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# PRACTICAL MECHANICS

MARCH

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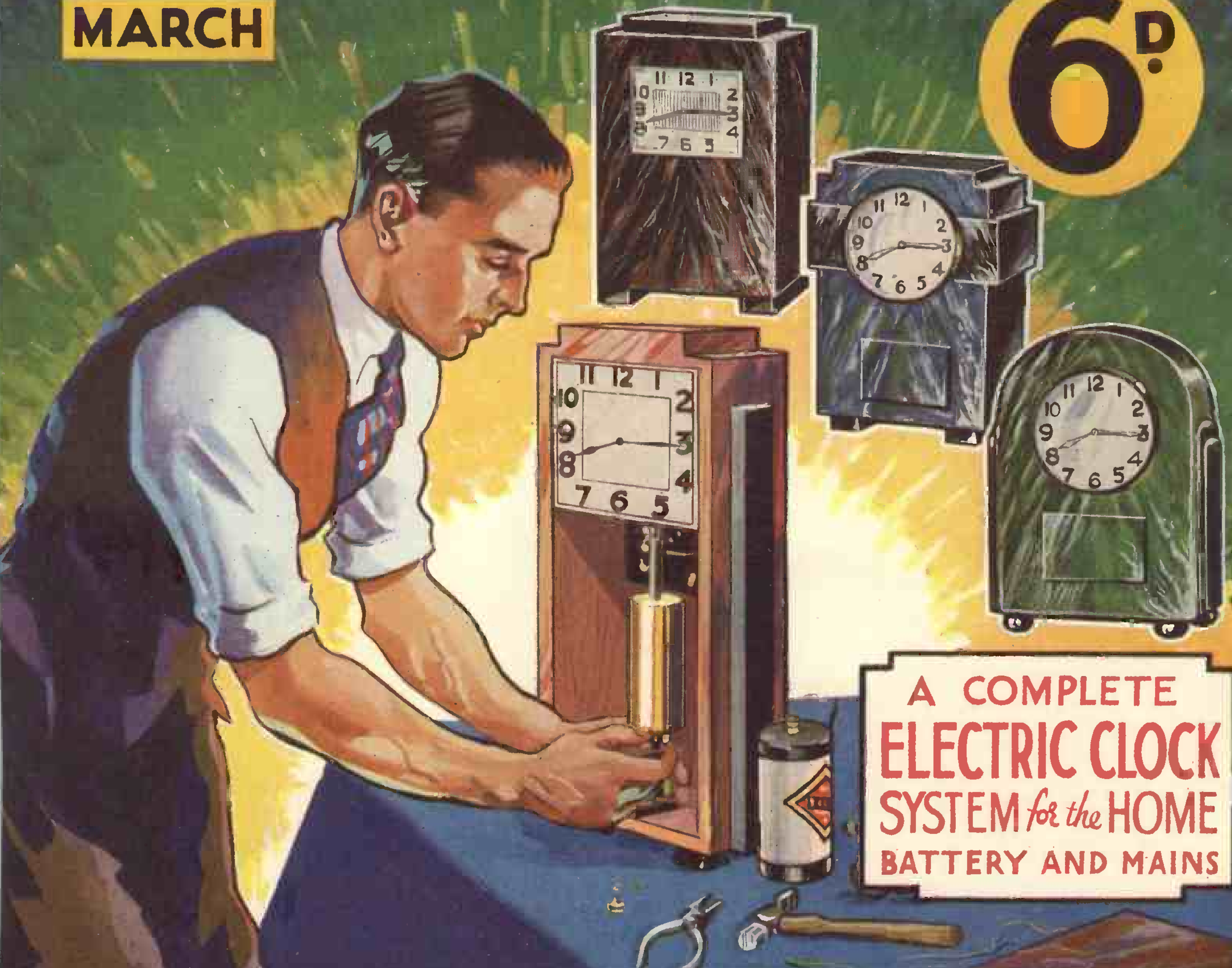


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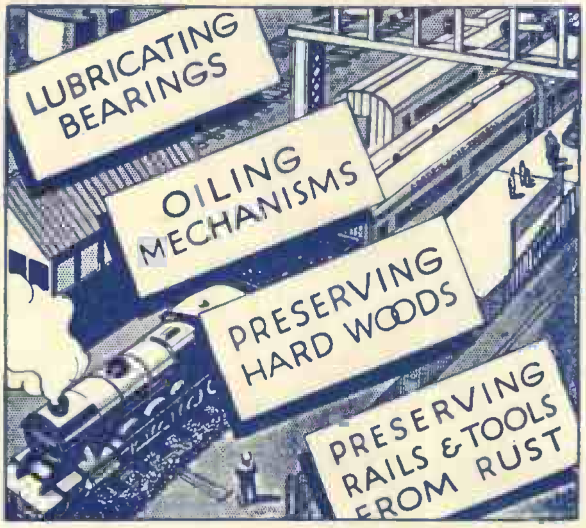


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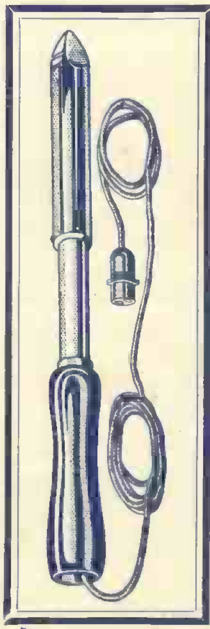

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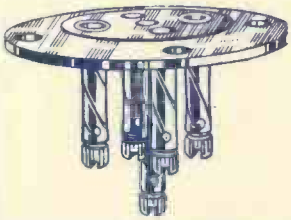

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# Practical Mechanics

Edited by F. J. CAMM

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# Notes, News and Views

### Electric Clocks

IN response to many hundreds of requests from readers we are publishing this month the first of two articles explaining how to make a battery-operated house clock system. This month we deal with the master clock which will control any number of slave clocks distributed throughout the house. The construction of the slave clock will form the subject of a contribution to be given next month. The work is extremely simple, does not necessitate the use of a lathe, and when finished will prove a fascinating example of one's own handiwork.

### Suggestions from Readers

THOUSANDS of suggestions have poured into this office as a result of my invitation to readers last month to let me know the style of article they require. Some of them are of little value to me, and merely view the matter in a purely personal way. The model locomotive fraternity, for example, (always a noisy minority) would, with a somewhat avaricious outlook, have the entire issue devoted to model locomotives. Now I do not think I am far wrong in saying that, fascinating as that old hobby is, it represents the smallest interest in the world of handicraft, and I do not, therefore, feel justified in increasing the space already devoted to that subject. There are other readers who would like more lathe work, others who would like six or seven pages of chemistry, and a large band who have no use for anything else but electrical experiments. Uneasy lies the editorial head. However, I am carefully analysing on a percentage basis the criticisms and suggestions I have received, and have no doubt that I shall satisfactorily be able to amalgamate these diverse interests.

### Great Britain's Largest Power Station

THE recently completed extension to the Barking Power Station of the County of London Electric Supply Company makes that station the largest in Great Britain, with a capacity of 390,000 kilowatts. In one power house, two huge turbo-alternators, working on high-pressure steam, generate 75,000 kilowatts of electricity. The steam for the turbines is supplied by a battery of boilers 50 ft. in height, to which coal is automatically fed. Current is generated at a voltage of 11,000, and this is "stepped up" to 33,000 volts by two immense transformers which are stated to be the largest in the world. On one wall of the control room is a large chart representing the 3,000 square miles which the company supply. Small discs, moving over a network of coloured lines, indicate at a glance what is happening at every substation throughout the system.

### Over Three Million Cubic Yards of Concrete

FROM base to crest the huge Boulder Dam, now under construction in America, will rise to a height of 730 ft. It will be 660 ft. thick at the base, 45 ft. thick and about 1,180 ft. long at the crest. Altogether, about 3¼ million cub. yds. of concrete will be used on this structure; 130,000 cub. yds. for the power house, 100,000 cub. yds. for the four intake towers, and 45,000 cub. yds. in the penstock tunnels.

## THE MONTH'S SCIENCE SIFTINGS

*German aeroplane experts are contemplating the construction of a trans-oceanic seaplane capable of travelling at 187 miles per hour, and designed to carry over 200 passengers, in addition to freight. This would be a considerable advance on the "Do-X," hitherto the largest passenger-carrying seaplane, which carries fifty-nine people, and has a speed of 115 miles per hour.*

*A wireless station that works on the shortest wavelength ever used commercially was recently put into service at Lympne Aerodrome. The wavelength used is only 8 in., and it is to be used as a radio link across the Channel to assist continental air services.*

*A young Preston electrician has just invented a lamp which possesses the red rays lacked by existing lamps, and which gives a white light corresponding to daylight. An experimental installation is shortly to be tested in a London film studio.*

*The latest telephone marvel is a robot operator which repeats the words "Number engaged" or "Number unobtainable," as the case may be, instead of the usual tone signals. It consists of a strip of talkie film on a wheel 12 in. in diameter, with a lamp and photo-electric cell. The apparatus was produced at the Post Office Research Station at Dollis Hill.*

### Developments in High-speed Photography

HIGH-SPEED photography is now being employed in the laboratory as a means of inspection and analysis. Pictures can be taken at the rate of 6,000 per second, and projected at the comparatively slow rate of sixteen per second, thereby requiring about six minutes to reproduce action which has taken place in one second. It is only recently that commercially practicable means have been developed for taking a sufficient series of high-speed pictures consecutively to permit their projection for adequately studying more than the briefest phenomena. Extremely short exposures of only $\frac{1}{1,000,000}$ of a second are now possible. Improved light sources have also been experimented with for photographing a great variety of subjects, including snakes' tongues, flies' wings, and the formation of chemical materials. These experiments have proved invaluable for obtaining useful pictures, and then securing significant information from them.

### High Speed Trains

A NEW streamlined train, designed for use on the Union Pacific Railway of America, is expected to travel at a maximum speed of 110 miles per hour. The average speed will be about a mile a minute. The train carries 119 passengers, besides mails and baggage, and the three coaches form a single streamlined unit weighing no more than an ordinary Pullman car. Electricity is the motive power, the generator being driven by a 60-h.p. internal-combustion engine situated in the front part of the first coach. Sealed noise-proof windows, and special air-conditioning apparatus eliminate all dust and noise.

An even greater speed has been reached by a new French "bullet" railcar. A single coach is driven by four 200-h.p. racing motor engines, and is expected to travel at a speed of 115 miles per hour. It carries 52 passengers, and at top speed covers two and a half miles on a gallon of petrol. In the same class is the latest German train, which reaches 100 miles per hour, while an Austrian railcar, having a combination of pneumatic tyres and standard railway wheels, is capable of reaching ninety miles an hour.

### Shall We Ever Travel Vertically?

THE title to this paragraph is not a reference to the helicopter, but to the possibility of expanding our country by building *upwards*. All travel to-day is more or less in a horizontal direction. Could not a solution be found to our present traffic and housing problems by building *upwards?* We mean by this the erection of many-storied buildings, as in America, where escalators carry you from *floor to floor* when visiting various businesses, instead of, as in England, travelling from street to street by means of bus and tram, or taxi. In other words, shall we ever build towns *above* towns, in tiers, with their own airports, viaducts, and escalators? An interesting prospect, eh? Yet not so fantastic as it seems. Road transport grows apace, and we cannot rebuild England's ground floor; the *only* solution is to add a storey!

# Constructing an

## A COMPLETE "MASTER" AND SLAVE BATTERY

## ACCURATE—4-VOLT—BATTERY-

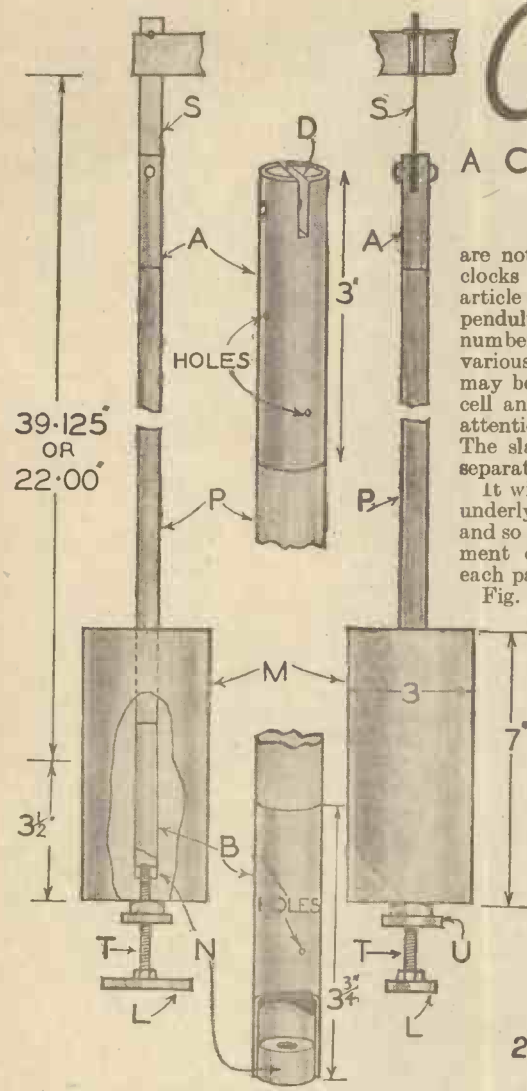



*Fig. 9.—Constructional details of the pendulum.*

NO one foresaw a few years ago that electric clocks would eventually oust the older type of spring-operated clock. The increasing use of electricity for domestic appliances and clocks of the synchronous type is giving rise to a great amount of interest (to those whose homes are not equipped with electric lighting) in clocks of the battery-operated type. This article explains the construction of a master pendulum clock which will control any number of heavy clocks distributed in various rooms throughout the house. It may be operated by means of a Leclanché cell and yet run for at least a year without attention or renewal of the cell elements. The slave clocks, of course, do not require separate cells.

It will be as well to outline the principle underlying the action of the master clock, and so acquaint the reader with the arrangement of the mechanism and purpose of each part.

Fig. 2 shows diagrammatically the complete mechanism and the manner in which the hands H, $H_1$ receive their motion, whilst the sketch Fig. 1 is intended to give some idea of how the clock will appear when the components have been assembled.

Referring to Fig. 2, A, B and C are three wheels mounted on independent arbors G, N and I, the wheel C rotates once each hour, from whence it follows that the arbor I carries the minute hand $H_1$. Loosely mounted on the same arbor is the "cannon" J, carrying the hour hand H; one end of J is attached to the wheel O, receiving motion through two similar wheels L and L' and a pinion K; the wheel L is driven by the arbor I. This group of wheels constitutes the "dial wheels."

The wheel C meshes with the pinion E of the arbor N; on the same arbor is mounted the wheel B that meshes with the pinion D carried by the arbor G, to which is secured the ratchet wheel A, driven by the "gravity arm" Q through the medium of the pawl P. The arm Q is secured to the arbor R, oscillated by a crutch rod S, and which is engaged at every alternate swing of the pendulum T. The combined weight of the arm and crutch rod must be adequate to cause the pawl P to propel the wheel A whilst returning to their initial position after displacement by the pendulum rod.

Matters are so arranged that when the pendulum swings to the left it displaces S and, consequently, Q in the same direction, simultaneously the pawl P is withdrawn and picks up a tooth of the wheel A. The pendulum now commences to swing towards the right, but is now followed up by the crutch rod and arm Q; the energy stored in the arm is now utilised in driving the wheel A one tooth forward, the movement in turn being transmitted through the wheel-work to the hands of the clock.

### The Vibration of the Pendulum

The scheme for maintaining the vibration of the pendulum is as follows: An ordinary wooden pendulum equipped with a heavy "bob" U has a threaded extension V terminating in the armature W. Fixed rigidly beneath the armature is an electro-magnet X, so that the armature just swings clear of the electro-magnet. When, however, the arc of vibration becomes reduced to a predetermined value, a small "finger," or "trailer," Y pivoted to the upper portion of the rod T fails to swing clear of small wedge-shaped block Z attached to a light spring 1, one end of which is riveted to a bracket 2, whilst the free end of the spring is equipped with a contact 3, engaging a stationary contact 4. On the return swing of the rod T, the finger Y having previously dropped into a nick in the block Z, levers down the spring and momentarily the contacts are closed, and the magnet X is energised. When the contacts close, the leading edge of the armature W is just about to pass over the magnet cores, consequently the excitation of X attracts the armature and the pendulum is impulsed. An increased arc of vibration of the pendulum results, so that the finger Y is again carried clear of the block Z for several swings of the pendulum.

Gradually, however, the swing becomes reduced and the finger again fails to clear the block Z, when the contacts are again closed.

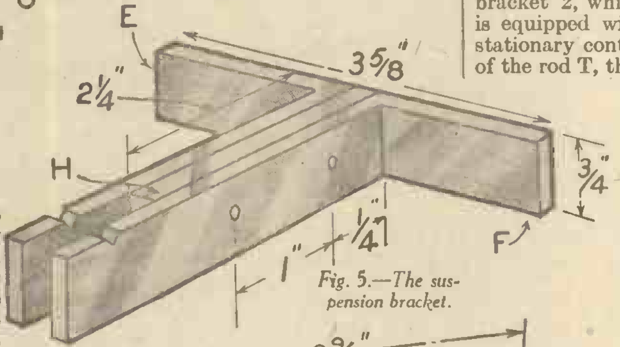



*Fig. 5.—The suspension bracket.*

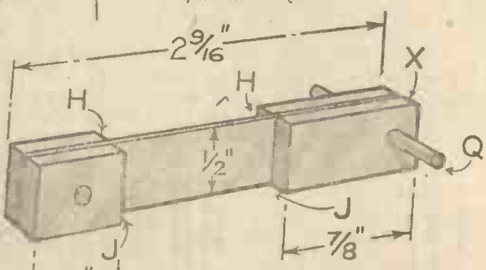



*Fig. 6.—Details of the distance piece.*

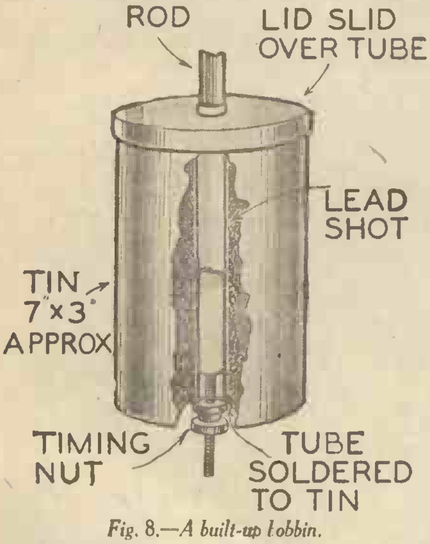



*Fig. 8.—A built-up bobbin.*

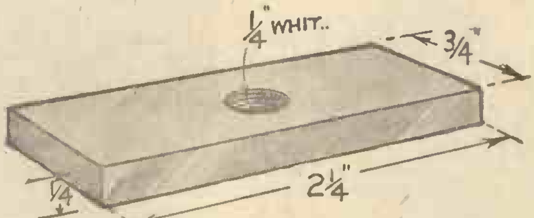



*Fig. 7.—How the armature is made.*

# Electric Clock

## CLOCK SYSTEM FOR THE HOME—EASILY MADE—OPERATED—AND CHEAP TO RUN

This simple means of impulsing the pendulum is automatic in action and economical as far as current consumption is concerned, and two or three quart Leclanché cells should run the clock for at least twelve months without any attention whatever.

### The Electro-Magnet

The soft iron yoke Y (Fig. 3) has riveted to it the soft iron cores C, the ends of which are shouldered down and are a driving fit in the holes drilled in the yoke.

For securing the electro-magnet in position a screw or piece of threaded rod S is riveted to the yoke. Slipped over the cores are the bobbins (Fig. 4); these are wound with the magnetising coils.

The bobbins are easily built up from thin brass tube of a size to fit the cores snugly, and are completed by soldering to the ends of the tube brass flanges in which a hole has previously been cut for the insertion of the tube. Before winding on the wire wrap a couple of turns of notepaper around the tubes and well brush with shellac varnish. To insulate the flanges, cut some discs of paper, of course, cutting the centre of the disc for the tube; cut through one side so that the discs can be placed on the bobbin, and then well brush with varnish. A couple of small holes may be drilled through one flange of each bobbin for threading the ends of the coil through.

Now proceed to wind on each bobbin as evenly as possible about 3½ oz. of No. 30 single silk-covered wire; cotton-covered wire may be used if at hand. Be particularly careful not to reverse the direction of winding during the process.

When the coils are wound, slip them over the cores and connect the finishing end of one coil with the starting end of the other, the two remaining ends of the coils should now be connected to a couple of dry cells or Leclanché cells to ascertain if there are any breaks in the wire; also, to check the pull of the magnet with a piece of soft iron.

Assuming the test is satisfactory, finish off the coils with a coat of some insulating varnish, and to give a pleasing appearance the coils may be covered with a piece of black velvet.

### The Suspension Bracket

Two pieces of steel or brass, E and F (Fig. 5), are bent at right angles and drilled with two holes for attachment to the back-board. Inserted between E and F is a distance piece H, a shade thinner than the thickness of the brass at X (Fig. 6). After truing up the sides of E and F coming against the piece H, the whole is drilled and riveted together, ensuring that the top and bottom edges of the bracket are square and parallel. Carefully cut a " V " notch in the top edge of E and F to receive the suspension pin Q (Fig. 6).

If necessary, file out the checks of the bracket until the brass blocks of the suspension spring are a snug fit and will permit the pin Q to rest in the notches.

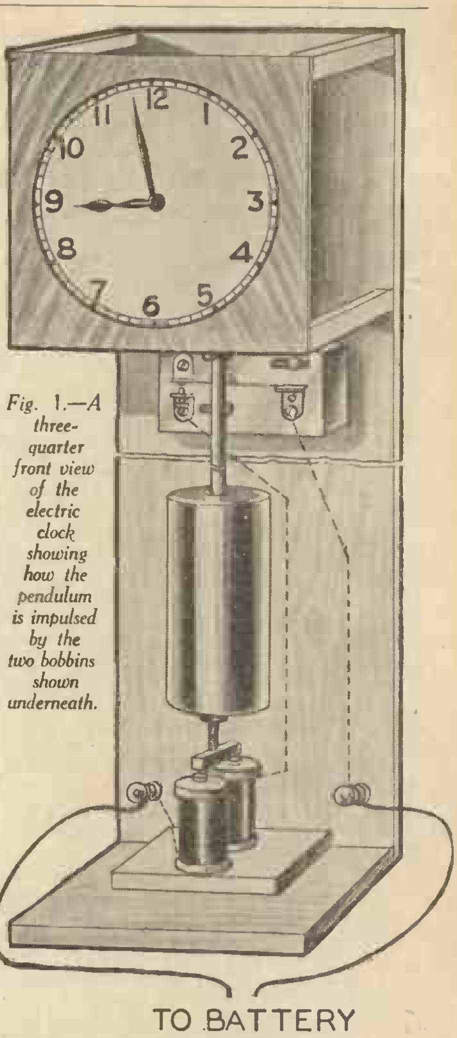



*Fig. 1.—A three-quarter front view of the electric clock showing how the pendulum is impulsed by the two bobbins shown underneath.*

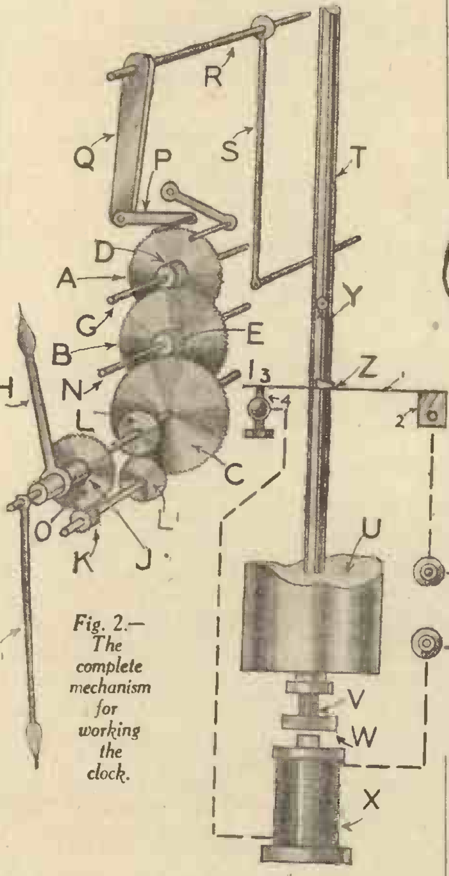



*Fig. 2.—The complete mechanism for working the clock.*

### Armature

For the armature (Fig. 7) use a piece of soft iron. A centrally drilled hole is tapped to suit the screwed rod attached to the end of the pendulum rod and is locked in position by a nut. It is as well to anneal the iron by allowing it to remain in the fire overnight.

