charge by moving the slider, up to increase the charge and down to reduce it.

PICTURES from a DISTANCE

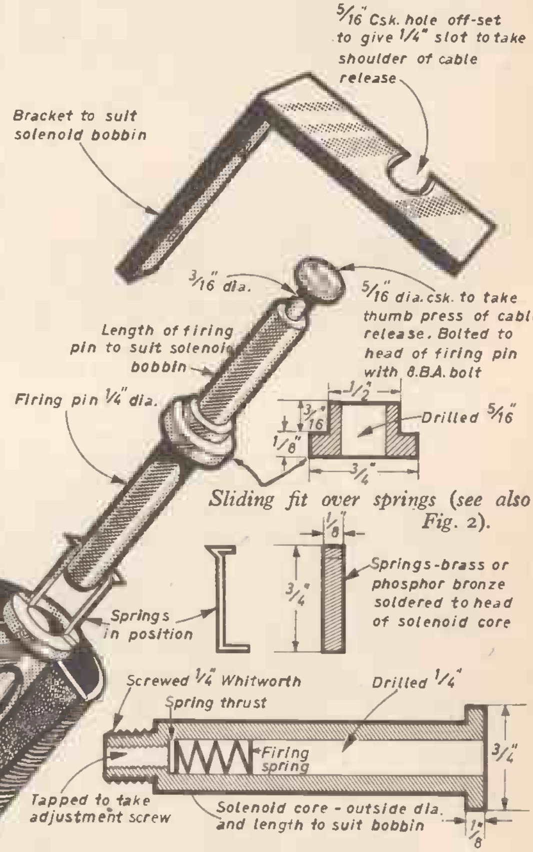
with this home-made device described by Anton Delmar

THERE are several devices on the market which enable a photographer to operate his camera from a distance, the most popular probably being one which releases the shutter pneumatically by means of a bulb and rubber tube. Although this is efficient, it has the drawback that its distance is limited to 20 or 30 feet.

It is sometimes necessary, however, to control the camera from greater distances, e.g., when it is set up in a tree to photograph a bird returning to its nest or when shots of young children at play are required. Children behave more naturally and are far less self-conscious when no grown-ups are around and the knowledge that someone is lurking round the corner with a bulb in his hand waiting to take a picture is often sufficient to destroy any atmosphere of spontaneity.

Solving the Problem

The answer to this problem is the electrical release shown in Fig. 1, where operator to camera distance is limited only by the length of wire available. Once the camera is set up, the subject may be watched



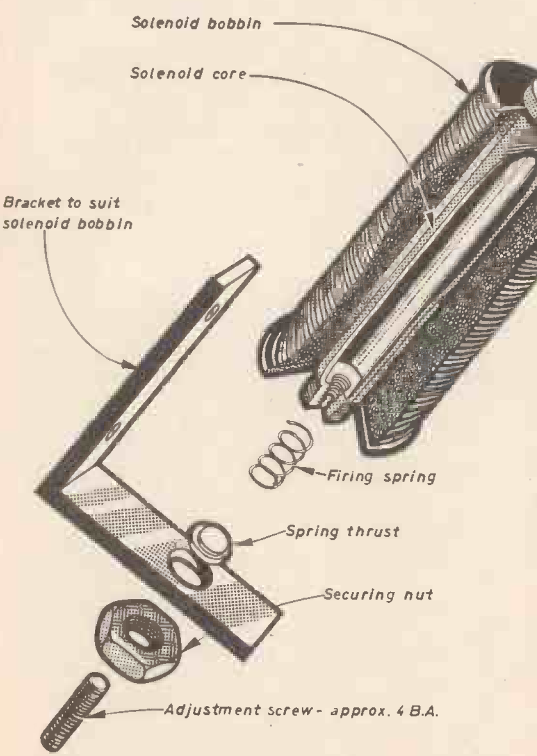


Fig. 1.—General layout of the device.

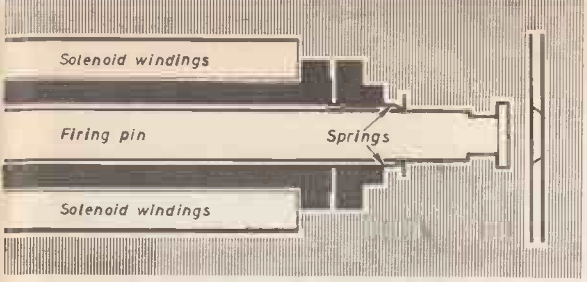
through binoculars from a hundred yards away and the shutter operated at the crucial moment either by the photographer or a trip wire.

The release consists of a brass plunger moving freely within the core of a solenoid, with an actuating spring at its lower end. (See Figs. 1 and 2.) It is "cocked" by locking it in the depressed position by sliding the soft iron collar to the heads of two small springs. This holds the latter firmly in the shoulder of the plunger.

When the current is passed through the solenoid windings, the collar is pulled towards the solenoid. This allows the two springs to move apart and release the plunger, which then depresses the cable release.

Apart from its compactness (its overall measurements are approximately 3in. × 1in.) this type of release has three advantages.

Firstly, the sliding collar does the bulk of the work in restraining the plunger and the two retaining springs need therefore be only very light. Those illustrated are only ⅛in. wide and ·01in. thick and were, in fact, cut from a strip of phosphor bronze draught excluder.



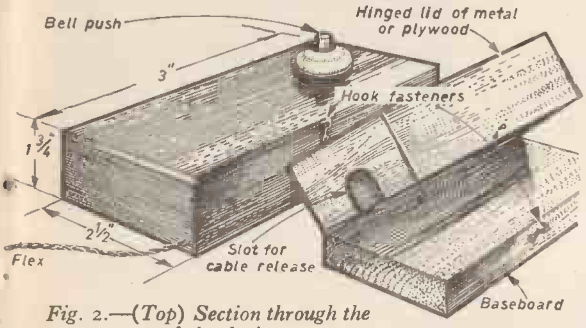


Fig. 2.—(Top) Section through the top of the device.

Fig. 3.—(Below) Box for the device and the control box.

Secondly, the collar has to overcome only the sliding friction of the ⅛in. springs during its movement of approximately ¼in. This is almost negligible and enables a small "bell bobbin" solenoid to be used, with a light 2A. flex and two 4½V. torch batteries.

Thirdly, the tension of the coil spring actuating the plunger is adjustable so that just sufficient force is used to overcome the resistance of the camera shutter, thus avoiding the possibility of damage by violent action.

No winding details are given for the solenoid as these are so easily obtainable ready wound. Their sizes, of course, vary considerably and, as this apparatus is built round the solenoid, the measurements illustrated are given as a guide only and may be varied to suit individual requirements. Also, owing to the variations in different camera shutters, no value can be given for the plunger actuating spring, which will have to be chosen to suit the particular shutter in use.