### The Pendulum

The pendulum is built up; a main portion P (Fig. 9) consists of a piece of ½-in. wooden curtain rod, the ends being fitted into pieces of brass tube, A and B.

The tube A is closed at one end with a piece of brass rod D slotted to receive the

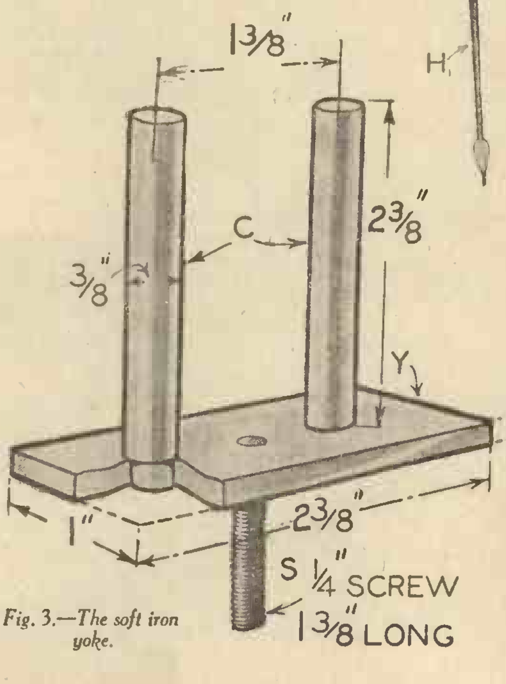



*Fig. 3.—The soft iron yoke.*

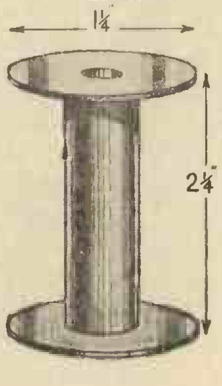



*Fig. 4.—Details of the bobbin.*

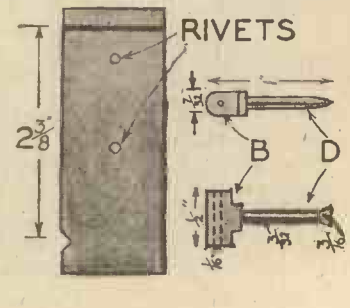



*Fig. 10.—The trailer or finger.*

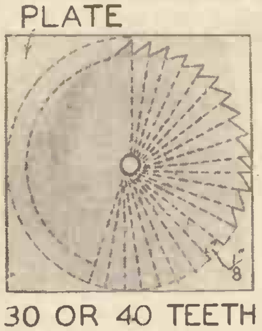



*Fig. 11.—Details for setting out the ratchet wheel.*

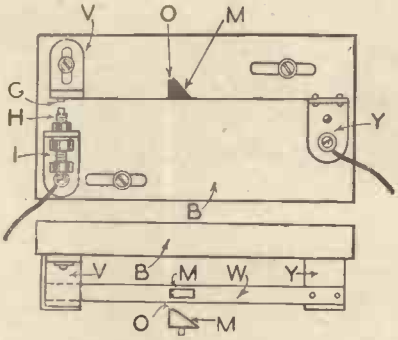



*Fig. 14.—The contact maker.*

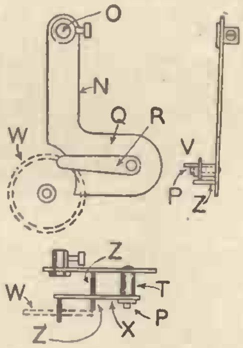



*Fig. 13.—The gravity arc.*

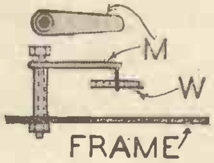



*Fig. 15.—The back-stop.*

its length will be 22 in., measured as shown in Fig. 9, and the number of teeth in the ratchet wheel will be 40, since a ¾-sec. pendulum makes 80 swings per minute. On the other hand, if a long or seconds pendulum is preferred, with a length of 39·12 in., the ratchet wheel will have 30 teeth. Frequently, on counting the number of teeth on the highest-driven wheel of a movement, they will number 40, which is suitable for a ¾-secs. pendulum.

In this case it is not absolutely necessary to substitute a ratchet wheel of 40 teeth, but the driving pawl will have to be carefully shaped to fit the teeth of wheel. If it is decided to replace the wheel by a ratchet wheel with either 30 or 40 teeth, particulars for setting out will be found in Fig. 11.

The length of the pendulum will not affect the other details of the clock, which can now be considered in detail.

suspension spring S, a small bolt and nut being the means of attachment. The rod is reduced to fit into the tube and a couple of small holes are drilled through the whole to receive rivets made from soft wire.

The tube B is attached to the rod in a similar manner, but before attachment a ¼-in. brass collar N (or nut filed down) is driven into the end of the tube and soldered; screwed into the collar is a piece of threaded rod T to carry the timing nut U and the armature L. Sliding freely over B is the bob M, which should weigh from 10 to 15 lb., and may be of iron or lead.

Fig. 6 shows the method of attaching the suspension spring to the brass chocks by small rivets.

Use steel ribbons or "feeler" blade steel for the spring, which should be from 3/1,000 in. to 5/1,000 in. in thickness.

A built-up bob is shown in Fig. 8, which is self-explanatory.

The ends of the spring should be a good fit in the suspension bracket and the end of the pendulum respectively; the upper end of the spring has a pin Q that normally rests in the notches of the bracket. The length of the pendulum is measured from the bottom of the bracket to the centre of the bob; any slight error in length is easily corrected by altering the position of the bob by means of the timing nut U.

### Trailer or Finger

A piece of steel wire D (Fig. 10) is flattened at one end, the other end is driven into and soldered to the block B; the latter has a hole drilled at right angles to D to take the pin carried by the pendulum fitting.

The whole fitting should be as light as possible; to reduce wear the flattened end of the wire D should be filed to a point and hardened.

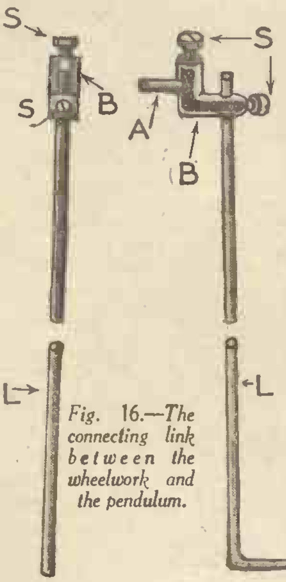
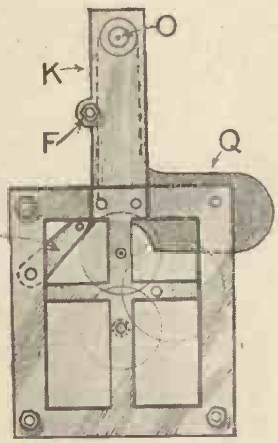



*Fig. 16.—The connecting link between the wheelwork and the pendulum.*

To support the finger, the special fitting (Fig. 18) will have to be built up. This consists of a piece of thick tube T to fit the pendulum rod R freely, and on opposite sides of the tube are soldered the bosses A and B; these are drilled and tapped to receive respectively the milled screw S and the pin P.



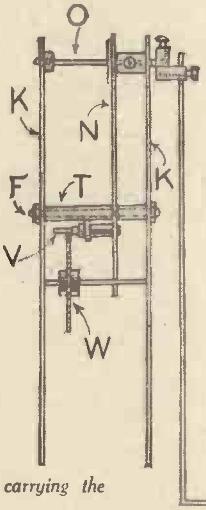




*Fig. 12.—The support for the arbor carrying the gravity arc.*

The screw S provides for adjustment of the finger up and down the pendulum rod relative to the contact-maker.

### The Wheelwork

To reduce the amount of work and the tediousness of building up the wheelwork, necessitating the correct pitching of the holes for the pivots of the various arbors, it is proposed to utilise the movement of an alarm or other clock.

It will be appreciated that, although certain additions are made to the frames and wheels removed, yet the positioning of the wheels will not be affected.

If the movement has a seconds hand, remove all the wheels in the alarm train, then remove the "balance wheel" and "escapement"; after that, the large wheel carrying the main spring of the going train. The movement will now consist of the wheels depicted in Fig. 1.

The next matter is to decide whether the clock is going to have a long or medium-length pendulum.

If a ¾ seconds pendulum is used

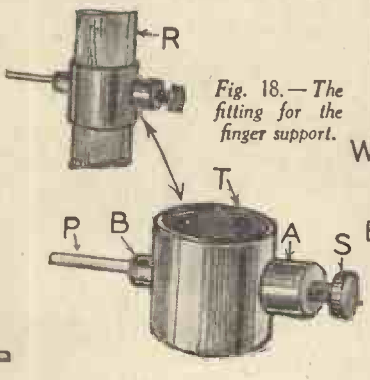



*Fig. 18.—The fitting for the finger support.*

### The Frames

To support the arbor carrying the gravity arm it will be necessary to rivet or bolt to the frames two brass strips K (Fig. 12); these are tied together at the upper ends by a length of 2BA threaded rod F; a piece of tube T slipped over the rod serves as a distance piece when the nuts are screwed up. Viewing the movement from the back, it will be advisable to remove the top right-hand pillar originally fitted for keeping the frames the correct distance apart.

Holes are drilled in the strips K to take the gravity arm arbor O.

On account of clock frames varying in size, it may become necessary to modify slightly the dimensions given in Figs. 12 and 13, but no great difficulty will be experienced.

### The Gravity Arm

This component is readily made from a piece of sheet brass, and should be of ample proportions to have the required weight to propel the ratchet wheel.

A projection Q (Fig. 13) on the lower end

(Continued on page 258.)

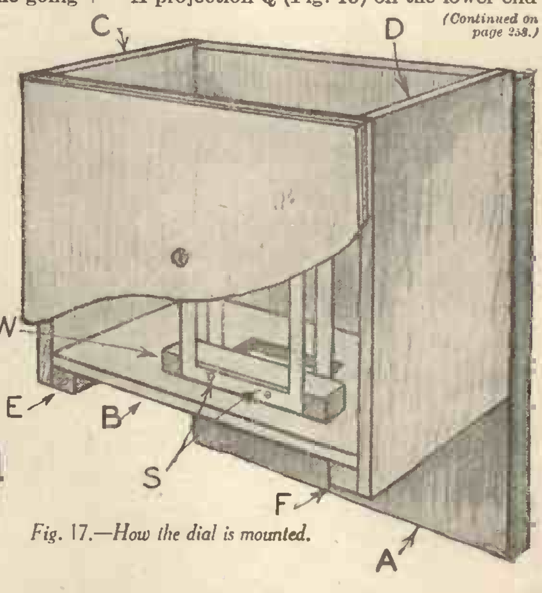



*Fig. 17.—How the dial is mounted.*

# THE BRITISH POWER GRID SYSTEM EXPLAINED

**Being an explanation of the grid, facts and figures about its construction and operation, together with what it is hoped to achieve in the distribution of electrical power in Great Britain.**

*A double-circuit tower in the centre of a road of a new estate at Sidcup, Kent.*

WHEN we take a railway journey, a motor car ride, or maybe just a walk round outside our home town, we cannot help but think of aerials and wireless when we see massive steel towers and suspended cables similar to those illustrated in Figs. 1 and 2.

The object here is to describe simply what these towers and cables, which are now a feature of our countryside, actually represent and why they are there.

### In the Beginning

To start with, it is a question to do entirely with the increasingly wide use of electricity in both industry and the household. It is necessary before going fully into the subject to mention two important Acts that have been passed through the increased use of electricity since the war, namely, (1) the Electricity Act of 1919, which set up an Electricity Commission with power to govern the supplier and consumer of electricity; and (2) the Electricity Act of 1926 (a much more important Act), which authorised the creation of the Central Electricity Board. To this Board was entrusted the work of constructing a National Grid System of electricity distribution. It was to provide for the construction of all electrical power transmission lines and transforming stations required for interconnecting the power stations which had been selected for supplying electrical energy, and for providing supplies to undertakings which had no power stations. It is these transmission lines (about 4,000 miles of them, with their 2,500 towers) on which a large portion of the allotted £36,000,000 has been spent that we now see extending over our British countryside.

### Object of the Grid

The National Grid was designed to bring a supply of electricity efficiently and cheaply to the whole country at standard voltages and frequency, co-ordinating the production of electricity and achieving uniformity of price. The Central Electricity Board decided that, for maximum efficiency and cheapness in the generation and transmission of electrical energy, A.C. current was the better of the two types (A.C. and D.C.) to choose from. It was found to be cheaper and more practicable to transmit this power overhead at high voltages in relatively thin wires, transforming down to working voltages at the required points, than to lay underground, very heavy current-carrying cables at working voltages, this latter being the system necessarily employed when distributing direct current.

So here we see the origin of the grid. The general system of transmission supply was alternating current, three-phase, 132,000 volts between phases, at 50 cycles.

### The Grid Construction

The choice of conductor material for these overhead transmission lines depended largely upon the mechanical properties of the available metals, and to overcome certain difficulties (getting suitable tower sites, etc.) made it essential to use spans of the maximum length, and in this respect steel-cored aluminium conductors were found to be the best. The suspended cables generally consist of a central core of seven strands of galvanised steel wire about $\frac{1}{10}$ in. diameter, surrounded by about thirty strands of aluminium wire of the same diameter, giving an overall diameter of $\frac{3}{4}$ in. On the lower-voltage sections of the grid (66 kv. and 33 kv.) sometimes copper conductors are used, but not usually on spans more than 400 ft. The towers for supporting these lines are mostly of the lattice-steel type, although reinforced concrete and even wood have been used as tower constructing materials. Fig. 1 shows

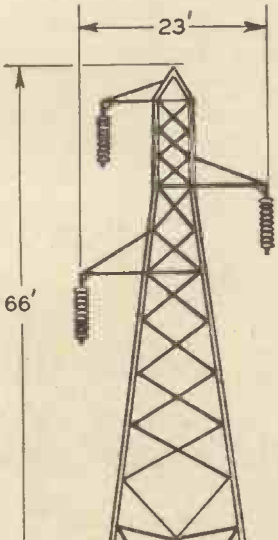
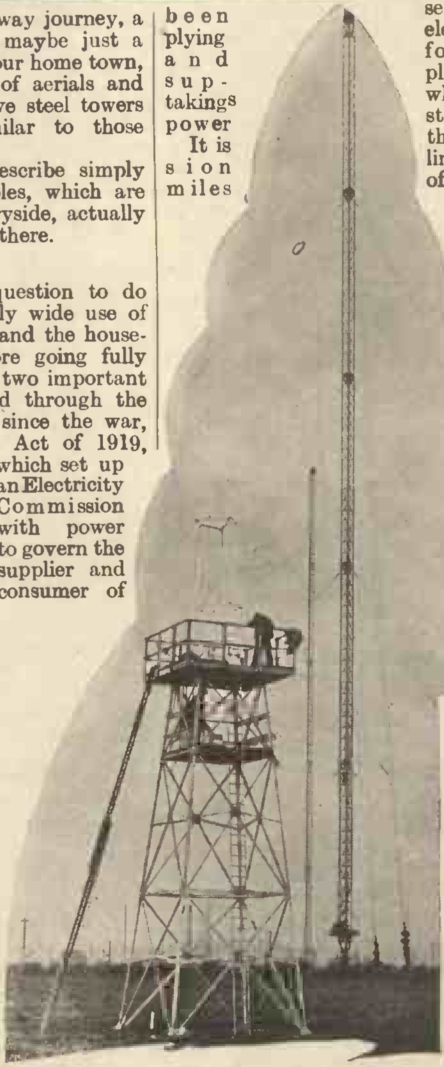
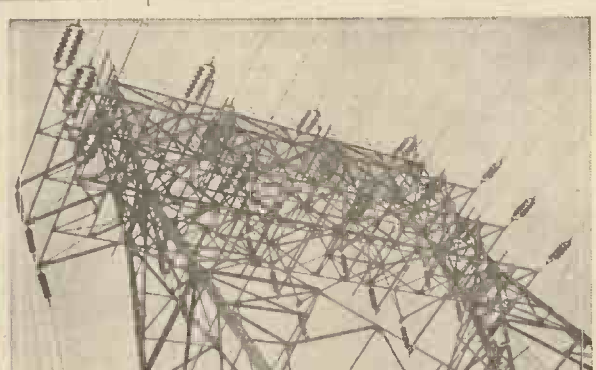



*Fig. 1.—A single-circuit tower for main transmission line working.*



*A neon danger beacon is being built to the order of the Air Ministry to warn aircraft of the 12 giant wireless masts at the Rugby station. Work began only a few days before the crash at Ruysselede, Belgium, when an air liner flew into a similar group of wireless pylons with the loss of 10 lives. The 35-ft. tower, with the 14-ft. of neon light tube, in the middle of the maze of twelve 820-ft. high steel wireless masts, at Rugby.*



*One of the giant towers which supply the grid electric scheme at the new grid electric power station at Dunston, Newcastle-on-Tyne. This is the largest plant of its kind in England and cost £3,000,000.*

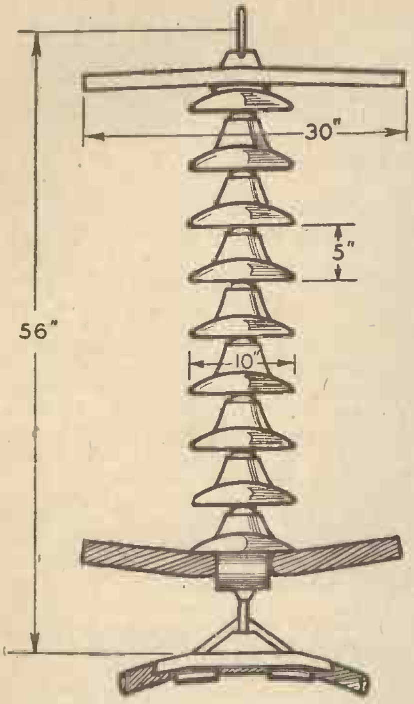



*Fig. 3.—A standard suspension type insulator.*

a single circuit lattice-steel tower for main-transmission line working, and Fig. 2 shows a double circuit tower. On the lower-voltage sections these towers are rather smaller, some being only 42 ft. high. The normal length span for the 132,000-volt lines is about 900 ft., although they may be much more under favourable ground contour conditions, and river crossings. The clearance between the lowest line conductor and earth is about 20 ft., while over buildings the minimum clearance is 12 ft. These towers are, of course, designed to withstand certain loadings, apart from the weight and tension of the lines and insulators, such as wind resistance or a coating of ice.

Three types of tower foundation, viz., excavated earth, concrete ball, and ordinary concrete, are used, depending on the nature of the subsoil in which the tower stands. In Fig. 3 a standard suspension type insulator is shown, but on a smaller type only 5 units are on the chain, the overall length being about 2 ft. 6 in.

**Grid Operation and Performance**

Whilst the details of generation and transformation of these high voltage lines and switchgear involved, methods of connecting the power for our normal use, etc., do not come within the scope of our subject, a few facts and figures regarding the working output of the grid are interesting. The novelty of the grid scheme lies in its magnitude and in the comparatively high voltage employed. A particularly interesting accomplishment of the grid is the crossing of the River Forth. Here the actual crossing span is 3,050 ft. between two suspension towers 338 ft. high, giving a high water clearance of 158 ft.

In connection with the grid's output at present, only three billion units of electricity of this country's annual consumption of 13 billion units pass through the grid. It is hoped and estimated that when the grid is carrying more nearly its normal full load that it will distribute 17 billion units in 1935 and about 25 billion units in 1940.

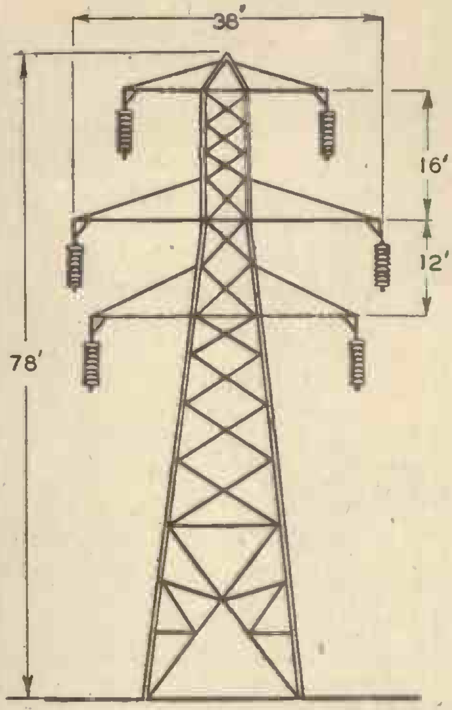



*Fig. 2.—A double-circuit tower of a similar type to the one shown in Fig. 1.*

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## MAKING AN ELECTRIC CLOCK

(*Continued from page* 256.)

of N carries the pawl R, engaging with the teeth of the wheel W, whilst its upper end is fitted with a bush to suit the arbor O. On account of the clock frames varying in size, the dimensions Y on the gravity arm can only be given approximately; the constructor can modify this to suit his special requirements.

The pawl is built up from a brass strip X, mounted on and soldered to a piece of thick tube T, to act as a bush, which in turn oscillates on the pin P projecting from Q.

A pin V, riveted to the outer end of X, engages the teeth of the ratchet wheel; the pin should be filed to suit the shape of the teeth.

To prevent the pawl from dropping and picking up more than one tooth when withdrawn by the pendulum a pin Z may be set in the arm on which the pawl may temporarily rest.

The back stop M can be manufactured in much the same way (see Figs. 12 and 15).

**Contact Maker**

This device takes the form of a light sprint W, riveted at one end to a brass bracket Y (Fig. 14), screwed to a wooden or ebonite base B. The free end of the spring is provided with a contact G, engaging with an adjustable contact H, carried by the bracket I.

To restrict the play of the spring, an adjustable stop V is introduced; thin strips of leather, etc., may be glued to it to silence the action when the spring is released.

The spring should not be too stiff, otherwise in depressing it a lot of unnecessary work will be thrown on the pendulum.

Riveted or otherwise mounted on the spring is a small wedge-shaped block M; the latter has a small nick cut at one end for the entry of the point of the finger.

The baseboard B should be provided with slotted holes for adjusting purposes.

**Crutch Rod Details**

The connecting link between wheelwork and pendulum is the crutch rod L (Fig. 16). To render the rod adjustable up and down the pendulum, as well as on the gravity arm arbor A, a small fitting B will suit all requirements. The item is cut from a block of brass and has two holes drilled at right angles to take the arbor A and the lever L respectively; tapped holes receive set screws S for locking purposes.

**Hands and Dial**

The design of the hands and the dial are left to the constructor's taste; the former should be fairly light and correctly fitted to the movement. The dial may be of cardboard, brass, etc., and about 7 in. across; suitable dials may, however, be purchased for a few pence, although there is no reason why it should not be home produced.