Construction

The construction may be easily followed from the illustrations. All the materials used should be non-magnetic, with the exception of the solenoid core and the sliding collar, which should be of soft iron.

The solenoid assembly is screwed to a suitable base plate when completed. To allow for slight variations in shutter working positions, the bracket supporting the shoulder of the cable release should be clamped in position while testing. This enables the critical position to be ascertained before finally screwing down. The tension of the plunger spring should be adjusted so that only just sufficient power is used to operate the camera shutter.

The windings from the solenoid are carried to a small two-pin plug or direct to the flex as convenient and a plywood or metal cover—slotted to allow for the cable release—hinged to the base plate and secured by a hook fastener (Fig. 3).

The batteries, two 4½V. torch type, are housed in the control box (Fig. 3) and connected in series with a bell push.

BOOKS Received

"Fun With Electricity" by Tom Kennedy Jnr. 120 pages. Price with soft cover $2.65 (approximately £1); and with hard cover $3.75 (approximately 27s.). Published by Gernsback Library, Inc., 154 West 14th Street, New York 11, N.Y.

THIS is a simple, do-it-yourself guide for beginners in electricity and is ideal for helping to develop a boy's interest in electricity and science. The theory of electricity is briefly explained in simple terms. Step-by-step instructions are given for building a galvanometer, building a simple D.C. motor, a Tesla coil and many other simple but interesting projects. The book is well illustrated.

"The Machining of Steel" by F. C. Lea, O.B.E., D.Sc., M.Inst.C.E., M.I.Mech.E., and Eric N. Simons. 208 pages. Price 21s. net. Published by Odhams Press Limited, London.

THIS is a handbook designed for students, apprentices, operatives and all others interested in engineering production. The book presents the fundamental principles of cutting and shaping steel and its alloys, together with much practical information on the machines and methods used. Its chapters cover turning, planing, shaping, milling, drilling, broaching, reaming and sawing, etc. The book contains nearly 130 drawings and 20 photographs.

"Power Stations Work Like This" by Rolt Hammond 57 pages. Price 9s. 6d. net. Published by Phoenix House Limited, London, W.C.2.

THIS book explains how a power station is planned. how it works, and how it supplies electricity to its users. Coal, oil, water, wind and uranium are all of major importance in the production of power and the whole subject is briefly and clearly covered. The book is well illustrated with 54 line drawings. This is one of the "Science Works Like This" series designed for teenagers and contains advice on careers in electric power production, a list of essential words used in electricity and an index.

"Engineering Drawing for Students" by Richard Marriott. 80 pages. Published by Methuen & Co. Ltd.

THIS book is intended as a textbook for students in engineering drawing, and it is hoped that it will be of particular value to those who are preparing for the General Certificate of Education and other examinations. Various types of projection are explained, first and third angle orthogonal, isometric and oblique, and suggestions are given to help in developing the ability to make simple freehand drawings. Information is also given on types of bearings, lubrication devices, riveted joints, bolts, screws, keys and keyways. The book is of course well illustrated with line drawings.

Try something different with STATIC ELECTRICITY

Says A. Lutman

AT one time or another the reader may have noticed that a water tap can be regulated to give a thin unbroken stream of water, especially if fitted with an anti-splash nozzle. This thin stream of water can be attracted by an electrified rod of Ebonite, Perspex, Polystyrene, or even a plastic comb run through the hair. By mounting the electrified rod in a stand of some kind the deflected stream can be directed almost horizontally to the side.

Fig. 1 shows the arrangement and the stand can be made from wood lath and a dog-clip. The puzzling aspect of this experiment is that work must be done by the electric charge deflecting the water, and it will keep on doing so for a comparatively long period of time. The charge, however, does not appear to be " used up " any quicker by pulling the stream aside. In other words, the charge apparently dissipates at the same rate whether it is doing work or left to do nothing.

Fig. 2.—A further experiment in water deflection.

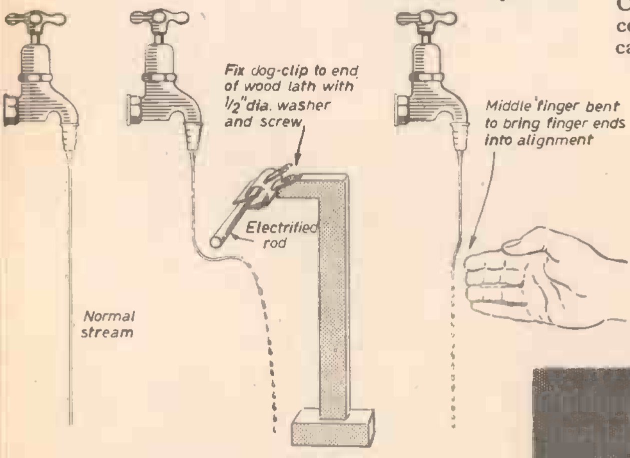


Fig. 1.—Adjusting the faucet and deflecting water.

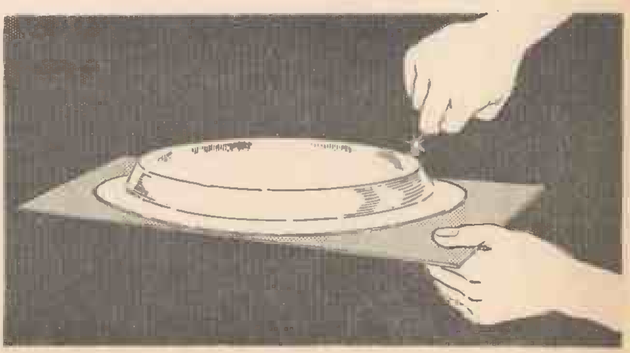
Animal Repulsion?

The second experiment is very puzzling, and consists of adjusting the tap until a very thin stream of unbroken water is flowing, then rubbing your fingers vigorously on your woollen jumper or tie and swiftly putting the fingers near the stream. This repels the water momentarily as in Fig 2. The hands should be clean and dry success is impossible with hands that are perpetually damp. You should satisfy yourself that the effect is not due to air disturbance when the hand is moved quickly. This can be ascertained by doing the experiment without a " charge ". It may occur to you also that the deflection could be caused by heat generated by friction, but this is not so. Who knows but what the principle of this experiment might lead to the " anti-gravitation barrier " so earnestly desired by future space travellers.

Sparks and a Snowstorm

The materials used in the next experiment are arranged to provide a simple but powerful form of electrophorous. The first thing needed is a sheet of Celluloid or any insulating plastic like Polystyrene or cellulose acetate or indeed anything in sheet form capable of giving a static charge by friction. A flat baking tin with no sharp edges is placed upside down on the sheet to collect the charge. The procedure is as follows: Place the sheet of insulating material on a clean table or better still, a flat metal surface and stroke briskly with the clean dry hand then place the baking tin in the centre. No charge will appear until the sheet is lifted up from the table. Large sparks can be drawn from the baking tin if you present a knuckle to it as in Fig. 3. Do not present the finger end because large sparks have the unpleasant habit of striking under the fingernails.

Fig. 3. (Below)—A simple form of electrophorous.



Having now described the generation and testing of a static charge, we can also proceed to experiment. Assuming you have " excited " the sheet and placed the baking tin in position, put a little pile of puffed rice or oats, or chips of elder pith on the top of the tin. On lifting the sheet the pile will disintegrate and the puffed oats will fly up into the air. I once tried a pile of dry flour and this flowed into the air in a steady stream like a snowstorm.

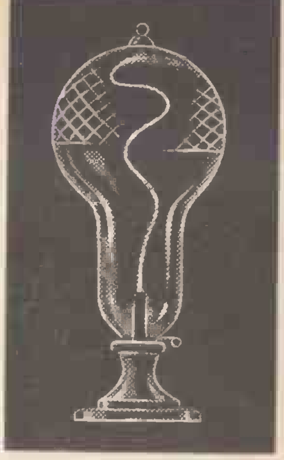


Fig. 5. (Right)—The snake phenomenon.

An Electronic Snake

If a glass tube is fitted at each end with an electrode; fixed to a vacuum pump and an induction coil or Wimshurst machine connected to these electrodes, a glow of light called the positive column fills the tube on lowering the pressure. If water vapour is present in the tube, however, the positive column develops into a thin stream of light in the centre and does not broaden out to fill the tube.

An interesting experimental tube was made from an electric bulb as shown in Fig. 4. It had an internal electrode of aluminium, and an external electrode in the form of a wire net. Water vapour was present because it was not dried out. A Sprengel mercury pump, as in Fig. 4, was used to exhaust; the tube being connected at X and then sealed off. The tube was then fixed to a stand and connected to an induction coil to see whether it would act as a Leyden jar or condenser. On switching off the coil a thin column of glowing light writhing about inside the tube like a snake was seen, and it persisted for several minutes, (see Fig. 5). This tube was used for several years to mystify friends. The late R. G. Lunnon, Professor of Physics at the University of Durham explained the action: The tube, acting as a condenser, discharged slowly through the coil; the water vapour inhibiting or " crowding " the positive column into a narrow ionised path which searched about the glass dielectric until the latter was totally discharged.

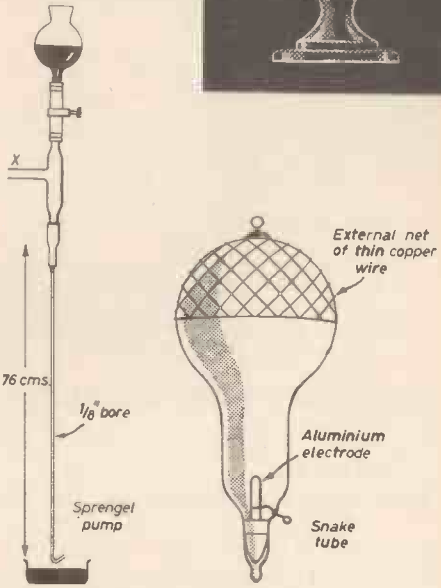
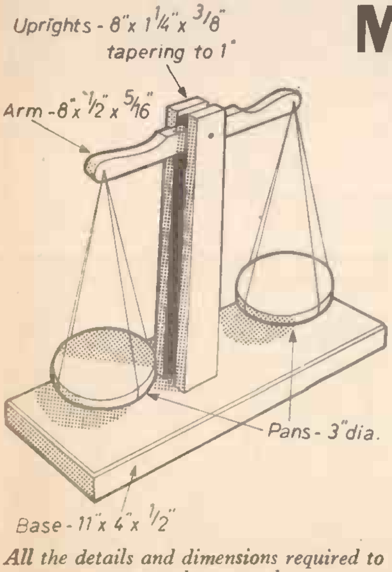


Fig. 4.—Sprengel pump and snake tube.

Make these Toy Scales

They will amuse your child for hours



All the details and dimensions required to construct the toy scales.

TOY scales will amuse a child and, if they are accurately balanced, they will also serve to weigh small quantities of cooking ingredients and letters, etc.

Size

This is, of course, a matter of choice. The dimensions used in the prototype were: uprights 8in. × 1¼in. × ⅜in. tapering to 1in.; base 11in. × 4in. × ½in.; arm 8in. × ½in. × $\frac{5}{16}$in. and pans 3in. in diameter.

Construction

The uprights, separated by a filling piece 2½in. long, are tenoned into the centre of the base. The arm is shaped as shown and pivoted to the uprights by means of a 16G. panel pin 1½in. long, a hole being first drilled in the arm just large enough to allow it to swing freely. The pans can be made from tobacco or cocoa tin lids and be suspended by fine but strong twine. Any small balancing adjustment necessary can be effected by glueing paper or thin card to the underside of the lighter pan.

Weights

Real weights may be used—they are not over expensive to buy—or they may be made up from moulded lead.

SWITCHING WITH LIGHT BEAMS

Part 13 in our Automatic House Series by E. V. King

IT is often useful to either put on, or off a switched circuit when a person or object interrupts a beam of light. Such a device can be made to operate automatic door opening mechanism, burglar alarms, baby alarms, counting devices, etc. The general scheme is shown diagramatically in Fig. 112. Where the switch is to be used to operate devices with the coming of darkness or daylight no low voltage lamp is required.

Photo transistors, barrier layer cells and emissive cells are suitable; barrier layer and transistor types will not be dealt with here.

Photo emissive cells are of two types and the *gas filled type* must be used for this apparatus. The actual valve used is not very important; the one stated gives perfect results. When using photo cells NEVER let a glow appear in the cell for more than a few seconds or it will be ruined.

The unit to be described is a simple one operating off D.C. supply and so requires a simple power pack for A.C. use.

The unit will work as a " daylight " switch when placed near a window, and will work fully and well from a beamed 24W. lamp.

The unit will be termed Unit No. 1 and will be the first of three.

The Power Pack

The following parts are required:

Switch. Any type toggle will suit.

Warning Lamp. Arcolectric Neon S.L. 160 (240V., red) is suitable.

Transformer.—Any mains transformer giving outputs of 6V. and 250 or 300V. If of the 250-0-250 type then one half of the H.T. winding is not used, as in prototype. The current required is only a few m/A. The R.S.C.'s " Midget Type " will suit.

Metal Rectifier, half-wave, 300V. 20 m/A. Prototype uses No. 356 from Messrs. Benson, 136 Rathbone Road, Liverpool, 6.

C 18/19. Electrolytic condenser, 16/16 μF. or similar capacity. Fixing clip is also required.

R 19. Between 2K and 5K, any value will suit, 5W.