There are various ways of mounting the dial, one is shown in Fig. 17, and shows the dial secured to a three-ply dial-board, which is in turn screwed to the pieces C and D.

**Mounting and Wheelwork, etc.**

All the components are erected on a substantial backboard, so that the whole may ultimately be placed in a suitable case; the batteries may also be housed in the bottom of the case. The clock frame fits over the block W, attached to the board B, the latter slides in between two wooden uprights C and D, and rests on the strips E and F, attached thereto. The sizes of C and D will be decided by the dimensions of the framework; holes are drilled in the clock frame for the screws S, securing the frame to the block W.

The backboard A should have drawn on it a centre line, and is then hung up or set so that the line is truly vertical. Screw the pendulum suspension bracket to the top of the board so that the pendulum hangs in front of the line on the board. Next place the electro-magnet in position so that the cores are central with and about $\frac{1}{16}$ in. below the armature; the gap can be reduced to a minimum later by packing up the magnet with a piece of cardboard. The magnet is best supported by a bracket or shelf, as shown in Fig. 1.

The position of the contact maker is found by experiment, mounting its base-board a little above the mid-position of the pendulum rod. The rod should hang vertically at the time and the board set so that the nick in the steel block is on the left of the finger.

Now lower the finger attachment on the pendulum until the former is about $\frac{1}{16}$ in. below the block. A little experimenting will be necessary to get the best results, raising the finger may be necessary if the spring is depressed more than, say, $\frac{1}{32}$ in.

The slave clocks will be dealt with next month.

# MAKING AND USING SELENIUM CELLS

By H. J. BARTON CHAPPLE,
WH.SCH., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

*Although the initial discovery of the properties of selenium gave promise of many important uses, its sphere of activities has been rather seriously overshadowed by the more spectacular and scientific utilisation of photo-electric cells. In spite of this, however, the selenium cell is capable of providing many interesting uses in the hands of practical constructors and has the advantage of being much cheaper.*

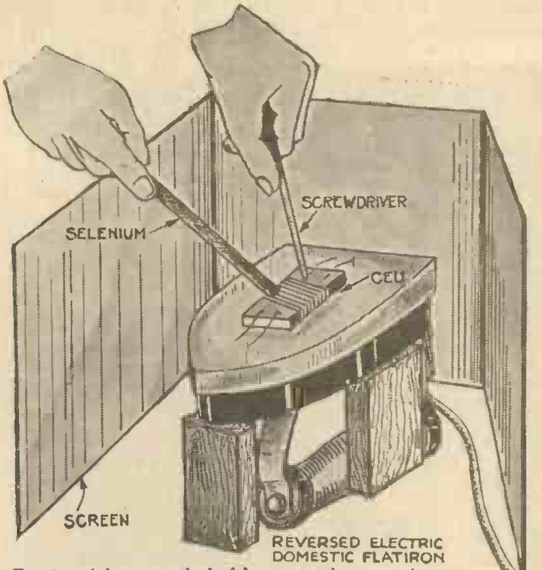



*Fig. 4.—A better method of heating and coating the cell.*

WHEREAS the construction of a photo-electric cell is beyond the scope of the amateur, this is not the case with a selenium cell. Stated briefly, the principal property of selenium is its reaction to light, or, in other words, it is a light sensitive substance. Its action in this respect was found quite accidentally in 1873 when a transatlantic cable operator noticed his instruments behaving in a very erratic manner. The high resistances then used were made from selenium, and every time the sun shone on them, the needle indicators moved. Upon careful investigation it was learned that the resistance altered. Furthermore, when connected up in circuit the magnitude of the current flowing could be regulated by varying the amount of light to which the selenium was exposed.

Here, then, was a device which opened up a wide vista of possibilities, but, as will be mentioned later, these, in many cases, failed to materialise owing to certain defects.

### Making Up Cells

The main consideration at the moment is how one or two simple forms of cell can be built up by the amateur with the exercise of a little care. One of the simplest is shown in Fig. 2, this being termed the wire-wound type. Obtain a rectangular piece of non-conducting material which, for convenience, may be slate, unglazed porcelain or mica, the size being approximately 2 in. × 1 in. × $\frac{1}{16}$ in. to $\frac{1}{8}$ in. thick. Cut small notches in each long edge for a central distance of 1½in., the distance between the notches being $\frac{1}{16}$ in., the insulating material resembling Fig. 1, where the notches have been exaggerated for clarity.

Now take a length of, say, No. 30 S.W.G. bare copper wire, and fixing it to one end, as shown in Fig. 2, wind it on the plate tightly so that it is gripped in *alternate* notches, as shown by the unbroken lines in Fig. 2. Finally, anchor the end and leave a short length free. Repeat this with another length of the same wire, but wind now so that the remaining notches hold the wire, this being indicated by the broken lines in Fig. 2. In this way a double spiral is formed, and great care must be taken to ensure that the wires do not touch at any portion of this length.

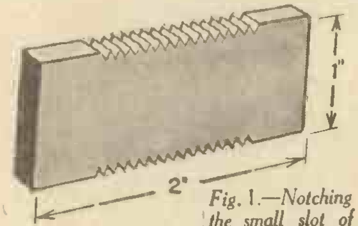



*Fig. 1.—Notching the small slot of insulating material.*

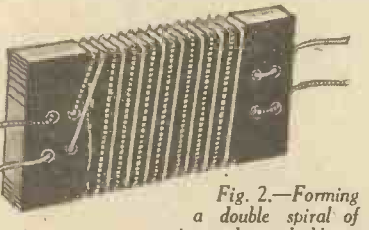


*Fig. 2.—Forming a double spiral of wire on the notched base.*

The next task is the most difficult, and is termed the coating operation. The selenium itself may be obtained in sticks from any scientific supply stores, and to apply it to the "wired plate" or base, heat must be applied. The crudest way of doing this is to take a piece of sheet iron, and, after laying the "base" on it, hold the iron with a pair of gas pliers over the flame of a bunsen burner, taking care to keep away any direct flame contact (see Fig. 3). When the base has reached a certain temperature (found by trial), the selenium stick, when rubbed against it, will run fairly easily in much the same way as a stick of sealing wax. Coat one side of the base *evenly* with as thin a layer of selenium as possible, bearing in mind that the thinner the layer the more efficient and more rapid to light response will your cell become.

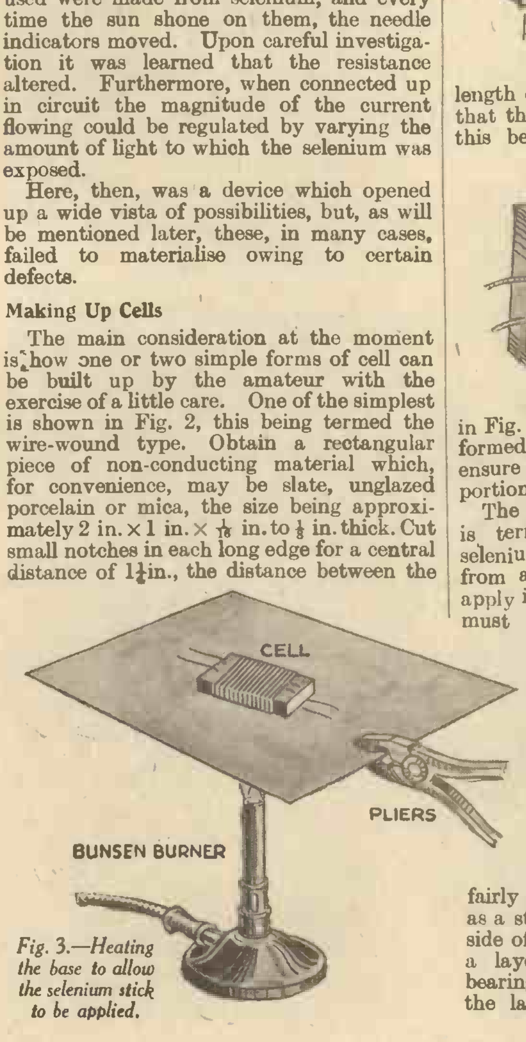



*Fig. 3.—Heating the base to allow the selenium stick to be applied.*

At first the selenium will exhibit a tendency to collect in globular form, but later it will adhere to the base as a thin layer, and as soon as this effect is noticed, let the cell cool slowly. The original shiny stove enamel appearance will give way to a grey colour, and on close examination the surface will reveal a formation of small grey crystals. This indicates that the selenium has changed from the non-conducting amorphous to the conducting crystalline or metallic form. Allow the cooling to take place slowly, and, in addition, if at all possible, exclude traces of humidity in the air.

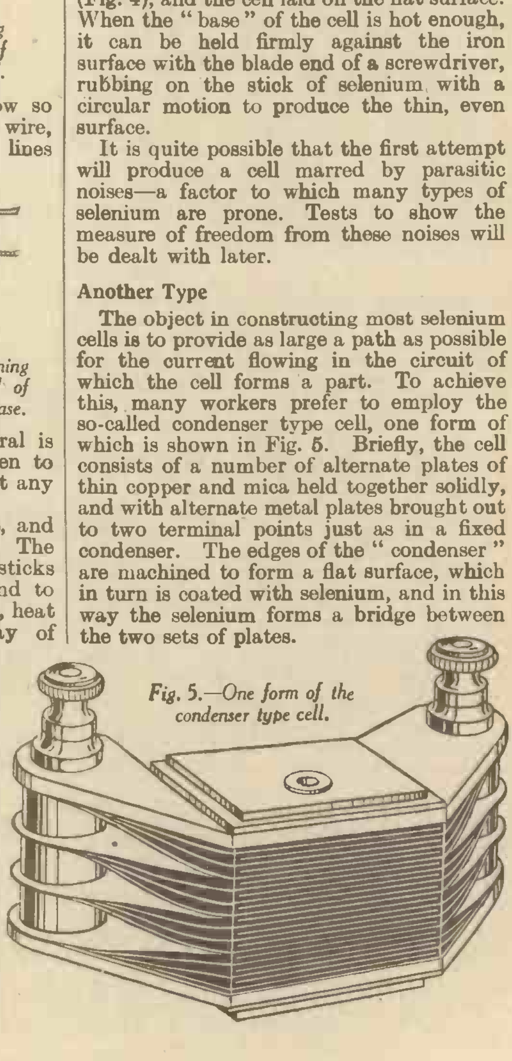
A more efficient way of carrying out the heating and coating operation is to use the domestic electric iron, shielding away draughts by surrounding it with cardboard. The iron must be supported upside down (Fig. 4), and the cell laid on the flat surface. When the "base" of the cell is hot enough, it can be held firmly against the iron surface with the blade end of a screwdriver, rubbing on the stick of selenium with a circular motion to produce the thin, even surface.

It is quite possible that the first attempt will produce a cell marred by parasitic noises—a factor to which many types of selenium are prone. Tests to show the measure of freedom from these noises will be dealt with later.

### Another Type

The object in constructing most selenium cells is to provide as large a path as possible for the current flowing in the circuit of which the cell forms a part. To achieve this, many workers prefer to employ the so-called condenser type cell, one form of which is shown in Fig. 5. Briefly, the cell consists of a number of alternate plates of thin copper and mica held together solidly, and with alternate metal plates brought out to two terminal points just as in a fixed condenser. The edges of the "condenser" are machined to form a flat surface, which in turn is coated with selenium, and in this way the selenium forms a bridge between the two sets of plates.

*Fig. 5.—One form of the condenser type cell.*



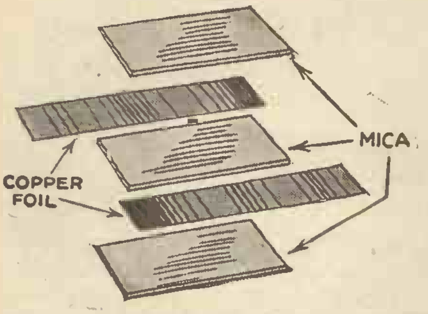



*Fig. 6.—Assemble alternate layers of mica and copper foil as in a fixed condenser.*

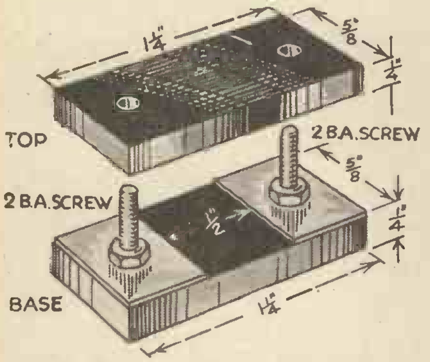



*Fig. 7.—The top and bottom bakelite mountings.*

The constructor has full scope for exercising his own ingenuity in making a condenser type cell, but as a guide to those who prefer some actual working data, the following dimensions will prove useful.

First of all cut up twenty strips of thin copper foil about ·001 in. thick, so that each strip is ¼ in. wide and 1¼ in. long. Next obtain a piece of mica sheet about ·008 to ·01 in. thick, and cut out twenty-five rectangular pieces ⅝ in. wide by ⅝ in. long. Build these up in condenser fashion, as shown in Fig. 6 (starting and finishing with two mica sheets at each end) so that, as far as possible, one edge of the combination is flat.

Lay this on one side for a moment and proceed to cut out two bakelite mountings, as shown in Fig. 7, the dimensions of each strip being indicated. Grip two small copper strips to one of these mountings, using countersunk brass screws and nuts. Now take up your " condenser " assembly, and, gripping it firmly, bend over the copper foil ends tightly, as shown in exaggerated form in Fig. 8, cutting away the foil ends so that they are ⅜ in. apart. Now seat this on the mounting with the copper contacts so that the bent-over copper foil pieces make metallic connections with it. Thread over this the other mounting and tighten up the nuts at the top to ensure a rigid and solid structure (see Fig. 9). The flat edge of this condenser base must protrude slightly from the clamped mountings, and to remedy any slight irregularity, take a very fine file and smooth off the surface so that it is a plain one. This will leave a surface consisting of thin bands of copper interleaved with thicker bands of mica.

Before attempting to coat this, test its insulation with a 100-volt battery and a voltmeter, for no conducting path must be present in this condition. If all is well, then this surface must be coated with a thin layer of selenium in the manner previously indicated, preferably using the domestic flat-iron method. Since the surface is quite flat it is generally easier to ensure a thin, even coating, for when the selenium has " run," the surface can be scraped carefully with the flat edge of a piece of glass, to remove any superfluous selenium.

**Testing**

One of the biggest drawbacks to the general use of selenium cells is the sluggishness of their action. That is to say, there is an appreciable lapse of time (relatively speaking) between the resistance alteration when a change of light exposure is effected to its return to the original condition. This therefore rules the cell out of question for television work. On the other hand, there is a greater sensitivity when compared with a photo-electric cell, and hence the amount of amplification necessary to interpret the cell's action is much smaller.

A simple experiment which may be tried to test the cell when made is to connect it in series with a 60-volt battery and a pair of high resistance (2,000 ohms) headphones. When the cell is shielded entirely from any form of light, no sound should be heard in the 'phones. If there are pronounced scratching and scraping noises, then the cell is not efficient, and it will probably be necessary to re-coat it. To test for light response it is very instructive to make a slotted disc—the number of slots are immaterial—and mount the disc on the shaft of a motor whose speed can be varied. Focus the light beam from a lamp through a lens on to the cell so that the beam passes through the disc slots. Now attach the cell in series with a 60-volt battery to the primary winding of an L.F. transformer, the secondary passing to the input of an ordinary L.F. amplifier (see Fig. 10). On rotating the disc, and thus chopping up the light beam passing to the cell, a clear and distinct note will be produced in the loudspeaker connected to the amplifier output terminals, the pitch of the note varying with the speed of the motor.

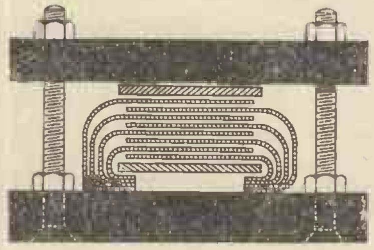


*Fig. 9.—Cell mounted in holder with a plane edge to the front.*

Many other simple applications of the cell could be described, but as these are really a repetition of those described last month in the article dealing with photo-electric cell experiments, there is no need to duplicate them, but merely to refer the reader to that issue. One additional feature may be mentioned, however, namely, that the selenium cell, provided it has been properly made, will function quite well with infra-red rays. These rays are, of course, invisible, and may be produced by interposing a thin sheet of ebonite in front of a projection lamp. For example, in Fig. 10 the experiment can be repeated when a thin sheet of ebonite is placed between the lamp and focussing lens so that all visible light is shielded from the cell, and it is influenced only by the infra-red rays.

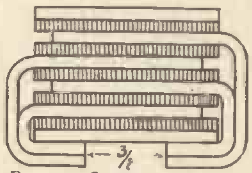


*Fig. 8.—Exaggerated view of copper foil ends bent round, only four foil sheets being indicated.*

Quite a novel burglar alarm may be built up in this way, using a polarised relay whose " tongue " is held over on one contact by the infra-red beam focussed on the cell. As soon as this ray is interrupted by someone crossing its path, the contact is released and can close a local alarm circuit, which in turn may be either a ringing bell or signal lights, or a combination of the two. It makes a very impressive demonstration, and is one which I have done on many occasions to show the principles of light sensitivity response, which, of course, is the principle of action of the selenium cell.

With reasonable care selenium cells made up in the manner described will have a very long life. As far as possible they should be used in a cool, dry atmosphere, every precaution being taken to prevent the cell from becoming wet, owing to the hygroscopic nature of selenium. Furthermore, treat the cell gently, for violent knocks will impair the contact between the selenium coating and the conducting electrodes.

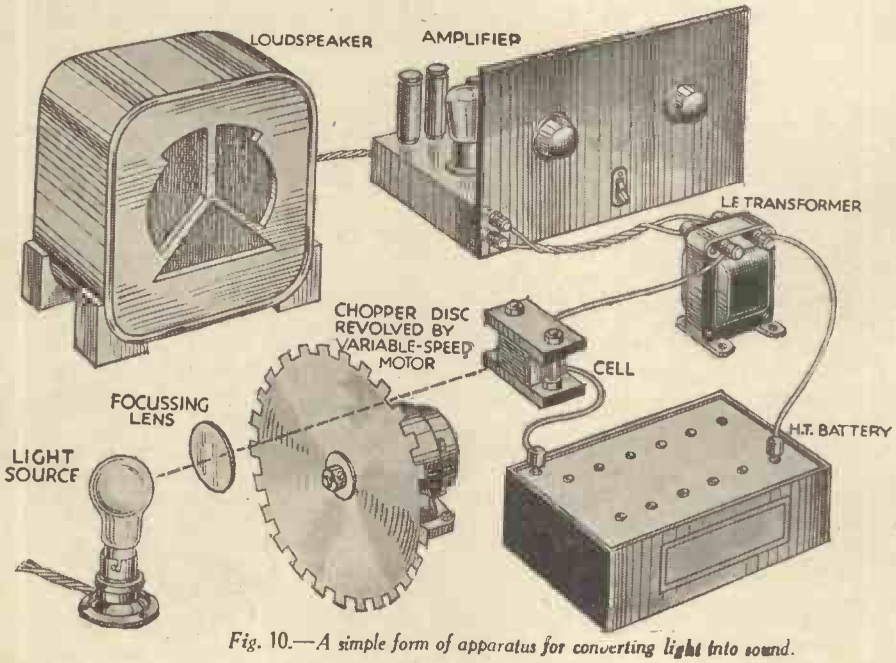
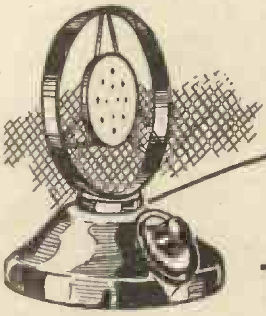
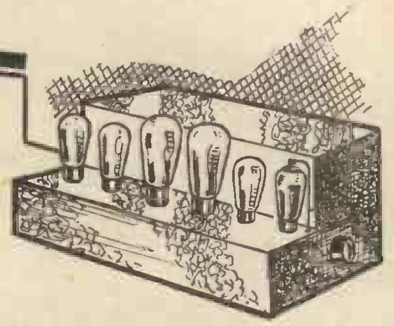



*Fig. 10.—A simple form of apparatus for converting light into sound.*

# MAKING A SENSITIVE DEAF-AID





FULL CONSTRUCTIONAL DETAILS ARE GIVEN IN THIS ARTICLE FOR A DEAF-AID WHICH WILL GIVE EXCELLENT REPRODUCTION

By FRANK PRESTON

THE usual type of deaf-aid which essentially consists of nothing more than a microphone and an ear-phone has many disadvantages, not least of which is its comparative lack of sensitivity. Another difficulty is that it does not generally give really high "quality" reproduction, as judged by present standards. Additionally, this type of instrument is usually very expensive and is often not within the means of many people who could benefit by its use. It is not intended to convey the idea that deaf-aids of the kind referred to are sold at unreasonable or exorbitant prices, for it must be remembered that all the more reputable makers employ ear specialists to examine would-be purchasers so that a special unit can be made up according to "prescription." This is not always the case, and there are some firms which survive on the incredulity of their customers.

As a matter of fact, in some cases the choice of a particular type of deaf-aid should be left in the hands of a medical man who is able to test the ears in a manner comparable with that in which the oculist tests the eyes. Nevertheless, there is no reason whatever why the average person whose hearing is defective (I would exclude those suffering from a punctured ear-drum or similar more serious complaint) should not make up an amplifier by means of which he can experiment to find adjustments which most nearly suit his own case. It is not proposed to describe the construction of the usual microphone and ear-phone amplifier arrangement, but, instead, of a more powerful and sensitive device which can be used when attending public lectures, theatres, and so on. The unit to be described, besides being more sensitive than the ordinary deaf-aid, will also amplify sounds with more fidelity and thus enable the music lover who is hard of hearing to enjoy concerts and wireless programmes as he could before he was afflicted by his disability.

### Deaf-aid Essentials

Before passing on to the actual constructional details, it will be better to consider the general form taken by the deaf-aid, and this will most easily be followed by making reference to Fig. 1. Here it can be seen that there is a microphone, this being followed by a microphone transformer and small battery, a valve amplifier and a pair of ear-phones. The microphone can be of nearly any type, although the pattern designed to hook on to the coat lapel will be convenient in most cases for outdoor and concert use. When the unit is principally intended for use in the home, one of the many "table" types will probably be better, and this can be stood on a table in the middle of the room so that it will respond to voices and also to gramophone and wireless reproduction. The microphone transformer should have a step-up ratio of about 100 to 1, and can always be obtained from the suppliers of the microphone. It might be mentioned that a very wide variety of microphones and transformers (to match) are sold by Messrs. Electradix Radios, 218 Upper Thames Street, London, E.C.4, and all readers w ll find a pair to meet their own particular requirement from the wide range offered.

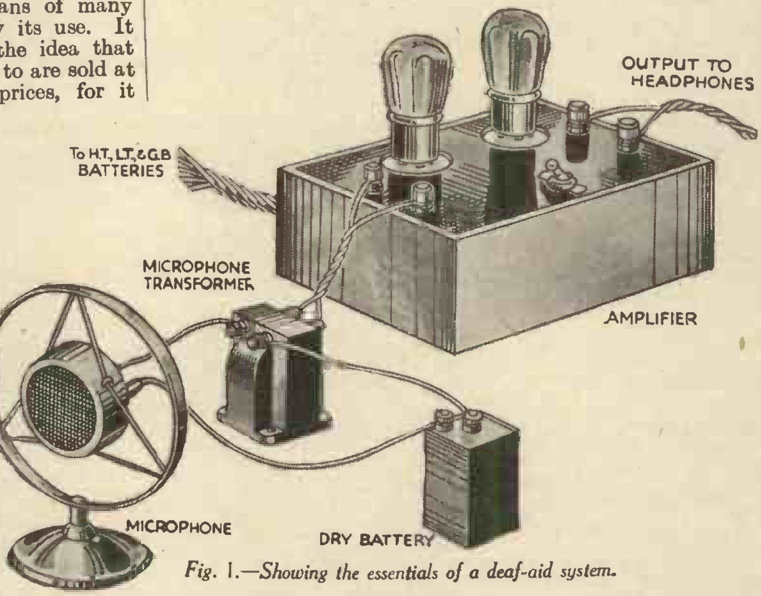



*Fig. 1.—Showing the essentials of a deaf-aid system.*

The small dry battery is for "energising" the microphone; this can generally be a 3-volt or 4½-volt torch battery, but the actual voltage necessary will depend to a certain extent upon the type of microphone employed. As for the amplifier, this is obviously the most important part of the equipment and must be considered separately.