VR. Variable resistor or potentiometer. Between 100 and 500K, any value will suit.

R (Optional). This is an optional safety resistor. The value required depends on a number of factors but roughly twice the value of VR (above) will suit. ¼W. is sufficient.

Terminal Block. Five-way or use tag strip.

Chassis. Tin or aluminium. Prototype uses 5½in. × 6in. × 3in. baking tin from a walk-round store. The tin is strongly soldered up all round.

Mounting the components

The layout is not in any way critical and provided shorts to chassis do not occur readers may mount the components wherever they please. Leave some space round the metal rectifier for ventilation. The layout of the prototype is shown in Fig. 113 and the wiring is also shown and may be checked against the theoretical circuit of Fig. 114. The unit is shown complete in Fig. 115.

When completed, switch on. The S.L. 160 will indicate voltage at the transformer primary. Slight humming will be heard. Switch off. Leave for 30 seconds and then short the main 300V. positive terminal to chassis using an insulated screwdriver. If all is well a spark should jump. The 70V. positive output terminal must not be checked in this way. If a good voltmeter is available it may be used on all terminals.

Photo Electric Switch Unit No. 1

The following parts are required:

R23 3.3 KΩ ¼W. resistor.

R21 and 22 two 4.7 MΩ resistors or one of 8 to 10 MΩ.

P.E.C. R.C.A. gas filled tube No. 868.
This is available surplus cheaply from Messrs. Henries Radio, 5, Harrow Road, London, W.2.

C (optional Fig. 116), see text. 50 μF. 50V. working.

Chassis as for power pack.

Valve. E.F. 50 available surplus for a few shillings, wired as a triode. Types with control grid underneath must be used, possibly 6J5 or 6C5 would also suit.

Valve base. With EF50 use B9G base, and for photo cell use 4-pin base, two large and two small pins (UX4).

Relay. The more sensitive the relay the better the unit. If it has a resistance of 100,000Ω so much the better. The prototype uses No. 2389, of 8,000Ω available from Messrs. Annakin, 25, Ashfield Place, Otley, Yorks.

Another very suitable relay is No. 229 (P.O. type 3,000 of 20,000Ω) from Messrs. A. T. Sallis of 93, North Road, Brighton.

VR. 100 KΩ variable potentiometer.

Mounting the Components

This too is in no way critical. Be careful to mount the P.E.C. so that the light rays definitely hit the sensitive surface. This means that viewed under-

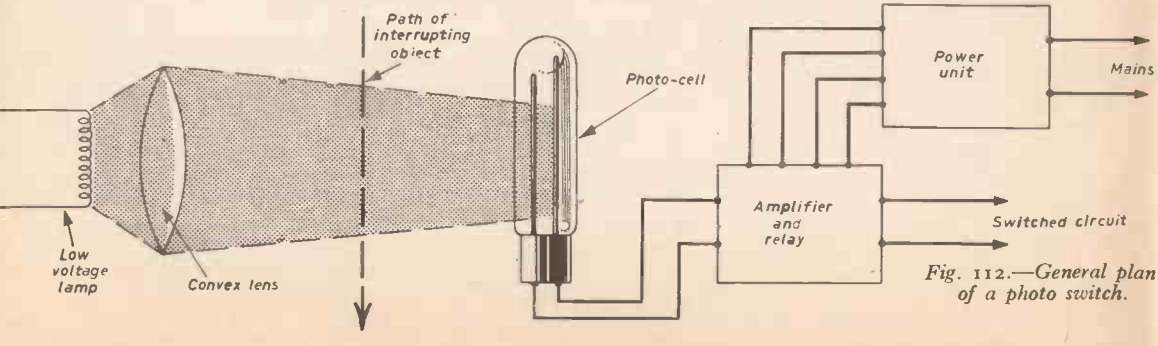


Fig. 112.—General plan of a photo switch.

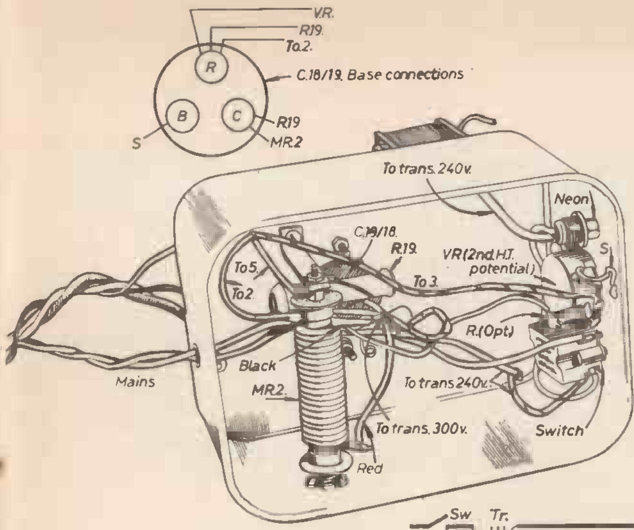


Fig. 115.—*Completed power pack.*

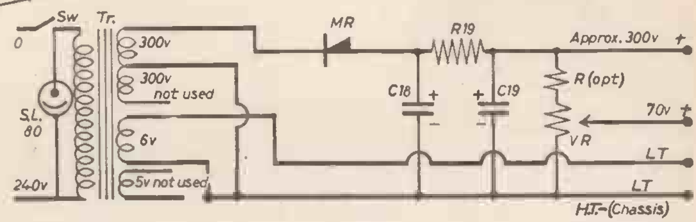


Fig. 113.—*General arrangement and layout of power pack.*

Fig. 114 (*Right*)—*Power pack theoretical circuit.*

neath, the holder must be mounted with the thick and thin sockets as illustrated in Fig. 118.

The positions used on the prototype are shown in Figs. 117 and 118, together with the very simple wiring. The letter "S" means solder to chassis. The wiring may be checked against the theoretical diagram (Fig. 116).

Wiring the Unit

The wiring is very simple and can be followed from Figs. 116 and 118. The resistors are in free space, held by the connecting wires. The lead from P.E.C. 4 to valve pin 7 should be short and as far as possible kept away from the filament wire going to pin 9.

The insulation of the holder for the P.E.C. is important, if it is not new it should be washed in detergent, fresh water, and finally in methylated spirits. The base of the P.E.C. should be cleaned thoroughly in alcohol before use. Sometimes the cleanliness of the glass itself also seems to affect the sensitivity.