### The Amplifier

The valve amplifier, such as is used in all wireless sets, is the most efficient known, and is very convenient for the purpose in question. It may employ either one or two valves, according to the degree of magnification desired, but a two-valver is recommended, because it allows a greater "reserve" and is capable of providing the necessary results without the use of a very high-voltage high-tension supply. This latter is, of course, an important consideration when the unit is to be easily portable.

Fig. 2 shows the essential parts of an effective two-valve amplifier in which a pair of ordinary 2-volt valves are employed. The first valve is of the L.F. type (such as the "Hivac" L210) and the second is a small power valve. When a very great output volume is not called for, however, another L.F. valve can be used in the second stage, and in that case a certain economy of current consumption can be effected. The most important consideration is, perhaps, the type of coupling used between the two valves. It is a recognised fact that most people whose ears are somewhat defective can hear the higher notes better than those of lower pitch. Consequently, it is best to make use of a transformer which will emphasise the high frequencies. There are three kinds of transformers which will do this, the simplest of which is that generally known as a "compensating" transformer. This is actually made to compensate for the loss

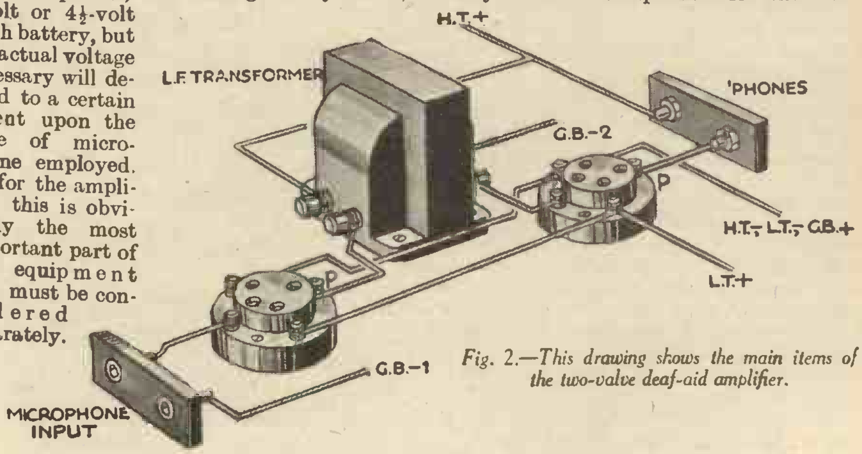
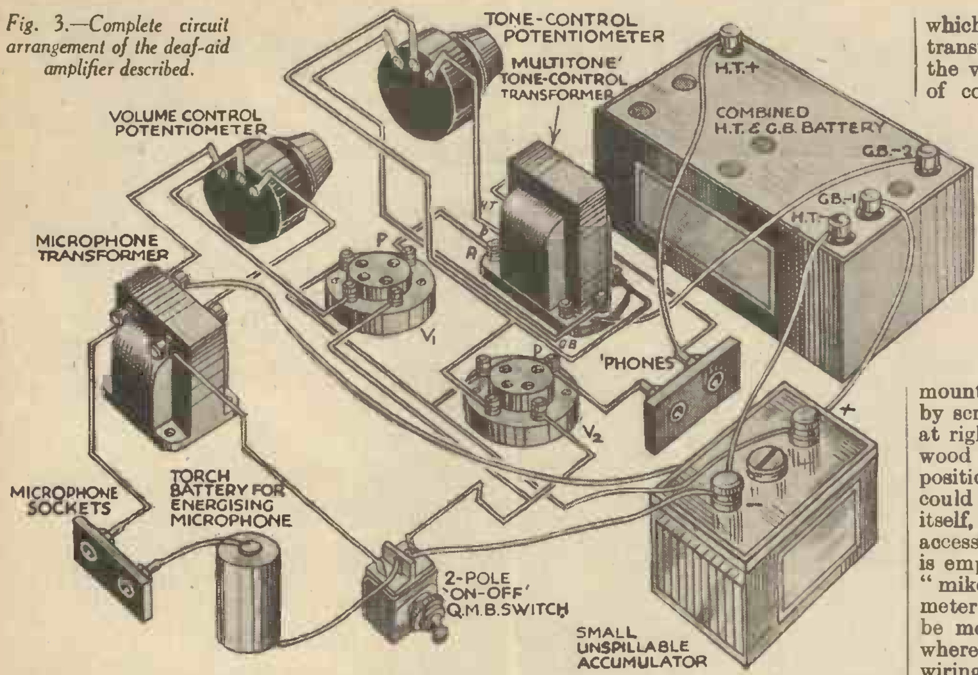



*Fig. 2.—This drawing shows the main items of the two-valve deaf-aid amplifier.*

*Fig. 3.—Complete circuit arrangement of the deaf-aid amplifier described.*




on the way of high-note response which is occasioned in a wireless receiver by the use of reaction. Another type is that sold by one firm under the name of "Rectatone"; this is similar in some respects to the first one mentioned, but can be used with a variable resistance by means of which the high-note emphasis can be varied in degree. The very best component, however, is the real tone-control transformer, because this can be used to give emphasis to either high or low notes at will, and the tone of reproduction can readily be varied between the two extremes. By means of such a transformer any of the simpler deficiencies of the ear can be compensated for very easily and the tone reproduced by the phones can be adjusted to suit all kinds of music and speech under practically any circumstances.

The power supply for the amplifier consists of an ordinary 60-volt wireless high-tension battery, which will last for several months, and an unspillable 2-volt accumulator of the kind made especially for driving model boats. Alternatively, if the deaf-aid is to be used for long periods continuously, it is better to use a small accumulator of the type designed for use in portable wireless sets. Grid bias is required for the valves, and this is most conveniently obtained by using a high-tension battery having an integral G.B. section. In regard to the ear-phones, these can be of any high-resistance (2,000 to 4,000 ohms) type, and may be purchased very cheaply from firms such as Messrs. Peto-Scott, who advertise in this magazine.

### The Complete Circuit

Having considered the general arrangement, we can examine the final circuit which incorporates all the features which experience has proved to be most desirable; this is shown in Fig. 3. The circuit is similar to that in Fig. 2, but incorporates a volume control by means of which the strength of the signals in the phones can be varied from maximum to zero as required. A two-pole on-off switch is also included to break the circuits of the microphone battery and filament accumulator when the unit is out of use. The tone-control transformer shown is the "Multitone"; this is used in conjunction with a special potentiometer which can be supplied by the makers of the transformer, or can be bought separately, the value being 250,000 ohms. Two pairs of connecting sockets are employed, one being for the microphone and the other for the phones.

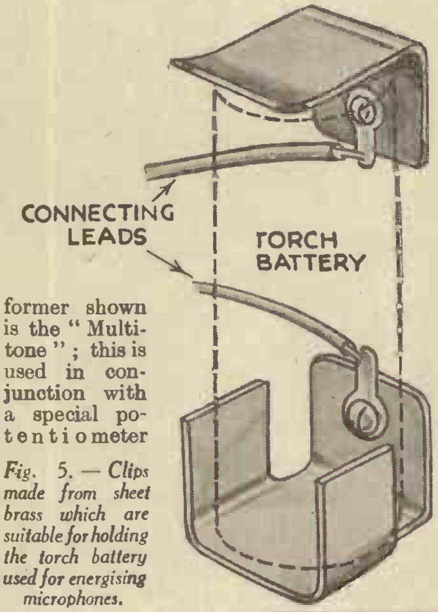



*Fig. 5. — Clips made from sheet brass which are suitable for holding the torch battery used for energising microphones.*

### Constructional Details

The complete deaf-aid unit can be made up in any convenient box container fitted with a carrying handle and need not weigh more than 8 or 9 lb. A suggested arrangement is given in Fig. 4, where the containing case measures approximately 10 × 10 × 3½ in. deep. The components are mounted on an "L"-shaped chassis made by screwing two pieces of five-ply together at right angles, and strips of ¾-in. square wood are attached to hold the batteries in position. As an alternative, all the parts could be attached to the inside of the case itself, but they would not then be quite so accessible. Whichever form of construction is employed, the on-off switch, phone and "mike" sockets, volume-control potentiometer and tone-control potentiometer must be mounted on the end of the container where they are easily accessible. The wiring can best be carried out in flex, since the connections will then be less liable to come loose due to vibration. Connections are not shown in Fig. 4, since these can be followed most readily by referring to Fig. 3. Neither are any dimensions specified, because these must naturally be governed by the exact components employed, and those readers who are also wireless experimenters will probably have most of the necessary parts already on hand.

One item which might not be quite clear is the method of mounting the torch battery used for energising the microphone. If desired, it could be attached to the chassis by means of a brass or fibre strap, the connections to it being soldered, but it is far more so convenient to make a pair of holding clips that replacement can easily and quickly be effected. A suggested method of making clips from sheet brass is illustrated in Fig. 5 and this calls for no further explanation.

### Using the Deaf-aid

After the components have been mounted and the valves inserted, the batteries should be connected, placing the H.T. + plug into the 60-volt socket, the G.B. − 1

(*Continued on page 274.*)

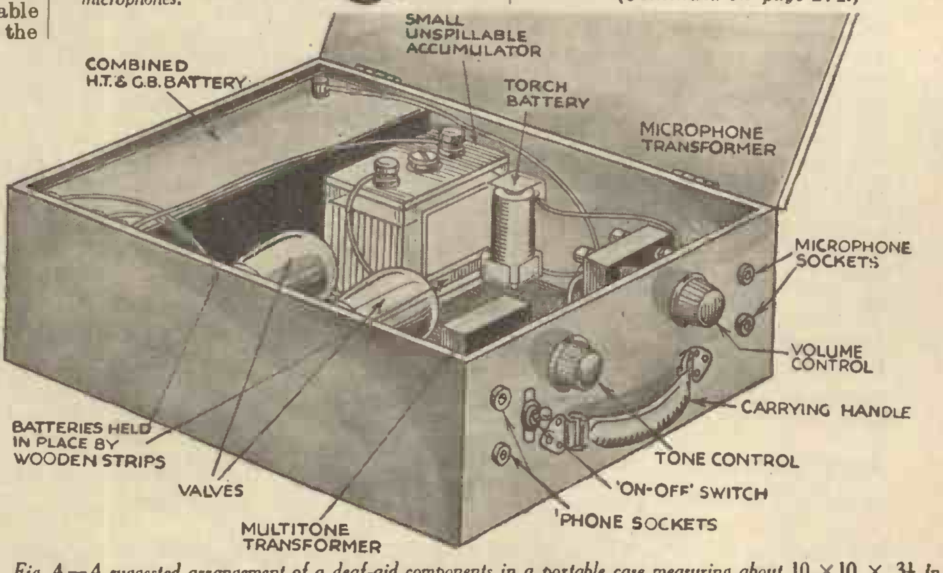



*Fig. 4.—A suggested arrangement of a deaf-aid components in a portable case measuring about 10 × 10 × 3½ in. The connections are shown in Fig. 3.*

# DEEP SEA DIVING

To more readily understand the modern methods of deep-sea diving, and to see how the equipment used has been evolved, a few remarks on diving in general and the principles involved are given below.

If a diver's lungs be represented by an ordinary bath-sponge and the sponge is weighted and lowered into deep water no change in its shape is noticed so long as the water percolates freely through the channels of the sponge. If, however, the sponge is placed in a rubber bag it would be compressed smaller and smaller as the water pressure gets greater at increasing depths. The only way to prevent this is to attach an air pipe to the bag and keep the bag extended by increasing the pressure as the bag descends in the water. Thus, at 30 ft. a pressure of 15 lb. per square inch would be required, and if the bag required 1 cubic foot of air on the surface it would take 2 cubic feet at 30 ft. below the surface. A diver is in precisely the same position as the sponge, save that he breathes the air supplied to him and therefore has to have it continually changed. This is arranged by having an inlet valve (non-return) in his helmet and an outlet valve lower down, in his helmet also, but spring-loaded with a spring of about a ½-lb. tension. Now the supply of air doubling at every 15 ft. requires a very large number of pumps or an expensive petrol pump. Hence a number of suits have been invented to resist the pressure and allow the wearer to breathe air at atmospheric pressure, whilst having freedom of movement under water. These are known popularly as Iron Men.

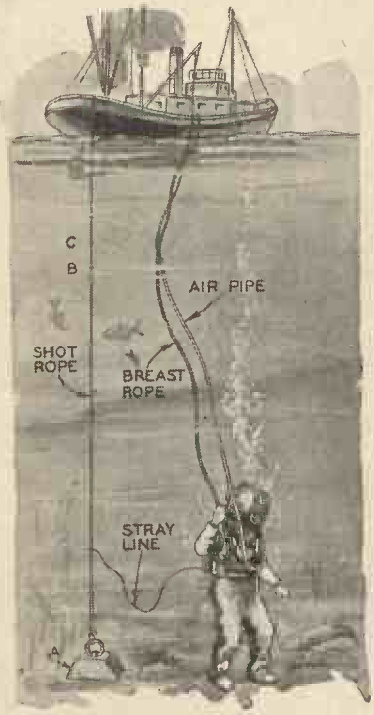



*Fig. 1.—Showing how the diver is brought to the surface in easy stages. B and C on the shot rope indicate the two stopping points of the diver before reaching the surface.*

### Iron Men

They have, however, had only a limited success. The greatest bugbear of diving is "Caisson," or compressed air disease. The cause of this disease is the amount of hydrogen saturated in the blood through working in compressed air. As soon as the pressure of air is relieved all this hydrogen forms into large bubbles and causes the dreaded "Bends" or "Diver Paralysis."

After exhaustive experiments it was discovered that this risk could be eliminated by bringing a diver to the surface by easy stages. The exact result of these experiments is set out in the form of a table. This table indicates all depths that might reasonably be expected to be reached. It also shows the number of feet below the surface. These are the stages at which the diver must stop. Opposite these are the times he must remain at the particular stage. For example, a diver working a short while at 27 fathoms, the table would show something like this :

| | | | | | |
|---|---|---|---|---|---|
| 30 | 20 | 15 | 10 | 5 | ft. below surface. |
| — | 2 | 2 | 3 | 5 | minutes' stop. |

This will be more easily seen in Fig. 1. On the order "Come up," the diver makes his way to his shot "A" and blows out his suit until he is sufficiently bouyant to glide gently up the rope. On arriving at "B," his first stopping stage, he is signalled by his attendant, who has followed the diver's ascent on the pressure gauge, which is calculated in feet and pounds. After two minutes the diver is again signalled and rises until he reaches "C," his second stopping stage, when his attendant again signals him, and here he remains two minutes. The same procedure goes on until he reaches the surface. It will be noticed that the longest stops are nearest the surface. This has been purposely arranged, although the whole time could be shortened slightly by having longer stops deeper in the water ; the stops are less trying near the surface. The example given is for a diver down a very short time. If he were deeper and had spent a considerable time on the bottom the stops might well run into hours and become very tedious.

*Fig. 3.—Pupils receiving lessons at the Royal Naval Diving School at Gillingham in the correct manner to fit the diving gear.*


*Fig. 2.—Showing how work is carried on by the diver from a diving bell.*

### The Decompression Chamber

Sometimes the diver is brought swiftly to the surface, undressed, and placed in a steel chamber. This chamber, known as the "Decompression Chamber," is then connected to an air pump and pressure is raised until the pressure at the first stop is reached. In the case of the diver mentioned above the pressure would be about 12 lb. per square inch, as all pressure gauges are marked in fathoms as well as pounds per square inch. It is an easy matter to work out with the tables. After two minutes the air is blown off until the gauge shows the second stop. This process is repeated until the air in the chamber is at normal atmospheric pressure. The valve for blowing off the air is so designed that it can be operated from the outside or the diver himself can work it inside. From this last method has been devised the deep-sea diving bell. The former method is not used for deep-sea work as the great length of air pipe and breast rope required greatly hampers movements and prevents the attendant from "feeling" the diver.

### Salvaging Bullion

To salvage bullion from a wreck lying in deep water either the bell or a suit of the "Iron-man" type is used. The depth that useful diving can be carried out is highly problematic, but may be placed about 50 fathoms or 300 ft. Various record dips, however, have been reported from time to time in excess of this. To locate the wreck a drag is trailed in circles along the bottom of the ocean. The centre of the circles being the spot where the lost ship is calculated to have sunk. When some object fouls the drag a diver descends and investigates the obstruction. Electrical instruments can indicate a steel ship on the bottom, and have been employed with some success. Gold diviners, people with the uncanny gift of feeling the presence of fine metals, have been known to locate a wreck containing gold.

### The Wreck Located

When the wreck is finally located the ship must be carefully moored over it. Three mooring clumps are sunk in a triangle with the wreck in the centre. The chain or cables from these are led to two separate winches, so that the cables can be slacked off and taken in easily with the rise and fall of the tide. These cables are buoyed so that they can be quickly cast off in the event of rough weather. If this should happen these buoys enable the cables to be picked up again when the weather moderates, and serve to locate the wreck quickly again. The matter of light under water is also a very controversial subject. Divers do not care about carrying lamps of high voltage, as a shock off one of these is rendered more severe than usual in salt water. Lights also attract numerous small fish fascinated by the glow. Sometimes Nature is kind and light from the sun penetrates to about 30 fathoms. Powerful arc lamps lowered to the wreck are about the best idea; they must, however, be kept well clear of explosives and the average diver would much rather work in semi-gloom than lay explosives by the light of an electric arc. Having located the wreck and settled the methods to be employed and other matters which can only be done at the scene of operations, a sounding is taken. The "Iron Man" is produced. He is a grotesque caricature of the human shape and half again as large as an average man. The head-piece is cylindrical and flat on top. It is about 2 ft. diameter and a man-hole is fitted for the operator to enter. Three observation ports are fitted of stout glass. The joints at the shoulders, thighs and knees are engine-turned ball and sockets, so precisely made and ground in place as to exclude the water. Two air pipes are necessary—one supply and one exhaust.

### The Advantages of the "Iron Man"

Unlike the ordinary diving suit, this "Iron Man" cannot exhaust his air against the water pressure, as his supply is only a little above atmospheric pressure. In fact, the wearer suffers no ill-effects and can remain on the bottom until fatigued, whereas all flexible suit-divers are limited by the "decompression tables" previously mentioned. The "Iron Man is provided with tongs and other tools; these are attached to the ends of his arms and must be operated from inside the suit. His advantages may be summed up as follows: (1) The wearer suffers no ill-effects from long diving at any depth. (2) One hand pump supplies enough air to him at any depth. (3) He can use a telephone freely. (4) He may carry a powerful light built in, and as his interior is not damp need not fear short-circuiting. (5) His weight (about 3 cwt.) keeps him steady in a tide-way. Some have an extra leg which can be screwed

*(Below.) Fig. 8.—Looking more like a sea monster, this odd machine of steel and glass is used for the location of sunken treasure.*

*Fig. 9.—A modern diving equipment usually called the "Iron Man."*

*Figs. 4 to 7.—(Reading from left to right). A diver with a 5 feet long conger eel which he managed to kill while he was diving. A diver coming up to report after having been down to inspect the damage to a sunken ship. The leader of an expedition to the Galapagos with the diving helmet in which he has made fifty descents to the bottom of the sea. Experimenting with the Davis Submerged Escape Apparatus which should afford each member of a submarine crew a fair chance of escape from a sunken submarine.*

*Fig. 10.—By means of special tanks similar to the one illustrated diving suits can be tested under similar conditions to those met with many hundreds of feet below the sea level.*

out through the rear; this props them up rigidly. (6) More leisurely observations can be taken and more definite instructions can be given to the crew of the salvage vessel (see 3).

His disadvantages are: (1) His immobility. Unless he is dropped on the scene of the operations, his long pipes and wire prevent him from moving very far, and his joints only permit a very short step being taken at a time. (2) His inability for dexterous work. His operator is totally enclosed and works with tongs inserted through water-tight bushes. (3) His joints require constant attention to keep them water-tight. The life of the operator depends on them, as a leak would be fatal.

His air pipe having been marked at the depth he proposes to go, the diver enters and the cover is bolted on. The suit is next hoisted clear of the deck, the diver tries the joints and signals all correct. The suit is then run out on the derrick and lowered below the surface, where a short pause is made to enable any leak to reveal itself by tell-tale air bubbles. If no bubbles appear, all is ready for a swift descent. The attendant on the air pipes will warn the winch men when the mark on the pipes mentioned above is reached. This is their cue to slow down and land their charge gently on the bottom. Once on the bottom the diver starts telephoned instructions to the winch men and is gradually warped near his place of work. Once on the spot he makes fast a light flexible steel wire to some prominent object to assist future divers and act as a guide for charges, etc., lowered from the surface. He has brought the end of this wire with him and fastens it by means of the tongs—not a simple task—and having accomplished it, may ascend and leave the job to his confrère, the deep diving bell, after making a few observations.

### Blasting Operations

Accurate plans of the wreck, if available, are consulted, and the observations of the diver in the "Iron Man" are taken into consideration when blasting operations are being worked out. Deck houses and superstructures are "spread-eagled"—that is, the roofs are blown off by large charges of gun-cotton and the four walls flattened. Projecting pieces being torn out by a powerful grabs worked by wires led to the winches on the deck of the salvage vessel. Each deck over the treasure is then blown away. The charges are usually laid, done up in fire hoses with an electric detonator every 2 ft. The effect of explosives in water is greater than would be supposed, as the pressure of the water "backs up" the force of an explosive, most wrecks being blown to pieces during salvage operations.

### The Diving Bell

A glance at Fig. 2 will make clear the working of a deep-sea diving bell. The bell "B" is a well-made cylinder large enough to take a diver and attendant. It is equipped with telephone, pressure gauges, and a flask of oxygen. It is lowered to a position near the wreck and the diver leaves by a manhole in the bottom. The air pressure in the bell excludes the water. This permits the diver to wear the ordinary suit. F is the diver's air pipe and breast rope lashed together. As soon as the diver is ready he returns to the bell, the manhole is closed and the bell speedily hoisted up and placed on deck, where it is "blown off" in a similar fashion to the "decompression chamber" described before. The advantages of the bell are: (1) It allows the diver free movement, unhampered by a great length of air pipe and breast rope. (2) It eliminates the tedious stages of stops necessary when working in compressed air. These stops being done comfortably on deck, without the risk when being transferred to a "Decompression Chamber," as previously mentioned. (3) Divers can be brought up instantly if rough weather breaks out. This could not be done, unless of course, a Decompression Chamber was available. (4) If two or more bells are in use the divers can be changed quickly and save much time.

It also has a few disadvantages too; the main ones are: (1) It requires two men working in compressed air. The attendant being paid danger money as well as the actual diver. (2) The telephone is not very efficient as the diaphragm will not vibrate in the compressed air. The divers' voices are reduced to a reedy treble. All this makes communication with the surface difficult. This is not so important as in the case of the "Iron Man," the bell diver being able to move around unaided by the winches. (3) It requires a very large air supply.