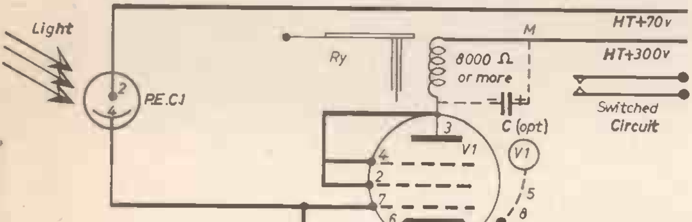
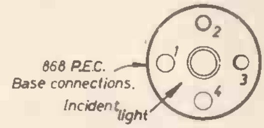


Fig. 116 (*Left*)—*Theoretical circuit of photo electric switch unit No. 1.*



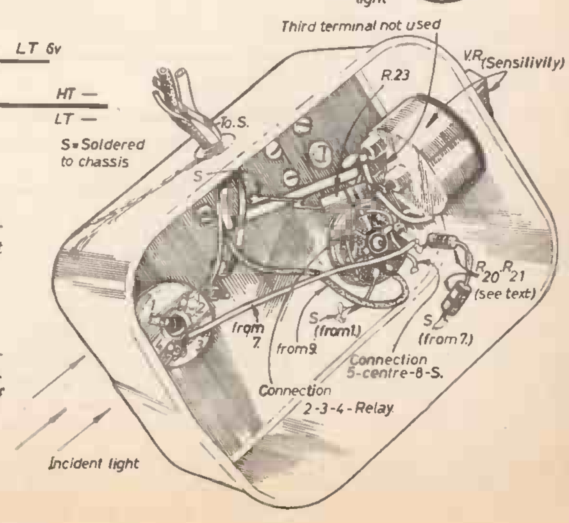


Fig. 117 (*Left*)—*The completed Unit No. 1.*

Fig. 118 (*Right*)—*General arrangement and wiring of Unit No. 1.*

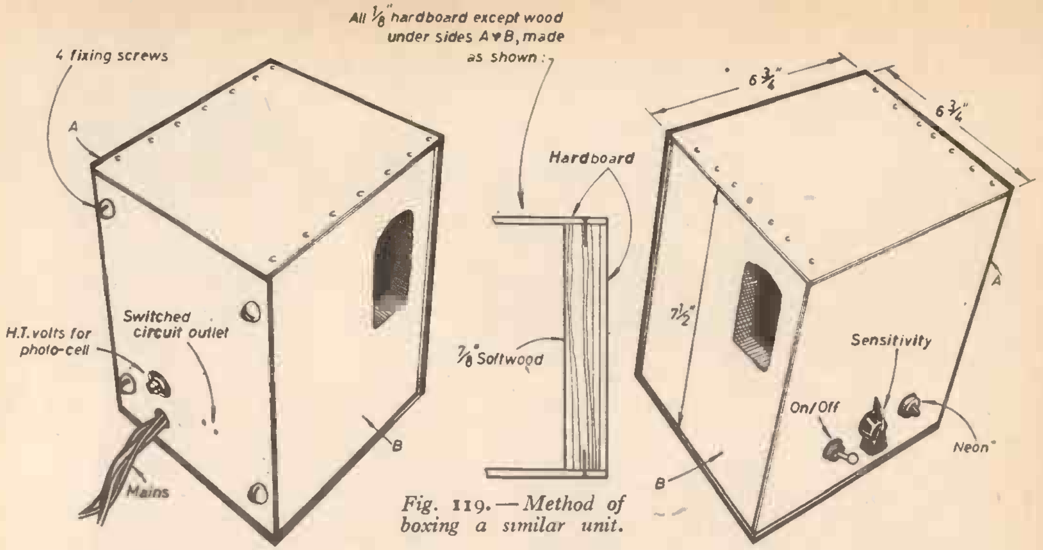


Fig. 119.—*Method of boxing a similar unit.*

Testing the Unit

Wire it up to the power pack as in Figs. 114 and 116. Set VR on the power pack to minimum and switch on. Watch closely in subdued light for a " blue halo " round the cathode wire of the P.E.C. Should it occur switch off at once to avoid damage. Change over the connections to VR (on the power pack) and repeat.

Now advance VR (power pack) until a blue glow is seen and *immediately* **turn** VR about 10 deg. backwards. If a voltmeter is available it may be connected from power pack 70V. terminal to chassis.

Slip some black paper or a box over the P.E.C. and advance the sensitivity control, VR, on the P.E. unit. Watch the relay contacts carefully. They ought not to close but if they do, turn the sensivity control backwards a little until the points open. Now remove the black paper and the points should snap to vigorously.

Further Operational Notes

The sensitivity may be increased by using a more sensitive or high resistance relay and setting the latter so that the armature is *almost on* the magnet when the relay is normal (not carrying current). The points must then be set to close *just before* the armature is pulled right in. With care, using the cheap relay specified, the unit will operate with very dull daylight.

If a meter is inserted in the main H.T. lead of the power pack, useful information is obtained about the effect of the light, light beam, etc. Typical results to be expected are:

Meter. Milliamps 0 to 10 range.
- Sunlight 10 m/A.
- Dull Cloud, indoors 6 m/A.
- 60W. lamp, 3ft. away, no focusing, 6 m/A.
- Darkness, complete, 2 m/A. standing current.
- 20W. lamp, focused, 24V. filament, 20ft. distant, 6 m/A.
- Lighted match, 3in. from P.E.C. 7 m/A.
- Match being struck as above over 10 m/A.

Any circuit may be operated, this particular prototype switching a circuit on when the cell is illuminated. A relay with change-over contacts may be fitted and then, if required, a circuit may be switched off when the cell is illuminated. For opening and closing doors automatically (as already described in this magazine) change-over contacts are fitted to the second power relay. Readers should not attempt to draw more than about ¼A. through the relay contacts, it is always best to fit another heavier relay to do the main switching.

Protection of Relay Contacts

If the unit is used as a burglar alarm, the relay points will hardly ever be used and no protection is required.

If used for door opening and closing, or other work involving electric magnetism (inductive loads) protection is advisable and a suitable and cheap method is to fit condenser and resistor across the *actual relay points*. The actual values must be found by experiment with the apparatus to be operated. A rough start is made with 0·5 μF and 200Ω, which in any case will greatly minimise the sparking.

Prevention of Chatter

With daylight-, gas light-, or battery-operated lamps no chatter will occur. With normal operation from mains illumination no trouble will occur if the illumination is bright enough. However, mains lamps flicker at the 100 cycle rate and this can cause the points to chatter if illumination is low or the beam is partially interrupted for a length of time. This may be prevented by fitting a condenser. This is marked C (optional) in Fig. 116. The condenser must be with the polarity as indicated

Boxing the Unit

The housing may be of wood or metal and the power unit may or may not be integral with the photo switch. In any event the P.E.C. MUST be in the same unit as the valve. For external use a window is necessary and waterproofing will be important. No light must enter the unit save through the window about the same size as the electrode (anode) of the P.E.C. Fig. 119 shows a similar unit fixed up in a suitable box, from which the essential points of construction can be gained.

Value of R (Optional) of Fig. 114.

Use 100K firstly and then increase its value slowly by 100K approx. jumps until no blue glow can be obtained from the P.E.C. when VR (H.T.) is on full. Try it at all settings of VR (Sensitivity) too. The resistor (R opt.) may be left out and a wire inserted in its place. It is only a safety measure to protect the P.E.C.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

New Electrode Holder

THE new Terrier 600 Special electrode holder is designed in such a way that the handle remains cold under extreme working conditions, using up to $\frac{5}{16}$in. dia. electrodes at up to 600A. The welding cable is connected direct to the head of the holder and the operator's hand is protected from any heat in the cable by a deflecting aluminium painted metal shield, under which the cable is housed in asbestos on its way to the head. The manufacturers are Interlas Limited, 9 Church Street, Ampthill, Bedford and the price is £4 18s. 6d.

Rechargeable Battery

A NEW bright idea for home and industrial users of torches and similar battery-powered instruments is a cartridge-type battery which is capable of being recharged time and time again. Called the Chilton Permabeam, it eliminates the use of conventional dry-cell batteries. It is the same size as two standard U2 batteries and is equipped with normal battery contacts and two-pin plugs for recharging. To recharge, it is simply plugged into an A.C. mains socket (110-240V.) and left overnight or during some convenient period. The manufacturers are Chilton Electric Products Limited, of Hungerford, Berkshire. The standard model is 2·5V., priced at £1 9s. 6d. Other models are rated at 3·5, 5 and 6V.

Chilton Permabeam rechargeable battery. (Above right): Terrier 600 electrode holder.

The Syrone multi-purpose tool.

(Below): Dansette Popular-One record player.

Combination Tool

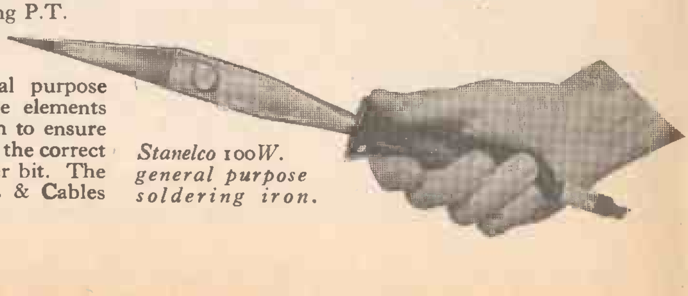
THE Syrone multi-purpose tool is a handy instrument for the workshop or garden. At one end there is a blade for cutting such materials as linoleum, etc., and at the opposite end a small glass cutter. In between the two is a knife sharpener, a shear sharpener and, farther along, a wire stripper. The tool costs 3s. 6d. plus 6d. for postage and packing from the distributors A. T. Lee & Co., of Elm Park House, Fulham Road, London, S.W.10. This tool may also be stocked by your local hardware store.

New Record Player

MARKETED by J. & R. Margolin Ltd., 112/116 Old Street, London, E.C.1, the Dansette Popular-One record player has a powerful amplifier and the latest B.S.R. 4-speed non-auto A.C. mains motor. All size records can be played with the lid open. The player is fitted with independent tone and volume controls, a 5in. round speaker and a dual turnover pick-up head, fitted with sapphire stylii for standard and L.P. records. A choice of colours is available and the price is 11 gns. including P.T.

Electric Soldering Iron

THIS Stanelco 100W. electric, general purpose soldering iron costs £1 9s. All the elements have been flash tested at 1,000V. to earth to ensure their safety. It produces a constant heat at the correct temperature for the weight of the copper bit. The manufacturers are Standard Telephones & Cables Limited, Foots Cray, Sidcup, Kent.



Stanelco 100W. general purpose soldering iron.

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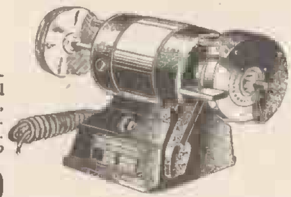

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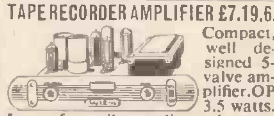

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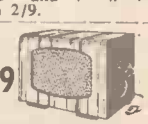

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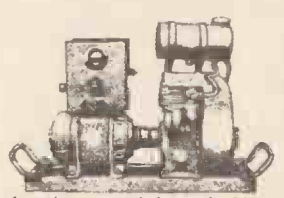

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LETTERS TO *The Editor*

The Editor does not necessarily agree with the opinions expressed by correspondents

Puzzle Solution

SIR,—In trying to solve the "Four Quarts" problem which appeared in your January issue, I found the following solution.

2 pt.	3 pt.	4 pt.	5 pt.	
—	3	—	5	Position at start
—	—	3	5	First position
—	3	3	2	Second position
—	2	4	2	Third position
2	2	2	2	Fourth position

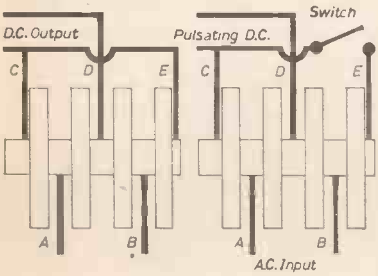
This differs from your solution in that it can be completed in four operations and not five as required.—C. R. Jones (Erith).

Improving The "Slipped Disc" Puzzle

SIR,—Regarding the "Slipped Disc" puzzle in your December 1960 issue, I remember this puzzle from several years ago when the minimum number of moves was 15 for 4 discs (2^n-1; n being the number of discs). By accident I discovered that a mistake need never be made if the discs are alternately coloured and like is never put on like; e.g. put black on white, not black on black, etc.—C. H. Farrington (Solihull).

A Pulse Power Unit

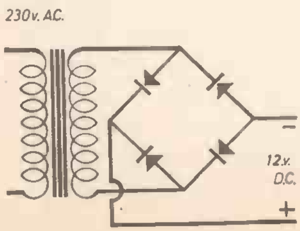
SIR,—With reference to Mr. Lingwood's query in the January issue concerning a pulse power unit for a transformer rectifier. The only extra equipment needed is a single pole on/off switch. The rectifier is wound as below left. The A.C. from the



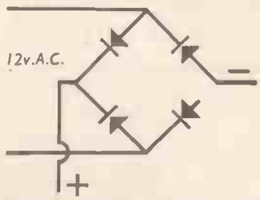
Rectifier wiring and fitting the switches.

transformer is taken to terminal A and B. The D.C. output is taken from the terminals C, D and E, D being positive and C and E being negative. As C and E are only used on alternate half cycles, they are coupled together. The effect of breaking this coupling is to cut off the power for half of every cycle giving pulse power. The switch should be fitted as shown above right.—S. R. Broadfoot (Dunstable).