### The Pump

The pump has to supply the bell or its diver with 1 cubic foot of air, an extra cubic foot for every 15 ft. has to be pumped from the surface, which means that taking the bell at 30 fathoms (and ignoring the slight extra depth of the diver for the sake of round figures), the divers and attendant require about 28 cubic feet of air per minute, but 336 cubic feet will have to be sent from the surface.

Sufficient air to bring the diver up is usually kept in bottles in case the pump engine should fail. This in the case mentioned above must be kept over 280 lb. to a square inch, otherwise it would not reach the diver.

## BOOKS worth READING

### Television for the Amateur Constructor

By H. J. Barton Chapple, Wh.Sch., B.Sc., etc. 12*s*. 6*d*. *net*. *Demy octavo*, 234 *pages*. *Sir Isaac Pitman & Sons Ltd., Parker Street, Kingsway, W.C.* 2.

Television, which is now on the threshold of success, is a subject on which literature is all too scanty. The author of "Television for the Amateur Constructor" has already covered the general principles, the history and the development of television in a companion volume entitled "Television—To-day and To-morrow." The present volume is essentially practical. The first chapter forms a brief, but complete, introduction to the general theory of television, but from that point the author plunges straight away into the practical avenues of his subject. The last chapter deals practically, if prophetically, with future developments. The extremely lucid and simple style adopted in the text is rendered even more understandable by the generous proportion of excellent illustrations in half-tone and line which punctuate it at almost every page. This is not a work for the highbrow; it gets down to the level of the man who wishes to build television apparatus at small cost and with limited income, and I can thoroughly recommend it.

Send for descriptive prospectus to Sir Isaac Pitman & Sons Ltd., Parker Street, Kingsway, London, W.C.2, mentioning Practical Mechanics.

### Henley's Twentieth Century Home and Workshop Formulas, Recipes and Processes

809 *pages, demy octavo. Published by the Scientific and Commercial Publishing Co., Artillery House, Artillery Row, S.W.*1.

This famous volume, which has gone through many editions, contains literally thousands of money-making ideas, recipes and formulas. It deals with every subject of interest to the practical mechanic, including workshop and laboratory methods, adhesives, alloys, antiseptics, cements and amalgams, beverages, metals, electro-plating and electro-typing, dyes and disinfectants, dentifrices and cosmetics, enamelling, etching, explosives and fertilisers, lacquers, chromium-plating, paper, perfumes, and plaster-casting, photography, solders, varnishes, watchmakers' formulas, water-proofing woods, etc. etc.

### The British Journal Photographic Almanac 1934

Editor: George E. Brown, F.I.C. 680 *pages, and* 64 *pages of photogravure supplements. Henry Greenwood & Co. Ltd.*, 24 *Wellington Street, W.C.*2. 2*s. net* (*paper covers*); 3*s. net*. (*cloth bound*).

Wonderful photography of the most modern type is reproduced in the 1934 volume of the "British Journal Photographic Almanac," just published. Gravure supplements (64 pages) show the latest achievements in pictorial photography as done by amateurs and by professional makers of photographs for advertising. This so-called "Almanac," however, is a book of 746 pages altogether, and contains articles on the latest developments in amateur photography and reviews on the many new cameras and other new apparatus now coming on the market, in addition to the construction of every conceivable branch in photography.

ALL RADIO QUESTIONS ANSWERED FREE.

# The PRACTICAL MECHANICS Wireless Experimenter

Every Question must be accompanied by the Coupon on page 300.

## THE P.M. "DOUBLE—O"

### An Economical Three-valve Battery Receiver having the Performance of a Five-valver

THIS month's receiver will appeal to every class of battery-set user, since it combines reasonable selectivity with long range and high power. It is selective enough to give excellent and interference-free reception of nearly every station transmitting under the Lucerne Plan which has recently come into force, its screen-grid H.F. stage is sufficiently sensitive to make possible the reception of every worth-while European station, whilst the Class B output stage is capable of delivering an undistorted output in excess of 1,000 milliwatts. Actually, an output of 1,250 milliwatts can be obtained by applying a voltage of 150 to the anodes of the output valve, but it is more economical to employ a 120-volt H.T. battery unless the maximum volume is desired. In any case, 1,000 milliwatts is quite ample for nearly every requirement, so that no serious imposition is imposed by using the lower voltage.

Although the receiver to be described is fitted with only three valves, it comprises four efficient stages. These being: one screen-grid high-frequency amplifier, leaky-grid detector, low-frequency driver and Class B output. As the Class B stage gives the equivalent results of two valves connected in push-pull, it will be seen that the set is really equal to a good five-valve instrument. Only a single valve is used for both driver and Class B, this being the very latest development in valve technique and the most recent product of the High Vacuum Valve Co. Ltd. This unique valve is styled the DB230, and it is significant to note that it is as yet produced by only one firm.

*This illustration shows the excellent and modern appearance of the "Double-O."*

The makers are to be congratulated upon the remarkable efficiency of such an unconventional and remarkable valve, for it is without doubt quite as efficient in every way as any two other valves of similar characteristics combined. Not only does the "driver-B" effect an economy in the financial sense, but it also saves an appreciable amount of space on the receiver chassis, and consumes only ·3 ampere, or a smaller amount of filament current than many Class B valves alone.

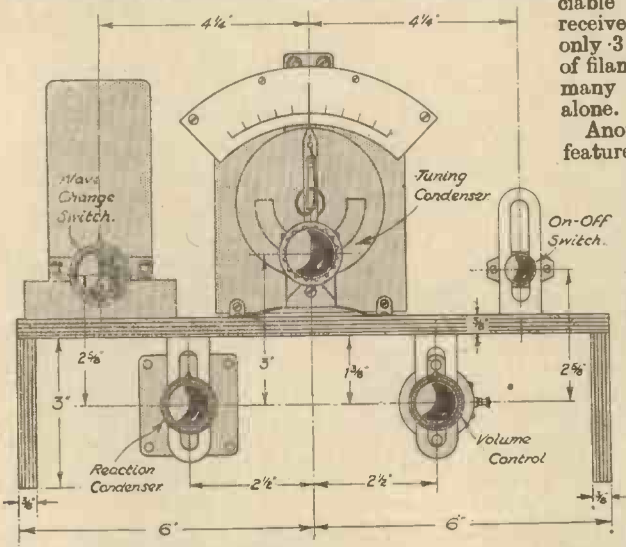
Another interesting feature of the receiver is that it is fitted with a neat and effective tone control by means of which the loudspeaker reproduction can be varied from "deep bass" to "high treble." Thus it is possible to obtain reproduction which will suit the ear of every listener and which can be varied to secure the most pleasing results on any type of programme.

#### Simple Tuning

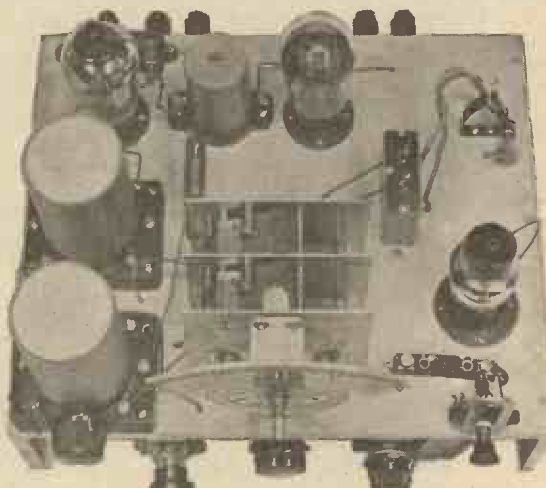
Tuning is carried out by means of a two-gang condenser of efficient and inexpensive pattern, the driving mechanism of which has a smooth vernier movement and is fitted with the latest and popular form of curved full-vision scale. The condenser is provided with two trimmers, by means of which perfectly accurate matching of the two tuned circuits can be obtained, although only a single knob has to be operated in order to receive any station on either the medium or long-wave band.

It has been said that the degree of selectivity is ample for all normal purposes, but it should be added that the exact sharpness of tuning can be varied over fairly wide limits according to the district in which the set is used. When the nearest transmitter is more than about twenty miles away, great selectivity is not required, and therefore the full sensitivity of the S.G. amplifier can be obtained. On the other hand, if there is a Regional station within some ten miles, the tuning can be sharpened by making a slight sacrifice in the way of maximum range of reception.

Before going on to describe the construction of the "Double—O" it might be well to say exactly what the set consumes in the way of high- and low-tension current. The filament current taken from the accumulator is only ·5 ampere and therefore the 2-volt accumulator specified will give approximately sixty hours' service before recharging becomes necessary. High-tension current consumption varies, as is the case with all Class B receivers, with the volume of sound delivered by the loud-




*Dimensioned front view of the chassis; this will be required in drilling the cabinet.*



*A three-quarter plan view which shows the simple component lay-out.*

speaker and ranges from some 7 milliamperes on weak signals to a maximum of nearly 30 milliamperes on extremely loud passages. The average consumption, however, works out at about 11 milliamperes when loud signals are being delivered. Thus it can be stated that the Class B H.T. battery specified will have a useful life of several months.

**Building the Receiver**

The constructional work involved is extremely easy and well within the capabilities of every reader, whether he has ever made a wireless set before or not. Moreover, the layout and wiring are so "clean" and straightforward that it is practically impossible to go wrong.

Having obtained all the component parts it is first of all necessary to prepare the metallised wooden chassis by marking out the positions of the valve holders and drilling the holes for these; those for the S.G. and detector valve holders are 1 in. diameter and that for the driver-B valve holder (the seven-pin one) is 1⅓ in. The valve holders can next be screwed in place by means of ⅜-in. screws, taking care that the metal sockets fit centrally in the holes. This is an important point, because if the sockets are allowed to touch the metallic surface of the chassis, short-circuits might occur which will render the set inoperative and possibly "blow" the safety fuse. After the valve holders it is best to mount all the components which are fitted inside the tray of the chassis, using ½-in. screws for this purpose. At this point it might be mentioned that the fixed resistances, small fixed condensers and grid leak are not attached to the chassis, but are held by their own connecting wires. Next mount all the parts on the upper side of the baseboard in readiness for wiring. In regard to the condenser drive, it might be explained that this is held in place by two ⅜-in. screws after it has been fitted on to the end of the condenser spindle. Before tightening the grub screws in the collar, the pointer should

**List of Components for the "Double-O"**

One Metaplex Chassis, 12 × 10 in. with 3 in. runners, Peto Scott.
Two Dual-Range Coils, Bulgin, type C.25.
One Two-Gang Condenser, B.R.G., type 15.
One Condenser Drive, British Radiophone, type 583A.
One ·0002 Differential Reaction Condenser, Burne Jones, type 1117.
One Super H.F. Choke, Ward & Goldstone.
One Screened H.F. Choke, Ward & Goldstone.
One 1 mfd. 250-volt working Fixed Condenser, T.M.C., "Hydra."
One 2 mfd. 250-volt working Fixed Condenser, T.M.C., "Hydra."
One ·0005 Fixed Tubular Condenser, T.M.C., "Hydra."
One ·0002 Tubular Condenser, T.M.C., "Hydra."
One ·0003 Pre-set Condenser, Ward & Goldstone.
Two 4-pin Chassis Mounting Valveholders Clix.
One 7-pin Chassis Mounting Valveholders Clix.
One 5 : 1 L.F. Transformer, B.R.G., type No. 66.
One Driver Transformer, Wearite, type B.J
One Controlatone, Bulgin, type A.
One 20,000 ohm Resistance, Varley.
One 1,000 ohm Resistance, Varley.
One 2 megohm Grid Leak, Varley.
Five Wander Plugs, marked H.T.+, H.T.−, G.B.+, G.B.−1, G.B.−2, Clix.
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Three Valves, types SG210, L210 and DB230, Hivac.
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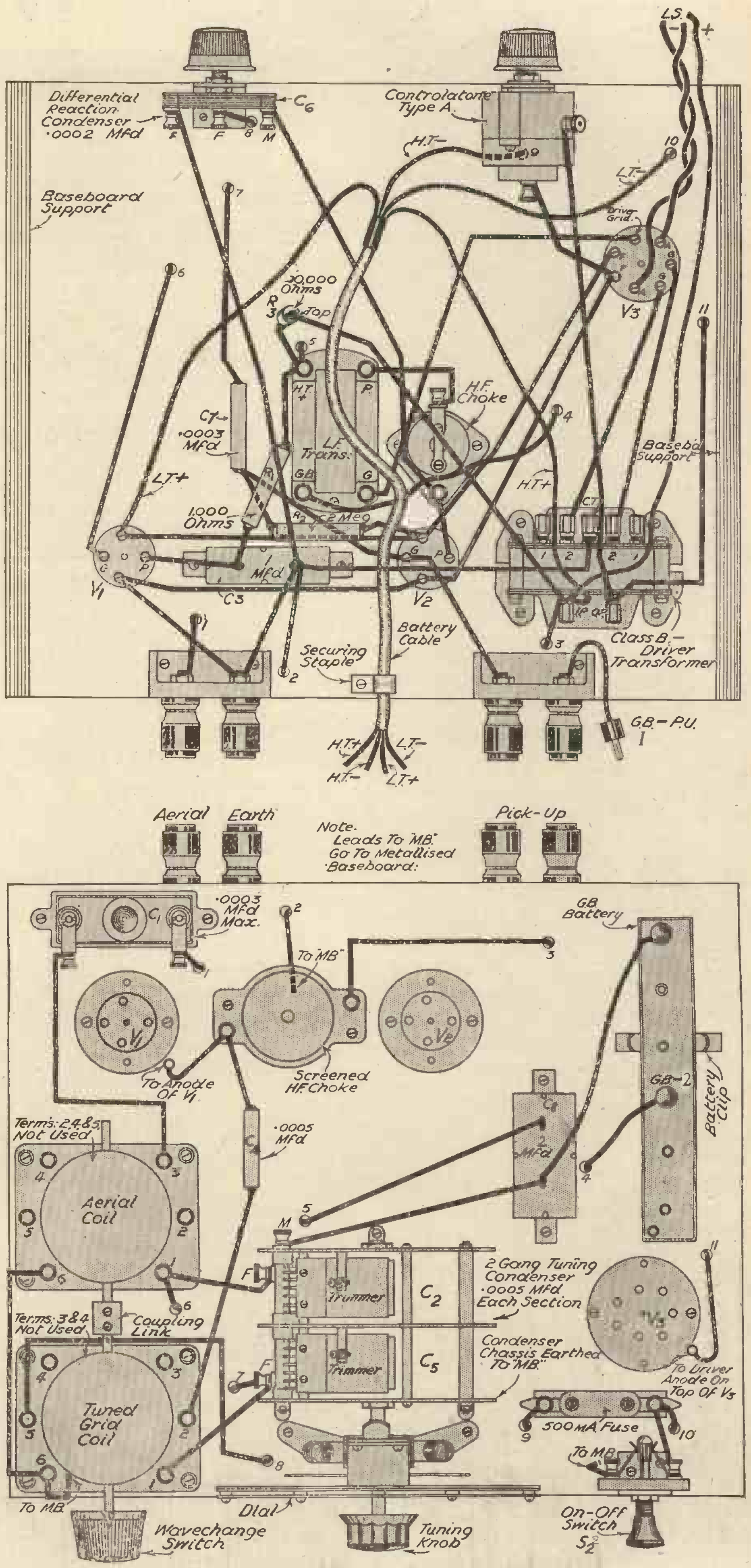
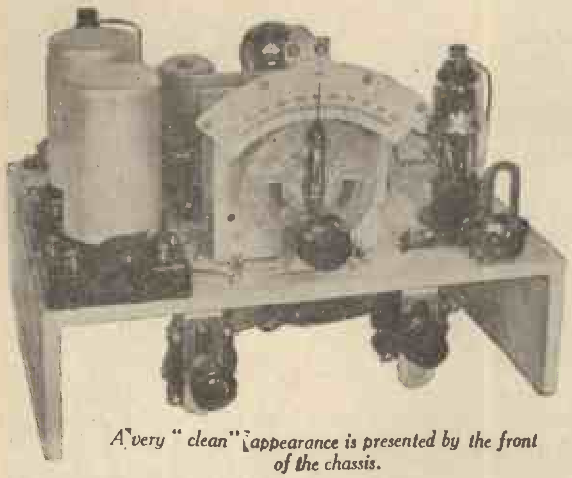
One Ediswan 2-volt Accumulator, type E.L.M.4.
One Cabinet. Peto Scott




*Above and beneath wiring plan of the receiver.*



A very "clean" appearance is presented by the front of the chassis.

be set to zero and the condenser plates fully "opened.'

In mounting the coils take especial care that they are both in the same relative positions, and before tightening the grub screws in the collar which links the two switch rods make sure that both switches are in the same position; that is, that the rods are turned either fully clockwise or fully anti-clockwise.

### Simple Wiring

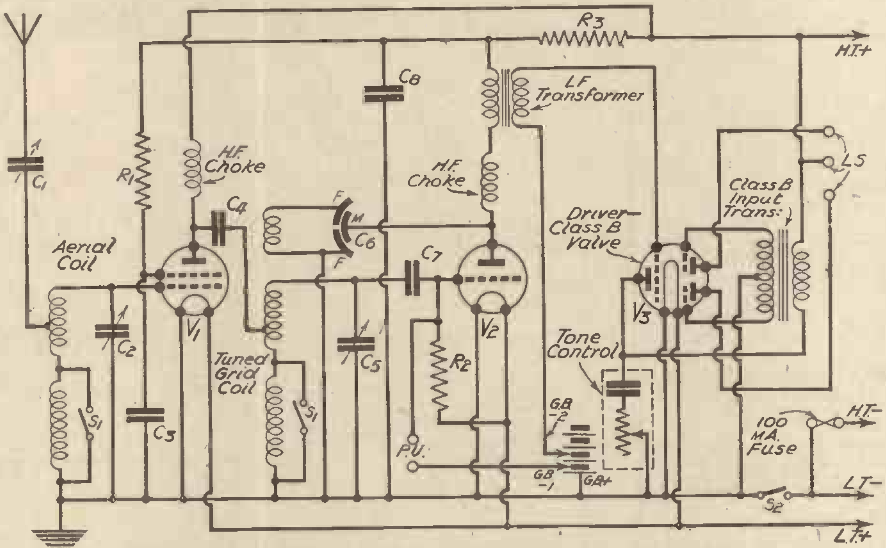
Little explanation is called for in regard to the wiring, since this can easily be followed by referring to the scale wiring plans given. It is best to follow some sequence, however, so that there is less chance of making any mistake, and it will be found most convenient to work from left to right on top of the chassis, and then to repeat the process on the underside. Those who are quite new to wireless construction will also find it very helpful to cross off each wire shown on the wiring plan as it is put in on the set. It might not be perfectly clear from the wiring plan that the wire joining together terminals 6 on the two coils is connected to earth *viâ* the metallised chassis by gripping it between the base of the coil nearest the front and the baseboard, whilst it will be seen that there is no wire between the end terminal (moving vanes) on the gang condenser and earth; this connection is obtained automatically by the frame of the condenser being screwed to the chassis.

Most of the connections are made by baring the ends of the wire, forming a loop, and gripping this under the heads of the terminals, but it is necessary to solder the connections to the fixed resistances and small fixed condensers, since the wire ends provided will not reach to the appropriate terminals.

Notice that the four-way battery cable is connected directly to the terminals on the various components. The connections for this can most easily be followed by observing the colours of the various leads to which the spade terminals and wander plugs are attached. Three short lengths of flex are required for making connections to the G.B. battery and these are fitted with suitable wander plugs of the types specified. It will also be seen that three flexible leads are fitted for connection to the Class B speaker.

### Fitting the Set into the Cabinet

The front of the cabinet must be drilled to receive the various controls and an opening must be made for the condenser-drive escutcheon; the positions of the various holes can be obtained from the front-of-chassis drawing given. It is best to make the holes for the various spindles about ⅜ in. diameter, and the opening for the escutcheon can be made either with a fret-saw or by making a series of small holes and cutting between them with a chisel, finally smoothing off the edges with a half-round file. Incidentally, the shape of the escutcheon opening can most easily be marked out by making a paper template and gluing this on to the front of the cabinet.




*The circuit is on fairly standard lines. Note the special "driver—B" output valve.*

### Connecting the Batteries

After the constructional work has been completed the grid bias battery can be slipped into the clip provided and the plugs inserted as follows: G.B. + into the positive socket, G.B. − 1 into the 1½-volt socket, and G.B. − 2 into the 4½-volt socket. Next connect the high tension and accumulator leads and wire up the loudspeaker, taking the lead from H.T. positive to the centre (red) one of the three terminals. Join the aerial and earth leads and switch on. Set the reaction condenser to zero (anti-clockwise) and rotate the tuning knob until a station is heard. Volume can then be increased by advancing the reaction control, after which the pre-set condenser should be adjusted to give the best compromise between maximum volume and adequate selectivity—unscrewing the knob will increase selectivity, and screwing it down will increase the volume. When still sharper tuning is called for than can be obtained in this way, the lead from the pre-set condenser should be transferred from terminal 3 to terminal 4 on the aerial coil.

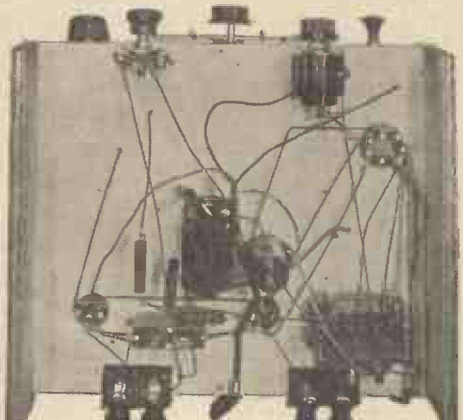
Finally, the trimmers on the gang condenser should be set to their optimum positions. To do this, first tune in a station that is received fairly weakly at about 30 degrees on the condenser scale when the wave-change switch is in the medium-wave (anti-clockwise) position. Then alter the adjusting screw on the second trimmer by means of a long screwdriver, meanwhile making slight adjustments of the tuning knob until maximum signal strength is obtained. After that it is best to check the setting by tuning in a station at a higher condenser reading and noting the effect of altering the setting of the first trimmer. When both trimmers have been properly set they can be fixed by tightening up the locking nuts, and no further adjustments will ever be called for.

Do not forget to make good use of the tone-control knob, for this will add considerably to the pleasure of reception, and will be found particularly useful when reproducing gramophone records by means of a pick-up (connected to the terminals provided). Turning the knob to the right gives increased bass response, whilst turning it in the opposite direction causes the higher frequencies to be emphasised.

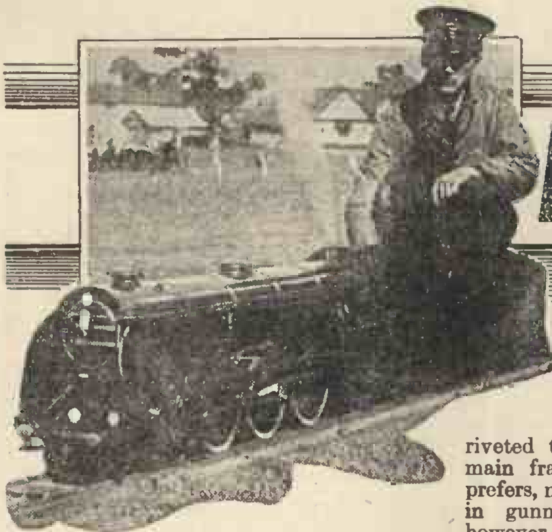
### The Loudspeaker

It should be mentioned that the loudspeaker specified consists of a chassis only, and this should be screwed on to a baffle board or mounted in a convenient cabinet. Alternatively, the speaker can be obtained in cabinet form at slightly extra cost. The "Microlode" speaker is provided with two rotating arms by means of which perfectly accurate matching can be secured between the speaker and the output valve. It will therefore prove well worth while to experiment with different settings of the tapping arms until the desired "tone" of reproduction is obtained. It is best to do this whilst the tone-control knob is in its central position, so that the maximum effect can be obtained from it afterwards.





*Simple and neat wiring is the keynote of the "Double—O."*



# MODEL RAILWAYS

## A 4¾-IN. GAUGE GARDEN RAILWAY LOCOMOTIVE. PART III

By E. W. TWINING

THE frames and the complete chassis of the engine should now be constructed. The main frame plates are cut from $\frac{3}{32}$-in. thick steel plate. The profile outline of these is shown in Fig. 7. In plan they are clearly indicated in the accompanying general arrangement plan (Fig. 9).

### A Frame Stretcher

Here it will be seen that the main plates terminate in front of the firebox, where they are riveted to a stretcher casting, which carries the pivot pin for the radial truck, the front end of the firebox, and serves as a brace. The rear frames are bolted to lugs on the back of this stretcher. As some difficulty may be experienced in arriving at a clear understanding of the exact shape of this stretcher, a supplementary sketch is given in Fig. 10, in which the casting is in perspective and in section on the centre line of the engine; that is to say, the drawing shows the right-hand end of the stretcher only. The rear frames are castings, and it would be advisable to have all these parts cast in gunmetal. It would, of course, be possible to cut the rear frames also from steel plate, but this would involve adding the lugs, which are shown on the tops of the frames, through which the firebox holding-down screws pass, and the bearings for the reversing lever and brake lever shafts.

### Stretchers and Buffer Beams

Two other stretchers are to be fitted between the main frames, one in front of the driving axle and one in front of the coupled axle. These are shown as made from steel plate with ½ × ½ in. steel angle riveted to them and riveted also to the main frames, but the reader can, if he prefers, make a pattern and get two castings in gunmetal. The only consideration, however, is the fact that the front stretcher has to carry the expansion plate, which is shown in Fig. 7 supporting the front end of the boiler. This plate must be in steel.

The front buffer beam is cut from a piece of hard English oak, and is secured to the frames by bolts passing through steel angles riveted to the frames. The centre of the buffer beam at the back is cut away to fit the cylindrical displacement lubricator, which is secured to the oak by means of lugs soldered to the lubricator barrel with wood screws passing through them. The rear buffer beam is of steel plate of the same thickness as the main frames. This is riveted with angles to the rear frames.

### Axle Boxes

Fig. 9 shows in plan all three of the axles, the axle boxes and the horns. The axles will, of course, be turned from steel shafting. The axle boxes are cast in gunmetal and those for the driving and coupled axles should be fitted with oil pads, as shown in Fig. 11, which gives full details of them, all four being exactly alike. The keeps are, of course, separate castings, the recess being formed in moulding. The oil pads which fill these recesses are best made from worsted wool, unravelled and worked into such a shape as to just fill the box or recess. The wool should be packed fairly tightly, but have sufficient elasticity left in it to press up against the axle. In action, of course, it will become saturated with oil and keep the bearings above from running dry.

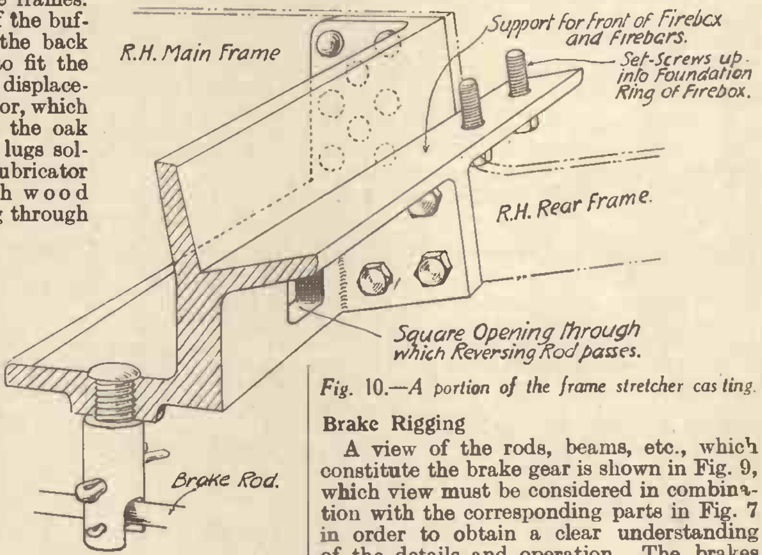



*Fig. 10.—A portion of the frame stretcher casting.*

### Brake Rigging

A view of the rods, beams, etc., which constitute the brake gear is shown in Fig. 9, which view must be considered in combination with the corresponding parts in Fig. 7 in order to obtain a clear understanding of the details and operation. The brakes are applied by means of a lever passing through the footplate. This lever is attached to a hollow shaft carried by the reversing gear shaft. The inner end of this tubular shaft is fitted with a short lever, to which the brake pull rod is coupled. This rod is led through the forked end of the radial truck pivot pin. The rod takes no

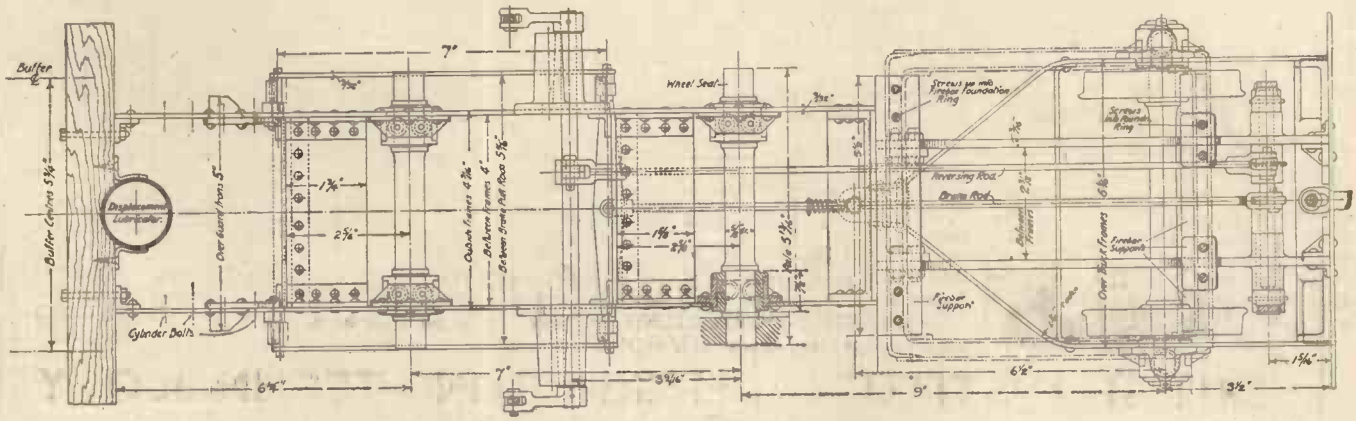



*Fig. 9.—Plan of engine frames, radial truck, etc.*

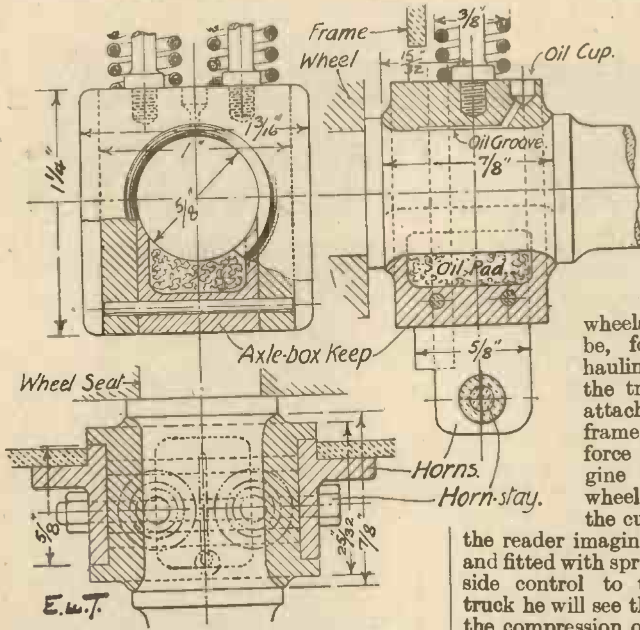



*Fig. 11.—Details of driving and coupled axle boxes.*

bearing here, but the pin forms a convenient point for applying the spring, which forces the brake blocks off the wheels when the brakes are taken out of action.

### The Radial Truck

The rear end of the engine is carried by a pair of trailing wheels having axle boxes in a frame which is movable in a radial path, the centre about which the swing of this truck takes place being the pin referred to in the main stretcher casting. The range of movement, or side play, of the truck is ½ in. on each side of the centre line, which is sufficient to enable the engine to negotiate a curve of 15 ft. radius. The truck frames are of the same steel plate as the main frames. They are riveted at their front ends to a block drilled to fit the pivot pin and at the back are riveted to a gunmetal cast stretcher. This stretcher has at either end a flat table corresponding in size and position with two other tables riveted to the rear main buffer beam. Provision should be made for oiling the surfaces of the tables, for it is upon these that the weight of the rear end of the engine is taken, and the tables slide one upon the other when the radial truck is swung to one side in rounding a curve in the line.

### Spring Control

Theoretically, there should be provided a spring on each side of the truck to come into action when the truck is moved sideways, but in this model a radical departure from standard practice is made in regard to the point of attachment of the drawbar; that is to say, the coupling between the engine and the train. Whereas such a drawbar is invariably attached to the main frames of the engine, it is proposed to fit the drawbar pin in the radial truck. By doing this it will be seen that the pull of the train will be transmitted from the truck to the pivot pin, and so the arrangement will be practically equivalent to pulling the train from a point just behind the driving wheels. This is as it should be, for when the engine is hauling its load at a curve in the track and the drawbar is attached to the rear of the main frames there is a very powerful force tending to derail the engine by forcing the leading wheel flange on the outside of the curve to mount the rail. If the reader imagines this engine on a curve and fitted with spring side control to the truck he will see that the compression of a control spring is putting a similar derailing force upon the outside leading wheel flange. The argument obviously is then that the truck is better without springs.

Some further details of the frames, main, rear and radial truck will be found in Fig. 12. This drawing shows the engine in cross-section at two different points. The left-hand half is a section taken through the centre of the firebox, whilst the right-hand is through the dome, boiler barrel and the frames immediately behind the expansion link bracket.

### The Boiler

The barrel is a piece of seamless copper tube, 5 in. in outside diameter with a thickness of No. 14 S.W. Gauge ($\frac{5}{64}$ in. thick). The firebox plates are of No. 13 Gauge, except the tube plate, which should be of No. 12 Gauge, $\frac{3}{32}$ in. thick, or, if the engine builder prefers, he can use this last thickness for all the plates of the firebox, although it will be found perhaps a little heavier for bending and shaping for flanging. The smokebox tube plate will also be of No. 12 Gauge.

For flanging the plates of the firebox, and, in fact, for all such plates in the boiler, some model makers use hardwood blocks cut to the shape required, but it will be found that flanging can be done much quicker and more efficiently over blocks of cast iron. The surfaces of the iron should have the roughness filed off, especially on the angles where the flanging of the copper is to be done. The overlap of all flanged joints in the boiler should be not less than ½ in., and the rivets should have a diameter of ⅛ in. and have a pitched space, or distance apart, of ⅜ in.

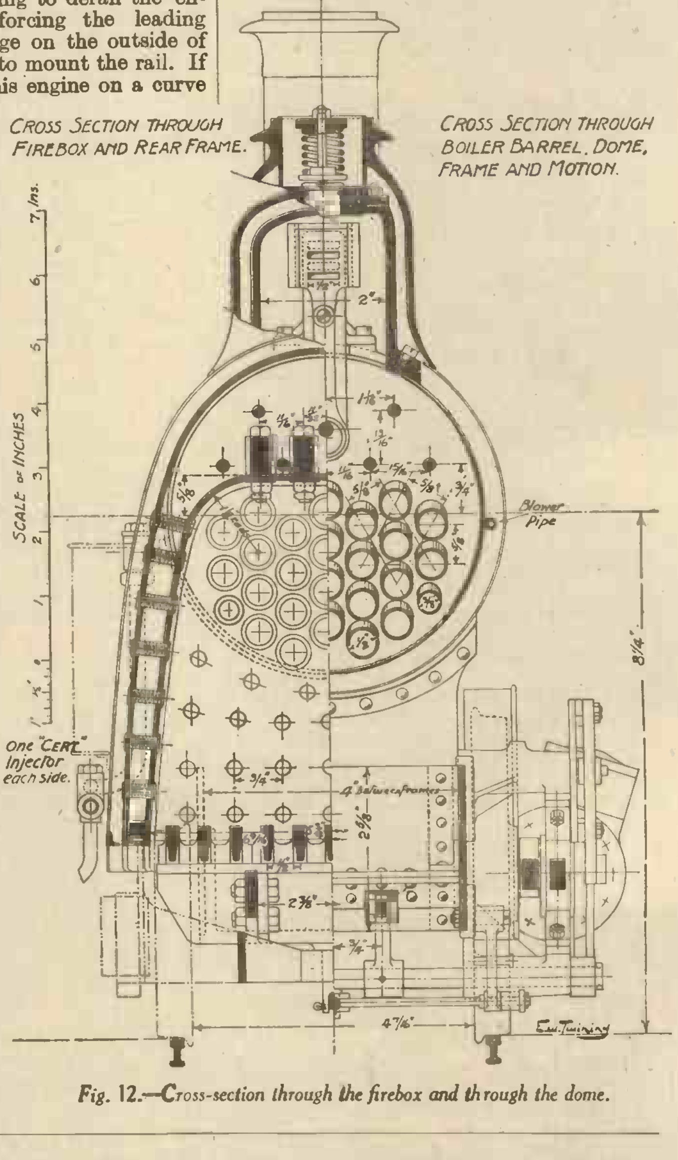



*Fig. 12.—Cross-section through the firebox and through the dome.*

plug into the socket which provides a voltage of 1½, and the G.B. — 2 plug into the 3-volt socket, when a power valve is used in the second stage. Where both valves are of the L.F. type, the two grid-bias leads can be joined to the same plug, which will be placed in the 1½-volt socket.

The microphone leads should be provided with plugs to fit into the sockets provided, the same thing applying to the phone leads, and these instruments can then be connected up and the unit switched on.

## MAKING A SENSITIVE DEAF-AID

*(Continued from page 262.)*

After that, the volume control should be adjusted so that the required signal strength is obtained. Adjustment of the tone control should then produce the desired effect and make it quite easy for the user to hear music and other sounds which are within range of the microphone.

It might be mentioned that some of the "table" model microphones are now supplied complete with transformer, switch and energising battery. Thus, if one of these is used, the amplifier itself will be simplified, for there is no need to duplicate any of the component parts. Generally, however, it will be found better to use a "plain" microphone, since it can then be replaced by one of the lapel or any other type without making any alteration to the amplifier unit.

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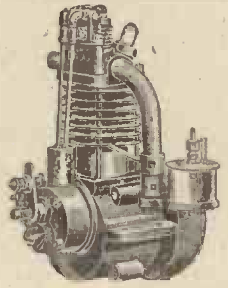

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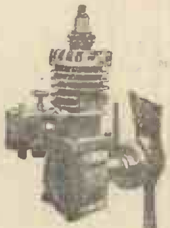

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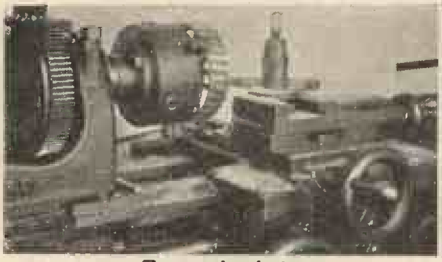
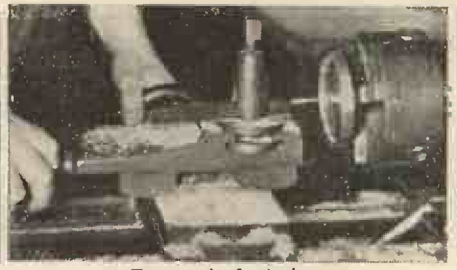
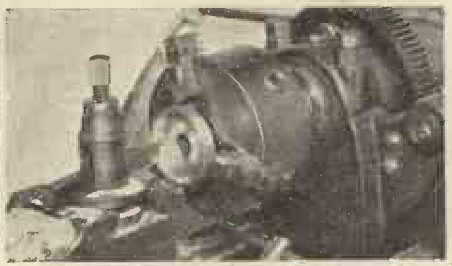

*Topping the wheels.*


*Turning the flywheel.*


*Turning the brake drum.*

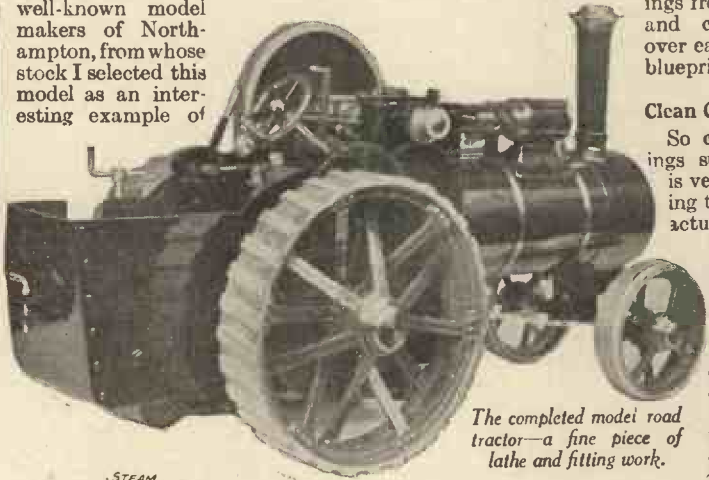

*Drilling the rear axle stubs.*


*Turning the chimney on a mandrel.*

# A WORKING MODEL OF—

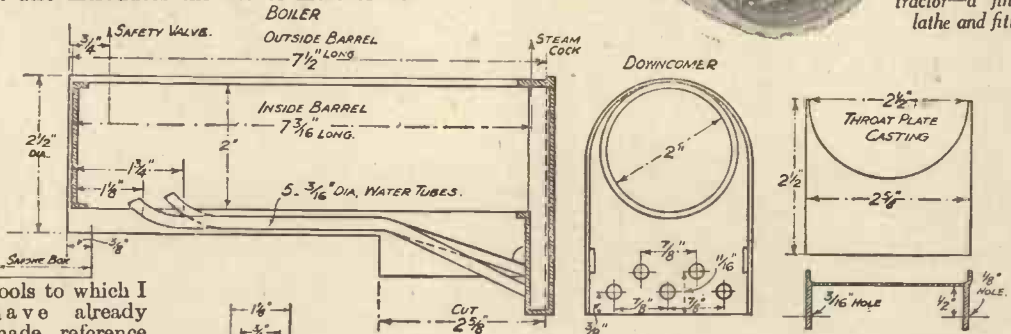
## How to make a realistic model from —

THE model forming the subject of this present contribution affords an excellent lesson in the various turning operations discussed in my previous articles, for not only does it embrace turning between centres, but also facing and boring operations, the turning of irregular-shaped castings, and the careful mounting of work. It also introduces the use of most of the tools to which I have already made reference and a number of hand operations which legitimately come within the subject of fitting and assembling. The example chosen has also the advantage that when finished it forms a valuable piece of work both as an ornament and also as an efficient working model. The construction of it would indeed be difficult if one had to make up the patterns and prepare the drawings, but, fortunately, all of the castings, materials, and partly finished mechanism, as well as detailed blueprints and general arrangement drawings, are available from Messrs. W. J. Bassett-Lowke, Ltd., the well-known model makers of Northampton, from whose stock I selected this model as an interesting example of lathe work. I think you will agree that the illustration of the completed model indicates the great degree of realism which is built into it. Obviously the first thing to do is to obtain the set of parts and drawings from the firm named, and carefully to check over each part against the blueprint.

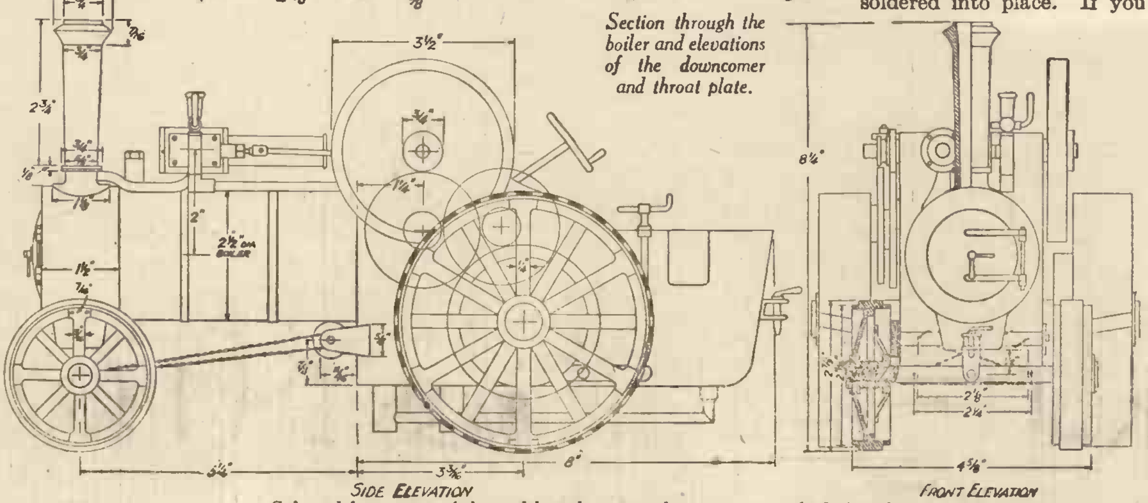

*The completed model road tractor—a fine piece of lathe and fitting work.*

### Clean Castings

So clean are the castings supplied that there is very little rough turning to be done. I have actually made all of the parts and photographed the various chucking operations which show the methods of working far more explicitly than any detailed description. The first part to commence work on is the boiler. It will be found that this is of the Smithies type, and consists of a copper tube with end plates turned to fit inside and brazed. This, in turn, is encased by an outer barrel which fits into two end castings which are respectively the downcomer and the smoke box. These parts should be carefully turned and fitted in the manner shown in the photograph, and then brazed or silver soldered into place. If you




*Section through the boiler and elevations of the downcomer and throat plate.*




*Side and front views of the model road tractor, the construction of which is described in this article.*

FOR AMATEURS

*Turning the rear-end plate of boiler in the four-jaw independent chuck.*

*Turning the chimney.*

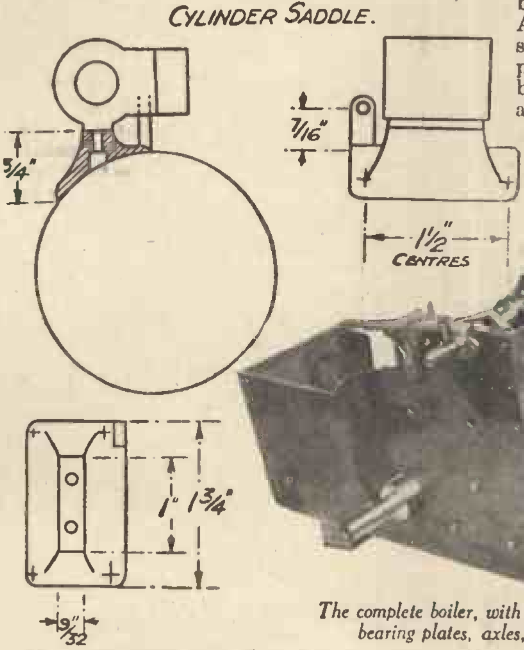
*Turning out the smoke-box and chimney base casting.*

# —A ROAD TRACTOR

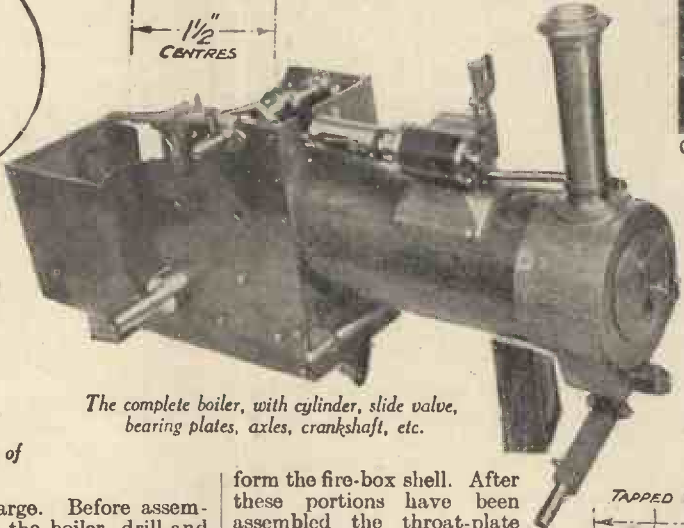
## — Standard Castings — By F. J. CAMM

are unaccustomed to brazing or silver soldering you will find the local cycle repairing depot will undertake this work for a very modest charge. Before assembling the barrel over the boiler, drill and fix the water tubes in the downcomer in the position shown in the drawing of the downcomer, and their entry into the boiler in the front end is also shown in the sectional drawings of the assembled boiler. These water tubes, of course, are also brazed or silver soldered into place. After the water tubes have been assembled the outer shell should be pushed over the recesses which have been turned on the downcomer, and also into the smoke box casting which will have been turned to receive the barrel.