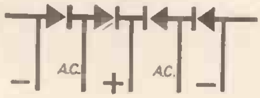
SIR,—Re Mr. Lingwood's query in the January issue, where he wishes to add pulse power to a transformer/rectifier unit, the circuit for a 12V. D.C. circuit is as follows:



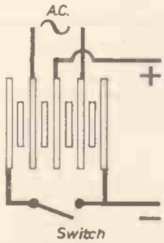
Pulse working is obtained if the two negative connections are separated and only one of them included in the circuit, as follows:

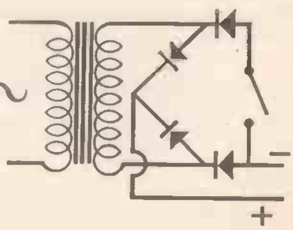


In practice the rectifier looks like this:



For full-wave rectification the ends are joined together. The best way therefore to get half-wave rectification is to place a switch in between the ends of the rectifier, thus:

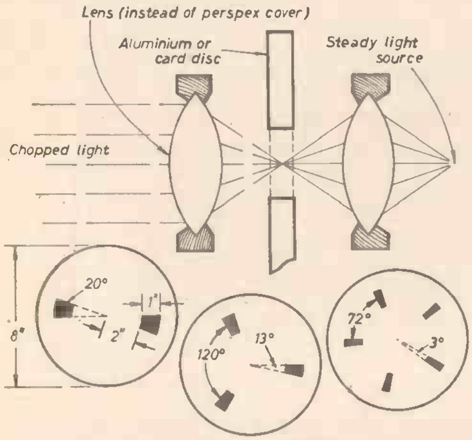




An alternative is to put a vibrator on the output of the transformer/rectifier, followed by a transformer and another rectifier wired as above. I suggest Mr. Lingwood puts a switch in the unit.—J. N. Arundale (Scarborough).

Stroboscope Construction

SIR,—With reference to the article " How to Make a Stroboscope " which appeared in your January issue, I note that you use holes in the discs. This is quite suitable when there are only two holes, but in Fig. 3c it looks as if the disc would allow light through for about the same duration of time as it cuts it off. Suppose you were looking at an electric fan, the blades would be lit while they travel halfway round, instead of at one point in their cycle. Another fault is that the beam to be interrupted is so thick that it would take some time for the hole to pass it. The arrangement should be as shown in my diagram, where the slits in the disc let light through in a flash, as they pass through the point of focus (through which all the light passes). The front lens is not really necessary but it serves to concentrate the beam within a reasonable distance from the bulb. Note that the width of the slits is at a constant ratio to one revolution, i.e. the more slits, the narrower they are. With this improved arrangement the reversing switch should not be needed. If the loss of light can be suffered, the width of the slits can all be reduced in proportion, giving a clearer image.—D. Williams (Edinburgh, 10).



Author's reply: I would agree that the system suggested is a better one, but at the same time it would be much harder for an unskilled person to obtain results. The focusing of both lenses would be important. The cost of the instrument would also be greater. The instrument as described works quite well on an electric fan, but would be unsuitable for very high r.p.m.

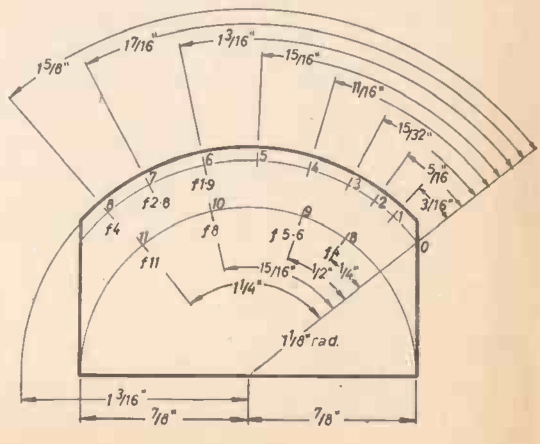
A Bedside Tea-Maker—Correction

SIR,—In my article on the bedside tea-maker in the November 1960 issue, I stated that either a Bulgin S265 or a Bulgin 270 switch would be suitable for the device. I have since found that the Bulgin S265 is unsuitable for the job. I apologise for any inconvenience caused to readers.—E. V. King (Surrey).

Exposure Meter Errors

SIR,—Re my article on building an exposure meter which appeared in the January 1961 issue, I regret that I have misled readers with respect to Fig. 8. This is wrong in two respects. The measurement to No. 5 on the top scale should read 15/16in. and not 13/16in. and all measurements on the lower scale are shown from the wrong datum line. A corrected sketch is shown below.

There were also two other mistakes. The dimension giving the radius of the top of the window in Fig. 2 should be 1 3/8in. and not 1 13/16in. as shown. The size of the aperture in the foil contact, shown as 50mm. × 37mm. in Fig. 3 and as 50mm. × 30mm. in the text, should actually be 50mm. × 30mm. I very much regret any inconvenience caused to readers by these errors.—D. D. Smith (Chesterfield).



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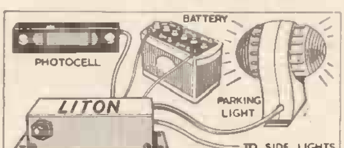

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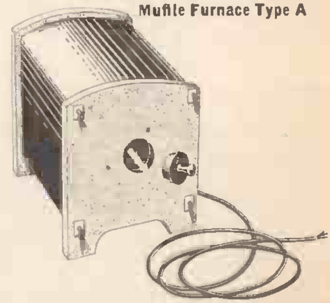

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Continued on page 319

YOUR *Queries* ANSWERED

RULES

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

A stamped addressed envelope, a sixpenny crossed postal order, and the query coupon from the current issue which appears at the foot of this page, 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.

Novelty Lampshades

COULD you please tell me how the novelty type lampshades work, that give the effect through the painted shade of running water, fire and other forms of movement?—R. Thomson (Dublin).

THIS effect is quite easily obtained. A cylinder is placed inside the lampshade and is activated byheat from the electric light bulb energising a fan which is fixed on the top of the lampby a bracket or some other support. This revolving cylinder has a veined top which causes the heat to rise and by movement sucks it away and creates convection. The inner revolving unit itself is usually covered by viscose of a heavy weight and may be patterned with strips which are responsible for giving a ripple of water and moving cloud effect. We publish a book entitled *Lampshade and Parchment Craft* which gives many other interesting ideas on the same subject. The price is 8s. 6d.

Paving Slab Mixtures

COULD you please advise me on a cement mix for white paving slab and also a suitable material for colouring same?—W. D. Pagon (Calne).

FOR the paving slab use a strong mixture of 1 part Portland cement and 3 parts best builder's sand. Any inorganic colouring material such as red or yellow ochre mixed in with the cement will colour the mixture. If you want a choice of materials write to: Wengers & Co. Ltd., of Stoke-on-Trent.

Electric Caddy Car

I WOULD like to make an electrically-driven caddy car of the three-wheeled type. The third wheel would do the driving with the motor and battery placed as near to the centre line as possible. The diameter of the wheels would be 12in. which includes the pneumatic tyres. What type of motor would suit my purpose and also what gearing and battery should I use?