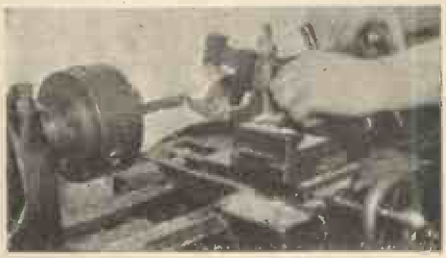
This will, of course, be cut and splayed at the rear end to form the fire-box shell. After these portions have been assembled the throat-plate casting should carefully be fitted and silver soldered into place. This now provides us with a structure upon which the remainder of the model is assembled. It will be necessary next to turn the chimney, and to mark out the position of the cylinder saddle, and then to lay out on the sheet metal supplied the shape and the positions of the bends of the driver's cab. This will require careful assembly by means of rivets and brazing or silver soldering. At this stage it will be as well, in anticipation of my concluding article, which will appear next month, to turn the outside diameter of the wheels, to face and drill the bosses, and to clean up the spokes and in the surfaces of the rims with a smooth file.



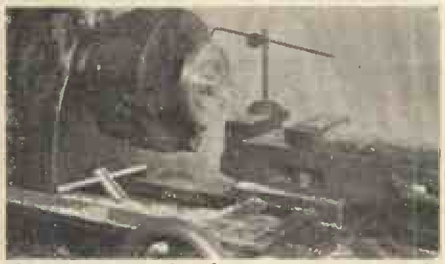

*Plan, end, and side views of cylinder and saddle.*



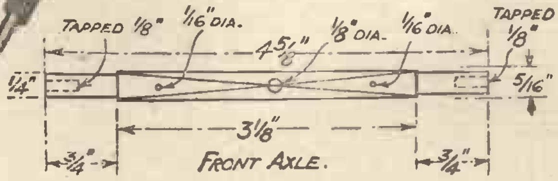
*The complete boiler, with cylinder, slide valve, bearing plates, axles, crankshaft, etc.*



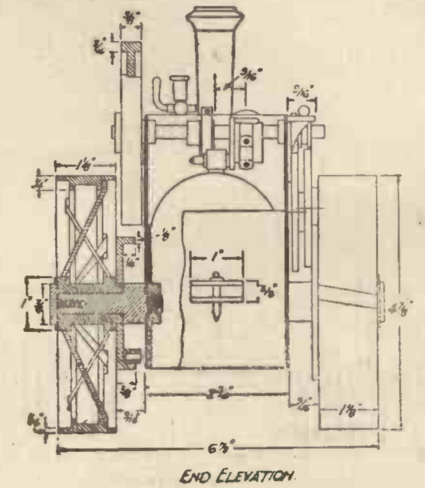
*Drilling the chimney base in the smoke-box casting.*



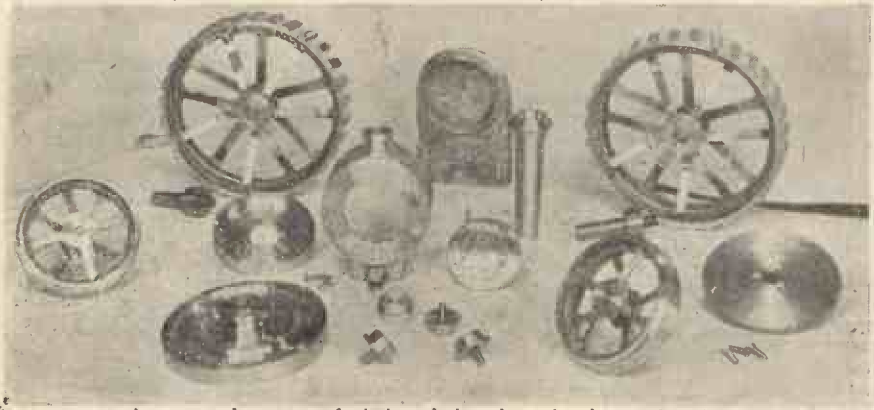
*Checking the truth of the flywheel with a scribing block.*




*The front axle.*




*Rear view with one wheel in section.*



*The various complete parts, the turning of which is dealt with in the photographic illustrations appearing on these two pages.*

# A PETROL-DRIVEN MODEL BIPLANE

By OUR AIR EXPERT

Previous constructional details of this model appeared in last month's issue.

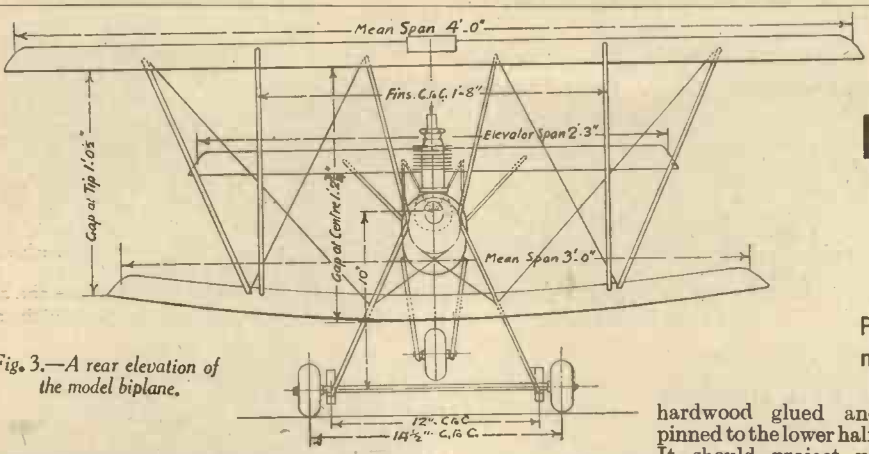



*Fig. 3.—A rear elevation of the model biplane.*

SINCE the construction of the wings of the 1–2P–0 biplane will be exactly the same as those of the 0–2P–1 model (described in our October issue), it is proposed to let the side elevation, Fig. 2, given last week, and the accompanying sketch, Fig. 3, which shows a back elevation, suffice. The elevator will have a mean span of 2 ft. 3 in. and a chord of 8 in. The design of this elevator is exactly similar to the main wings with ribs spaced at the same intervals and, therefore, of this item also no further drawing is needed.

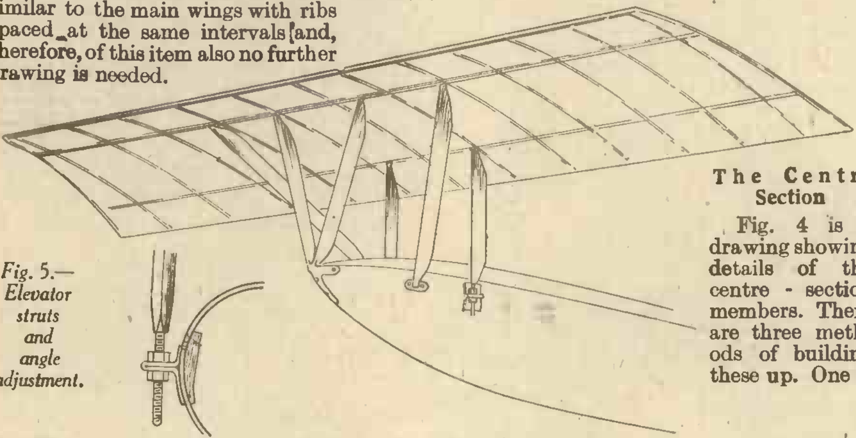


*Fig. 5.—Elevator struts and angle adjustment.*

### The Fuselage

As previously stated, this is to be moulded in paper upon a former carved to the exact shape and dimensions of the interior. The central portion of the top half should be made detachable; the movable piece extending from just in front of the cockpit to the engine. At either end of this opening it would be well to strengthen the fuselage by Balsa wood bulkheads. Besides these there must be glued on the inside blocks of suitable wood, such as mahogany, where all the attachments of elevator supports, front undercarriage and the centre section struts come. These, of course, will have to be put in before the fixed portions of the top are glued in place. The reader will, of course, understand that the cockpit is only introduced to render the model more realistic in appearance. The detachable cover over the battery and coil can, if preferred, have no opening in it.

In this fuselage it will be desirable and, perhaps, necessary, even more so than in the nascelle of the 0–2P–1 model, to make a strong and rigid joint between the upper and lower halves, since the longitudinal rigidity of the fuselage will be lost if the cover, or upper half, is loose. When referring to the nascelle I mentioned that a rebate must be formed on either the upper or lower half so as to make them fit together like a box and its lid. In the case of the present long fuselage the best plan will be to make this rebate of a band of hardwood glued and pinned to the lower half. It should project up into the cover about ⅜ in., and a row of tiny countersunk wood screws may pass through the paper into this rebate strip. The screws should be placed at intervals of about 2 in. By this means the cover is made to withstand the tendency for the sides of the lower portion to either spread apart or close together, according to the direction in which the stresses come.

### The Centre Section

Fig. 4 is a drawing showing details of the centre - section members. There are three methods of building these up. One is to use a very light brass tubing of comparatively small diameter; that is to say, about ¼ in., and, after all joints are made, streamlining with Balsa wood; another is to use a larger diameter tube, that is to say, about ⅜ in., and to flatten this, after annealing it, to give it an approximate streamlined cross section; and the third, which is perhaps the best of all, to make each member out of sheet brass of about No. 26 gauge. The brass should be cut into strips having a width of about ¾ in. These strips would be bent longitudinally around a steel or brass rod of about ¼ in. diameter. The two edges, of the strip, after bending, are brought together and soldered; the rod used for shaping being then withdrawn. These three forms of construction are shown at *a*, *b* and *c* in Fig. 4. The reason why I do not advocate the second form of strut is that I fear the reader would have difficulty in arriving at a perfect streamline shape, unless he took the trouble to make a pair of steel rollers turned to the correct profile in the lathe and mounted in a frame with a handle. The easiest and quickest will be the type of strut shown at *c*. For attaching the centre section to the fuselage plates of brass with lugs, shaped as shown in the drawing, will be required, whilst the attachment to the undercarriage will be by saddle-shaped plates made to fit the skids. The attachment to the wing spars must be such as to render the wings detachable, and I think the easiest way will be to put on the struts bent brass bands which can be opened out for the purpose of fixing the spars, the bands being secured by clipping with $\frac{3}{32}$ in. diameter Whitworth screws and nuts. It must be understood that all the joints of every kind in the centre sections must be silver-soldered.

### Elevator Supports

Fig. 5 is a perspective sketch showing all the members which secure the elevator to the nose of the fuselage, whilst adjoining the main drawing is a view in elevation of the incidence angle adjustment. If the general trim of the machine, that is to say, the relative loading of the elevator and

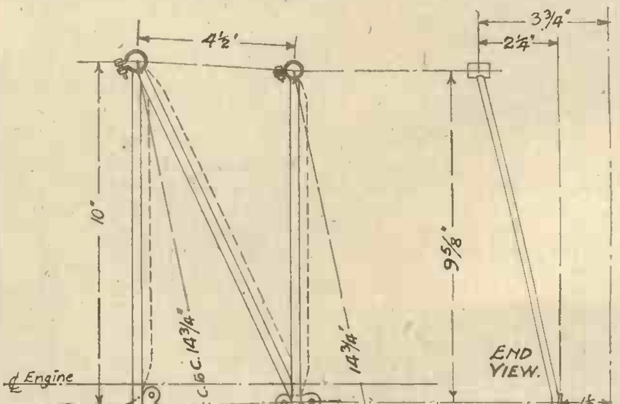



*Fig. 4.—Details of the centre-section struts.*

main planes, is about right, the angle of the elevator should not need to be varied, but it is, nevertheless, perhaps advisable to fit a means of adjustment in much the same way as is necessary on the tail of a 0–2–1. The two adjustment struts will need to be attached to the rear spar of the elevator in such a manner that they have a slight rotary movement. Indeed, in theory, flexibility is required on the four front struts also, and therefore it would be perhaps advisable to have the screw heads of the clips, which can be similar to those on the rear main planes, with their heads downwards. A small screwdriver can then, if necessary, be passed through a tiny hole in the fabric which covers the elevator.

### Propeller Shaft

The sketch, Fig. 6, also shows the bearing for the shaft immediately in front of the propeller. This I have shown plain and made of brass in an aluminium casting, but I should be inclined, for I think it worth while, to make a tiny ball bearing to carry the shaft here. This is quite easily done by buying about eight of the smallest steel balls obtainable and turning two steel cups to receive them, one to fit tightly on the shaft and the other in the aluminium casting, which will be secured by screws in the paper end of the fuselage.

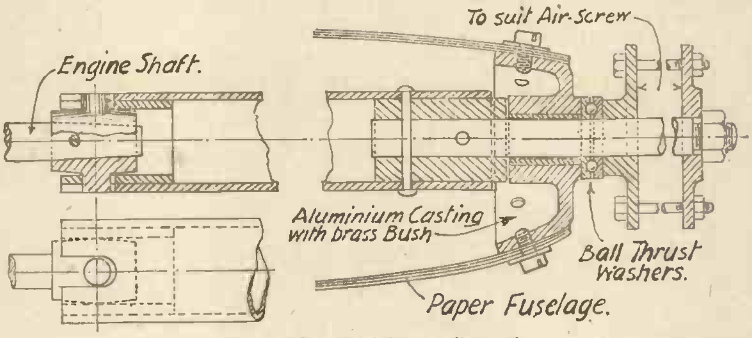



*Fig. 6.—Details of the propeller shaft.*

### Wing Covering

The main planes, tails and elevator should be covered with silk, although this material is not absolutely essential. A good strong Japanese rice paper makes a good substitute, and, moreover, it can be easily patched or a whole section between ribs cut out and replaced should it become damaged. It should be stretched on as tightly as possible without distorting the wings and then coated with a dope, which can be obtained from firms who cater for aero modellists. This has the effect of pulling the fabric taut. Paper covering can be rendered tight with thin water size, afterwards coating it with an oil varnish.

The paper fuselages and, in fact, all parts of the machines, except possibly the wings, will require to be painted, and for this purpose a cellulose enamel, such as "Belco" and other good brands, will be found the best. I should certainly advocate an aluminium finish for the wings, and the best way to apply will be to mix the aluminium powder with a cellulose lacquer and spray it on. It is possible to buy a simple hand-spraying implement for carrying out this operation, which does not need expensive air-compressing plant.

## A FOUR-CYLINDER COMPRESSED AIR ENGINE FOR MODEL 'PLANES

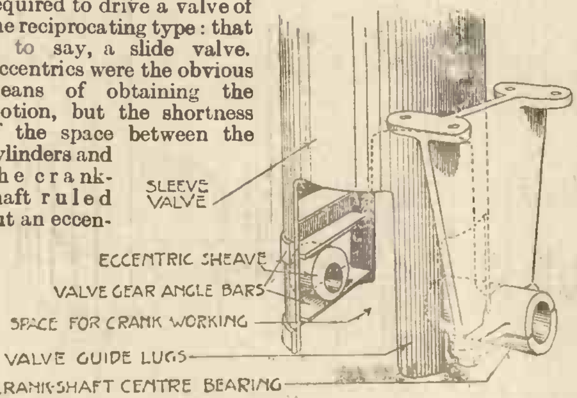
*An entirely new design for a compressed air engine in which the cylinder arrangement departs from the radial system usually employed, and more nearly approaches full-size practice. It will be noticed that the cylinders are placed in line, and that sleeve valves are also employed.*

BEFORE commencing to describe this engine I should like to say that the idea for a compressed air motor of the four-cylinder, in-line, vertical type, originated with our Editor, who believes, and doubtless with reason, that there is a demand for something new in this direction: something different from the stereotyped, three-cylinder, radial engine, which seems to be inseparable from compressed air as a source of power for model aeroplanes. So the suggestion was turned over to me to work out.

Now the obvious thing, perhaps, to have done would have been to adapt the rotary valve used on the radial engines, to the new type, taking four pipes from the valve box, which box would, of course, have to be at one end of the crank-shaft, one pipe to each cylinder, but there are objections to this arrangement. First there are the differences in the respective lengths of the pipes. One of the pipes would have to be fairly long, which would cause wire-drawing of the air to that cylinder furthest removed from the valve. There would, consequently, be losses in power in the more distant cylinders, due to the exhaust having to be driven back through the same pipe through which it entered. So it occurred to me to do away with the radial valve and let each cylinder have a sleeve valve, or liner, which should act as its own independent valve.

### The Valve Gear

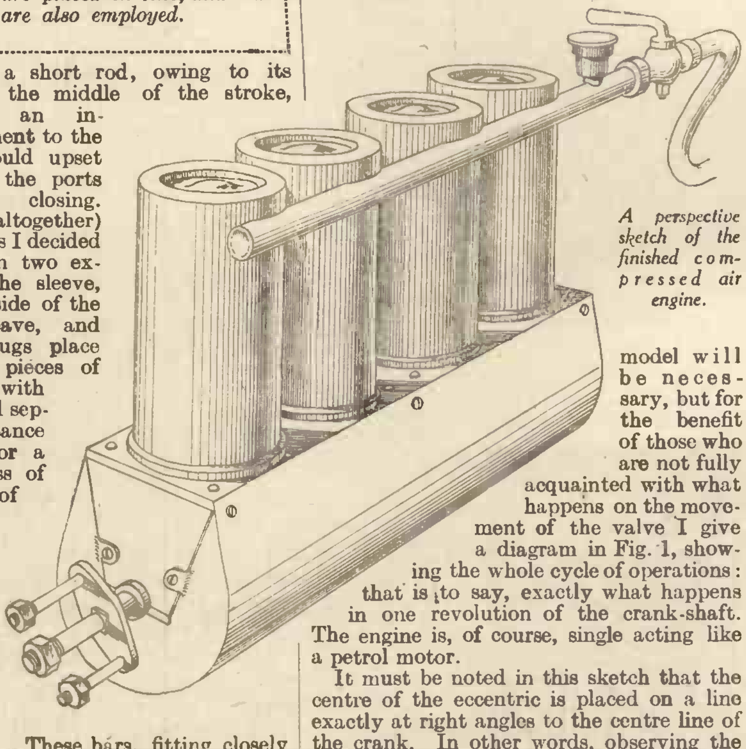
The next problem was the valve gear, for a valve gear is, of course, required to drive a valve of the reciprocating type: that is to say, a slide valve. Eccentrics were the obvious means of obtaining the motion, but the shortness of the space between the cylinders and the crank-shaft ruled out an eccentric rod for a short rod, owing to its angularity at the middle of the stroke, would give an incorrect movement to the valve and would upset the timing of the ports opening and closing. After two (not altogether) sleepless nights I decided to bring down two extensions of the sleeve, one on each side of the eccentric sheave, and across these lugs place two bars, or pieces of angle, parallel with each other and separated a distance apart equal or a little in excess of the diameter of the sheave.




These bars, fitting closely to the upper and lower sides of the sheave, give, on the rotation of the crank-shaft, an up-and-down parallel motion, which motion is equal to the required travel of the valve and equal to double the throw of the eccentric. In order to prevent partial rotation of the sleeve in its cylinder two further lugs are brought down on the opposite side of the crank, and these engage with the bearing, against which the edges of the lugs slide.

### The Working Principle

To those familiar with the functioning of the slide valve in the steam engine no explanation of the working principle of this model will be necessary, but for the benefit of those who are not fully acquainted with what happens on the movement of the valve I give a diagram in Fig. 1, showing the whole cycle of operations: that is to say, exactly what happens in one revolution of the crank-shaft. The engine is, of course, single acting like a petrol motor.



*A perspective sketch of the finished compressed air engine.*

It must be noted in this sketch that the centre of the eccentric is placed on a line exactly at right angles to the centre line of the crank. In other words, observing the direction of rotation, the eccentric is 90 degrees in advance of the crank. This means that the valve is given—as it is known in steam practice—no lead. By lead is meant the provision of a very slight opening of the steam, or air, port before the piston reaches the end of its exhaust stroke. Lead is obtained, or given to the valve, by setting the eccentric a trifle more

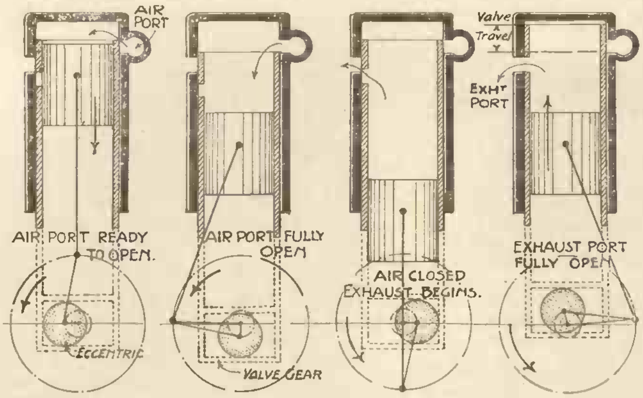



*Fig. 1.—The cycle of operations in the engine.*

than 90 degrees ahead of the crank, and I think that it would be some slight advantage in this model to give a little lead. It will have the effect not only of cushioning the piston at the top of the stroke, but of closing the admission of air before the piston reaches the bottom of the stroke.

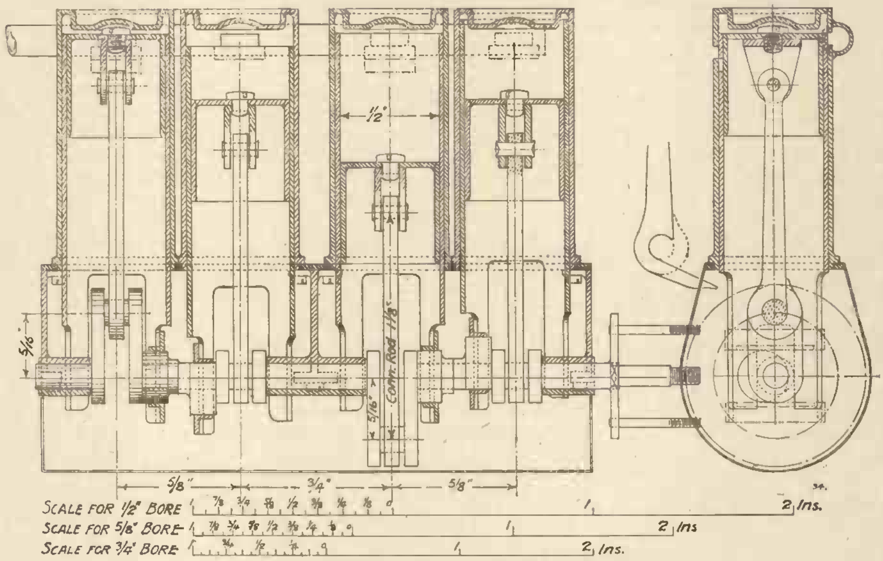



*Fig. 2.—Longitudinal and cross sections through the engine.*

### Highest Class Workmanship

The whole success and efficiency of this little engine will depend upon the workmanship put into it. I do not know that the sleeve valve presents greater difficulties in making or fitting and, above all, getting airtight, than any other valve, but it is certain that the power developed by this engine and its economy of air will rest solely upon the perfect fitting of the pistons in the sleeves and the sleeves in the cylinders. All three will be made up from brass tubing, each ground and lapped one into the other. To those who are used to lapping pistons and cylinders together, the job will be quite easy. The piston head and the cylinder head are slightly coned into their respective tubes and soft soldered.