THE three-wheeled design which you suggest would appear to be suitable but we advise good springing. A 12V. series or compound motor is suggested, preferably fed from a secondary battery of the nickel-alkaline type. Enclosed spur gearing running in an oil bath is advised for the main speed reduction. The following suppliers may be able to assist you:

Batteries: Britannia Batteries Ltd., 66 Victoria Street, London, S.W.1; Nife Batteries Ltd., Crabbs Cross, Redditch.

Geared motors: British Thomson-Houston Co. Ltd., Rugby; Veritys Ltd., Aston, Birmingham.

Immersion Heater Construction

COULD you please tell me how to make use of two 1-kW. heating elements, length 36in. × $\frac{5}{16}$in., in the construction of an immersion heater; also the gauge and type of tube to use and the most suitable length and type of thermostat.—M. O'Reilly (Manchester).

THE heating elements should be lightly coated with a refractory material, such as magnesium oxide, and enclosed in a tubular steel sheath which is surrounded by a second sheath of tinned copper. In your case you may find Pyruma a more convenient material for coating the elements. The inner sheath may be about 0·04in. thick, whilst the outer sheath could be somewhat thinner. In order to avoid overheating of the element the inner sheath should be a close fit on the coated element and the outer sheath a close fit on the inner sheath.

"Practical Mechanics" Advice Bureau. COUPON
This coupon is available until Mar. 31st, 1961, and must be attached to all letters containing queries, together with 6d. Postal Order. *A stamped addressed envelope must also be enclosed.*
Practical Mechanics. March, 1961

If a long thermostat, which extends practically the whole length of the vessel, is fitted vertically the temperature at which it operates will depend on the average temperature of the water in the vessel. A short thermostat fitted vertically will be affected by the temperature of the water at the top or the bottom of the vessel, depending on whether the thermostat is fitted at the top or bottom. Thus with vertical fitting it is advisable to use the longest practicable thermostat. For use on A.C. mains a micro-gap thermostat may be used, but for D.C. a mercury tube switch is advised.

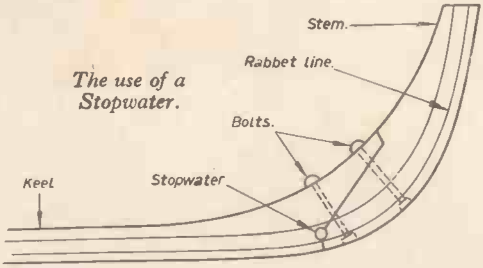
Filter for Well Water

I WISH to improve the quality of the well water we have to use, by means of a simple filter. The water comes from a spring and then by pipe to the well.—S. J. Griffin (Cragg Vale).

A SIMPLE type of filter could be made from a galvanised mild steel cylinder, say 6in. to 8in. dia. and 3ft. deep. Water inlet at bottom and outlet at top; but you would have to force the water through by either gravity or pump. Since we assume you will be drawing from well this indicates a pump. A grid should be inserted 2in. above bottom inlet and a pad of marbles 3in. deep rests on the grid. A similar grid is placed below outlet with top of marbles just below outlet. The space between grids is filled with kieselguhr.

The Stopwater

WHAT is meant by the term "stopwater" and what purpose does it serve?—A. Holt (Cheltenham).



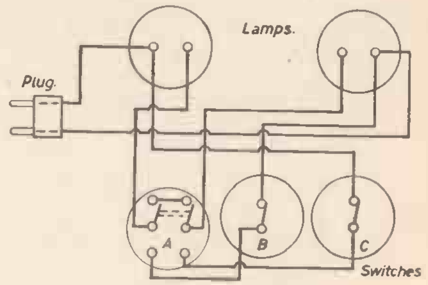
The use of a Stopwater.

WHEN a stem and keel are jointed together as illustrated above, a scarf joint and two bolts are used. Careful fitting is needed and finally the joint is secured using resin bonded glue on all surfaces to secure a watertight assembly. When dry a ¼in. dia. hole is drilled at the point shown in the diagram and a dowel rod is driven in after well luting with glue. This is called a stopwater and its purpose is to prevent water from getting into the joint. Being drilled in the rabbet the stopwater will be covered eventually by the planking.

Photofloods for Indoor Photography

COULD you please supply a diagram for using two photofloods for indoor photography? The requirements are that both lamps can be on full power (parallel), and half power (series). It is also required that either lamp can be switched off without affecting the other.—A. C. English (Whitley Bay).

WE think that the following circuit will meet your requirements. The selector switch A is a double-pole two-way switch, whilst the individual lamp switches B and C are ordinary single-pole single-way switches.



Photoflood circuit.

When the switch A is in the top (dim) position the two lamps are connected in series from the mains, irrespective of the position of the switches B or C. When the switch A is in the bottom (full power) position each lamp is fed direct from the supply through its individual single-pole switch and the selector switch A. With switch A in the bottom position, therefore, either switch B or C can be used independently to control the respective lamp. If it is required to be able to switch both lamps on or off full power by means of a single switch the switch A can be used for this purpose if you use for this a double-pole two-way switch with "off" position.

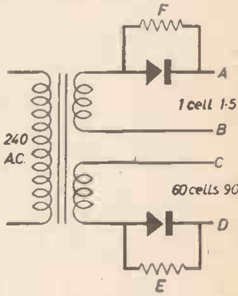
INFORMATION SOUGHT

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

Recharging Batteries

I UNDERSTAND that the circuit shown can be used to recharge dry batteries (Leclanché type). Could you please tell me the following:

1. **Voltage required at A-B?**
2. **Voltage required at C-D?**
3. **Value of resistor E and F?**
4. **How is the charge current determined?**
5. **How is the length of charge determined?**



Nylon Mouldings

PLEASE supply some information on how to make nylon mouldings.—W. J. Widowson (London, E.2).

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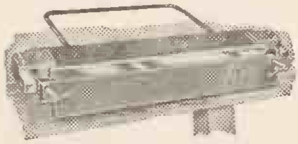

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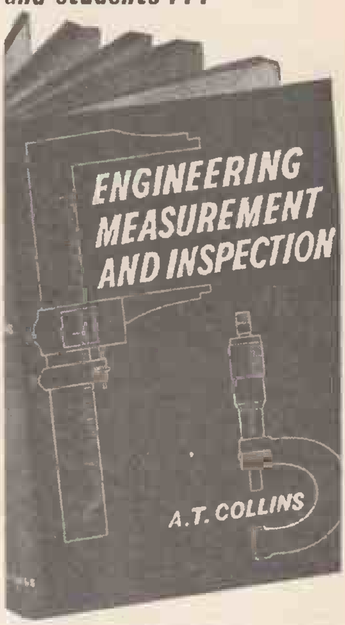

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