The cylinder covers are shaped as I have drawn them for the sake of economy of air. They can, of course, be made perfectly flat, but if they are so made a certain amount of air will enter the cylinders at each revolution which will do no useful work.

### The Crank Shaft

The crank shaft and the eccentrics, the former at any rate, must be made in mild steel. Eccentric sheaves can, if preferred, be in hard brass. The whole of this part of the engine must be thoroughly well silver soldered together. The best way to make the shaft will be to cut out all the crank cheeks, eight of them, from steel plate, drill them all together, packing the eight plates one upon the other and clamping them so as to ensure the holes for the shaft and the crank pins being exactly in line. The shaft is made from a length of steel rod. On this the eight crank cheeks should be threaded, and if they do not make a tight fit each one should be pinned in its right position, care being taken to make each pair of cranks make an angle of 90 degrees with the one next to it. The eccentrics also must be threaded on. Then the crank pins are passed through and the whole hard soldered. After cleaning up, the four portions of the shaft, which occur between each pair of crank cheeks, are sawn out.

### Connecting Rods

The little ends of the connecting rods fit into U-shaped pieces either riveted or screwed, as shown, in the top of the piston, and secured with gudgeon pins slightly countersunk and lightly riveted over. The big ends, however, are rather peculiar. The engine is so tiny that it would have been very difficult to fit caps held on to the rods by the necessary two screws, so I have devised a method whereby the big end can be made of one piece and yet be fitted on the crank pin. As the engine is single acting the thrust of the piston will only come in one direction, downwards, and little strength is required below the crank pin, so the big end can be cut to the shape shown in the supplementary sketch which I have made alongside of the cross-section in Fig. 2. The pointed end of metal is bent around the crank pin after the piston is passed into place in the liner for the last time: that is to say, when the engine is finally erected. It may not be noticed when examining the drawings, so I had better call the reader's attention to the fact, that the lower bars across the lugs on the sleeve valves, which engage with the eccentrics, would prevent the passing into place of the crank shaft if the whole of the bars were fixed before assembly. These four bottom bars must, therefore, be left off until the sleeves are in the cylinders and the crank shaft in its bearings. The bars will then be fixed by soldering to the lugs. The upper bars can, of course, be already on the lugs.

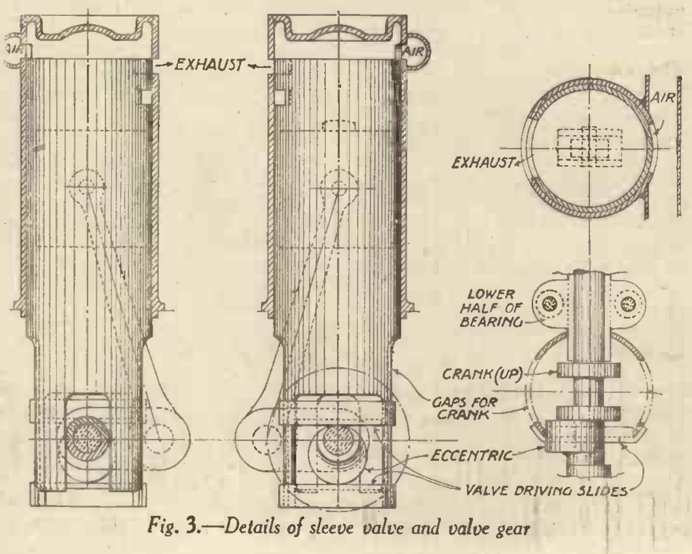



*Fig. 3.—Details of sleeve valve and valve gear*

### The Air Supply Pipe

This is a continuous piece of copper tubing filed out in four places to saddle on to the cylinders where it is carefully soldered. The filed gaps will, of course, fit over the air ports. The end of the pipe nearest to where the propeller will come is stopped with a disc of copper. The other end in the drawings I have shown broken off. The length of the pipe at this end and the shape to which it is bent will depend upon the position of the air reservoir. A stop valve will be wanted in the pipe somewhere here.

As the pistons and valves will require to be kept lubricated, a light oil cup should be soldered into and on top of the air supply pipe, close up to the first cylinder. This oil cup must either have a tap between it and the pipe or must have a screwed-on, air-tight cover. To lubricate the engine a few drops of oil are put into this cup before starting up. It will be noticed that in Fig. 2 I have made three scales by which measurements for the model may be taken off. These scales will enable the model maker to construct three different size engines.

### Model Aeroplanes and Airships

A popular handbook that every model aeroplane enthusiast should have on his bookshelf is "Model Aeroplanes and Airships," by F. J. Camm. This book describes in simple language how to make model gliders, helicopters, wing-flapping models, kites, airships, etc. The book is published by George Newnes Ltd., 8–11 Southampton Street, Strand, W.C.2, and is obtainable from newsagents and bookstalls, price 1/-, or by post 1/2 post free.

# NEW IMPLEMENTS FOR MECHANICAL DRAWING

By "DRAUGHTSMAN"

**The first of two articles dealing with the construction of a number of original drawing instruments designed by the author that will be found very useful to a draughtsman.**

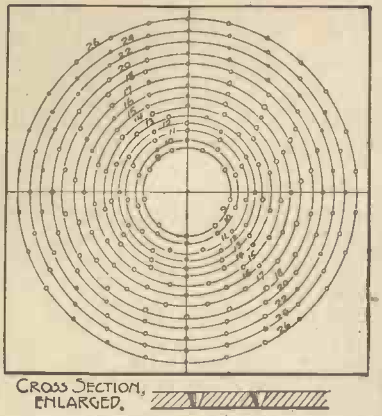



*Fig. 4.—This instrument, made of celluloid, facilitates the dividing up of circles in a drawing.*

FROM time to time during the many years which I have spent in doing drawing of all kinds—pictorial, engineering, architectural and aircraft—there has arisen the need for special implements and devices for saving either time or trouble, or for simplifying an operation in drawing. By special implements I mean, of course, draughtsmen's tools of all kinds which cannot be purchased because they are not made by manufacturers of mathematical instruments. In most cases when such need has arisen I have made myself the implement in a form which I have thought best filled the requirement, and as the number of these has accumulated, it has occurred to me that there may be many others to whom these little bits of kit would be equally useful, given the same conditions calling for their use. In this article, and in the accompanying illustrations, I shall give them in the order of their simplicity and ease in making. A few of them will require for their making some simple tools; in one or two, perhaps, either access to a small workshop or else the calling in of the services of a model maker or other light metal worker who has such a workshop.

### Measured Spacing

The first thing which I have illustrated is merely an addition to an ordinary celluloid set-square. It consists of the ruling of parallel lines on the under side of the square at definite intervals, as shown in Fig. 1. Of course, such lines could be spaced on either a 45 degree or 30–60 degree square. The spacing should be in inches and the subdivisions either in eighths or tenths, according to which is likely to be the more convenient, probably the former. The lines should be scribed in the celluloid with a needle point, and to erect them from the base, dead square and parallel with the vertical edge, an engineer's steel square is advisable. They are scribed first and then filled in with a carbon black, such as waterproof Indian ink or water-colour lamp black. The numbering of the lines is scratched upon the upper face of the celluloid. The draughtsman reader will probably be familiar with the semicircular protractors made of celluloid which are obtainable. An examination of one of these will show that all the lines are on the side of the celluloid which is laid upon the drawing. The object of this is, of course, to get such lines in actual contact with the paper, and I think that for this reason protractors of this form have the advantage over metal ones. To all intents and purposes the lines are on the paper. The purpose served by the ruling of a set-square is that spacing off on a drawing when erecting perpendicular lines can be done without having recourse to a scale or full-size ruler.

### Drawing Parallel Lines

The next implement (Fig. 2) is a flat piece of celluloid with parallel edges. Upon this are ruled spacing lines in the same way as was done on the set-square. The purpose of this is to facilitate ruling parallel lines at regular intervals, either in combination with the angles of a set-square or with the tee-square, or it may be at angles which are not automatically given by any of the squares. In using this parallel ruler the lowest line would be drawn first and the ruler moved up the requisite space and the first line drawn made to coincide with one of the lines on the ruler, the second line drawn and again moved up, and so on.

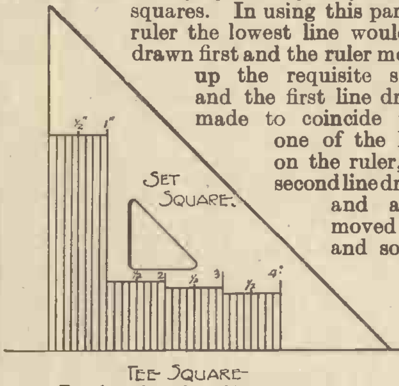



*Fig. 1.—A useful addition to an ordinary celluloid set-square.*

### Drawing Octagons

In the ordinary way there is no automatic method of drawing an octagon, and it must be set out by geometry. To save the necessity of doing this I made for myself a set-square by which I was able to draw either the sides of the octagon, as at A, Fig. 3, or one or more of the diagonals, as at B. This particular set-square is, perhaps, more useful when the octagon is placed as in the second sketch, because the diagonals are the more important and the sides can be drawn with an ordinary set-square. The angles of the square will, of course, be $22\frac{1}{2}$ and $67\frac{1}{2}$ degrees. The easiest way to make such a square will be to buy a 60–30 degree, and after marking out with a scribed line cut it with a sharp penknife and steel straight-edge, carefully planing the new edge smooth and true.

*Fig. 2.—A device for drawing parallel lines.*

### Dividing Circles

The next object which I have drawn in Fig. 4 is also in celluloid, but in this case it is not necessary that it should be so thick as a set-square. Sheet celluloid of about No. 22 gauge will do nicely. As will be seen, it somewhat resembles the division plate on a watchmaker's or precision lathe. Its object is to facilitate the dividing up of circles in a drawing. I may explain that the need for this implement arose at a time when I was making many external elevation drawings of locomotives in which all the spokes of the wheels had to be shown. This fact will render obvious the reason why the number of divisions in the rings range from twenty-six in the outermost to nine in the innermost. The largest locomotive wheels, of 7 ft. 8 in. to 8 ft. in diameter, have usually twenty-six spokes, whilst the smallest bogie wheels have only nine. The reader can, of course, if he uses the idea, divide the circles up in any other manner he thinks likely to be useful.

The celluloid should be cut dead square, so that it can be used with any one side on the tee-square, and the cross lines which I have drawn should be scribed to cut through the centre. From this centre the circles are inscribed on the under face with the point of a pair of dividers. After accurately dividing up each circle tiny holes are bored through the celluloid. The best way to make these holes will be to use a thin, flat piece of steel ground to a tapered point. The point of a penknife can be so ground, but whatever is used the resulting hole should be tapered and the tool should only just go through on the back of the celluloid, as shown in the enlarged cross-section in Fig. 4. To use the implement the circle representing the wheel, or whatever it may be, is drawn first upon the paper. The implement is then laid over the circle so that the cross lines scribed on the celluloid coincide with the compass mark, the tee-square being used to set the implement symmetrically. A fine-pointed pencil is then dropped into each of the holes on the ring corresponding with the number of divisions required. From this it will be seen that the holes in the implement must be just large enough to allow the point of a pencil to touch the paper and no more. Of course, a needle could be used for dividing up, in which case the holes could be a trifle smaller, but I think

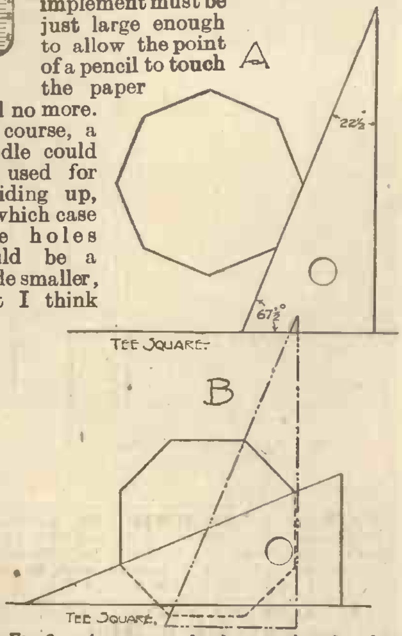



*Fig. 3.—A set-square for drawing the sides of an octagon, at various diagonals.*

that a pencil-point mark is better than a needle-pricked hole on a drawing.

**A Bridge Rule**

It frequently happens with certain kinds of drawing that it would be a great advantage if we had not to wait for ink to dry before drawing in other lines crossing those just previously made. This is particularly the case when we find we have omitted to ink in some little thing which we may forget if we do not do it at once, and to overcome this I produced what I call a bridge rule, because it bridges over other lines of wet ink. Such a rule may be made of any suitable material. From time to time I have made several in wood and metal, but the best material is celluloid. Such a bridge rule is shown in Fig. 5, in plan at A, in cross-section at B, and in perspective at C. The two knurled knobs are of use for lifting and turning the rule about to different angles. The narrow strip shown underneath the knobs is a strip of brass which is only needed in the event of the rule being made of celluloid.

As will be seen, the under side is fitted

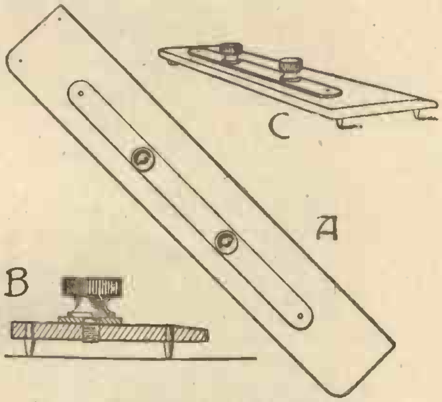



*Fig. 5.—A bridge rule for drawing lines without smudging the previous lines drawn.*

with four blunt needle points having a length of projection of a full $\frac{1}{16}$ in. If the rule is made of a length exceeding 6 in. in celluloid a fifth point should be fitted in the centre between the knobs to prevent risk of bending the rule downwards or cockling upwards of tracing paper or tracing cloth.

Just a word of warning. I have one or two of these rules made of thick sheet aluminium plate, but they are not successful, owing partly to the softness of the metal, along the edge of which the pen does not slide easily, and to the fact that the brightness of the metal reflects the light and so prevents one from seeing exactly where to place the rule. Without question the best material to use is celluloid, which should have a thickness of at least $\frac{1}{10}$ in.





# lithography for the amateur

By S. J. GARRATT

THE word "lithography" means in plain English "stone-drawing," and refers to a method of printing. The fitness of this interpretation will be quite clear when it is remembered that all lithography was at one time drawn upon and printed from stone slabs. Up to about the beginning of the present century stone remained supreme, but since then it has been steadily replaced by sheet zinc or aluminium. From many points of view stone is by far the best material, but of course it can only be used in thick flat slabs, which must necessarily be used on a printing machine having a flat bed moving with a reciprocating motion. The metal plates, on the other hand, are thin enough to wrap round a cylinder, and can therefore be used on a rotary printing machine, which may be worked at about three times the speed of the flat-bed machine.

## How it is Done

The principle of lithography has for its base the mutual repellance between grease and water. The design is drawn with a greasy ink on the perfectly clean stone, the ink is firmly held by the slightly absorbent surface of the stone which, after the drawing is finished, is sponged over with gum arabic dissolved in water. The gum is also absorbed by the surface of the stone, but only where there is no greasy ink. We may put the description in a nutshell by saying that if the ink gets there first the gum cannot attack the stone, but if the gum gets there first the ink cannot afterwards get a hold. The gum is allowed to remain on the stone for a time, after which the surplus is removed with a wet sponge and the surface of the stone left damp. Mere wiping is not sufficient to remove all the gum, some of which remains combined with the stone. A roller charged with ink is then rolled over the damp stone with the result that a layer of ink is deposited upon the greasy parts of the stone, but the ink is completely repelled by the damp parts. Then, upon laying a sheet of paper upon the stone and applying pressure, a print is obtained. The damping and rolling may be repeated, and as many prints as required may be obtained.

*Fig. 3.—A proof being removed from the stone slab.*

The amateur lithographer can use either stone or zinc, the latter being more commonly used than aluminium. All the necessary materials can probably be obtained from the larger dealers in artists' materials, but in case of difficulty one of the firms who specialise in printers' supplies can provide all that is required. The Editor of PRACTICAL MECHANICS will give the address of a suitable firm to any reader sending a stamped addressed envelope.

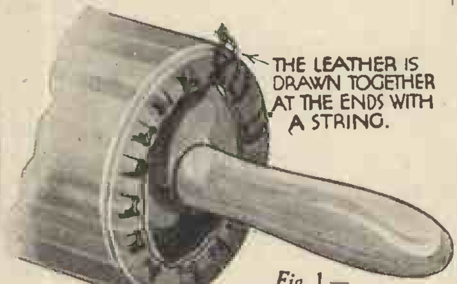



*Fig. 1.—Details of the roller.*

## The Stone

"Lithographic Stone," as it is called, is a special kind coming chiefly from quarries in Bavaria. It has a very fine grain, is of a slightly porous nature something like unglazed porcelain but finer in texture, and takes a good polish. Its colour may be described as a "creamy buff." The stones are cut into slabs about 3 in. thick of suitable size, and are prepared for use by grinding the surface flat with sand and water; two stones may be ground face to face, or an iron arrangement specially made for the job, called a "levigator," may be used. After grinding, the surface is polished with pumice stone and finally finished off with snake stone.

The artist then draws on the smooth stone with a pen or a brush, with a special ink of a soapy nature called "Litho Writing Ink," which may be purchased ready for use. The drawing must of course be made the opposite way round (*i.e.*, as a mirror image) otherwise it will appear reversed on the print; this may seem to be a difficult proposition for the beginner, but facility in this operation comes with practice. If required, the outline of the design may be traced down upon the stone by means of red chalk tracing paper, specially made for the purpose. It is used like the ordinary carbon paper found in manifold books, but don't attempt to use this latter because it is greasy and this would cause the traced lines to print with the drawn lines.

The smooth stone is well suited for drawing black and white line work with pen or brush and for "stippling," but if a grain is required to give a halftone effect (*i.e.*, greys in various strengths) a grained stone is required. The stone itself is the same, but the surface is finished with carefully sifted sand and is not polished with pumice stone. Considerable skill and experience is required in obtaining an even grain all over the stone. In this case the drawing is done with a lithographic crayon; when used very lightly this catches only on the tops of the grain and gives a light tint, while heavier pressure on the crayon forces the material further into the grain and gives a heavier tone. Solid blocks may be obtained by painting in with litho writing ink as for a smooth stone.

## The Etching Process

When the artist has finished the drawing—whether on smooth or grained stone—the whole surface of the stone is "etched" with a solution of gum, to which about 2 per cent. of nitric acid has been added. This is applied with a broad soft brush, and is washed off with water after a minute or so. The action of the weak acid has a double effect; it attacks and destroys the alkali in the ink or crayon, both of which are of a soapy nature, thus liberating the grease which becomes firmly attached to, and partly absorbed by, the stone, and the acid also attacks the stone itself, rendering it more sensitive to the action of the gum, which becomes to some extent combined with the surface of the stone. After the acid and gum solution is washed off the stone is sponged over thinly with plain gum solution (*i.e.*, without acid) and allowed to dry. It is then ready for printing. Spots and similar defects may be removed by scraping them out with a sharp knife and covering the new surface with gum.

To produce a print it is at first necessary to charge the design on the stone with ink. This is done by means of a leather-covered hand roller (Fig. 1). Litho printing ink of the required colour is spread out on a slab (an old litho stone does very well for this) and rolled out evenly by means of the roller. The stone carrying the drawing is wiped over with a wet

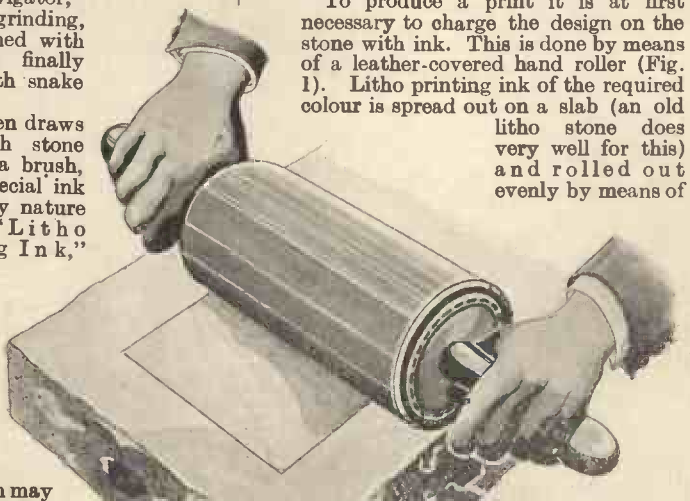


*Fig. 2.—Imparting ink to the greasy drawing by means of the roller.*

sponge to remove all the gum, and the surplus water is removed with a damp cloth, leaving the stone in a damp condition. While the stone is still damp, the roller is rolled over the surface and imparts ink to the greasy drawing, but not to the damp background (Fig. 2). Several applications of the roller may be necessary, but the roller should never be applied to the stone unless the stone is damped with the damp cloth. There is a certain "knack" about this rolling that may be acquired after a few trials. Always damp the stone if it shows signs of taking ink on the background.

### Pulling a Proof

The usual method of pulling a proof (Fig. 3) is to make use of a proper litho press, but if access to one cannot readily be obtained, good results may be achieved by means of the makeshift described below. A piece of smooth steel shafting not more than ¾ in. diameter and about 10 in. longer than the width of the stone should be obtained. After rolling up the stone with printing ink, fan it dry and lay the paper face down on the stone. On the back of this paper lay a few sheets of blotting-paper, then roll this with the piece of shafting, using the latter in the same manner as the ink roller, except that heavy pressure should be used on the shafting. The small diameter of the steel shaft serves to concentrate the pressure.

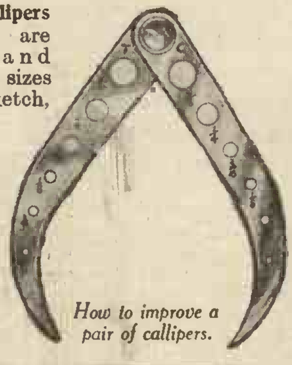
Certain types of paper will be found more suitable than others. Generally speaking, the paper should be soft and have a smooth surface. If any difficulty is experienced in getting a good impression the paper may be damped by laying it between damp blotting-paper for half an hour or so.

A great deal of commercial lithography is done by means of transferring the design on to the stone or plate, but this is rather a more complicated procedure and not so convenient for the amateur; also a good press is essential for such work.

Zinc plates may be used instead of stone by an amateur, but consistent results are not so readily obtained. Grained plates must be used, the surface being grained by a machine, which shakes glass marbles and wet sand over the plate. For making a few proofs the procedure of drawing and etching may be similar to that described above for stone, though when done on a commercial scale the operation of etching is somewhat modified.

### Improving Callipers

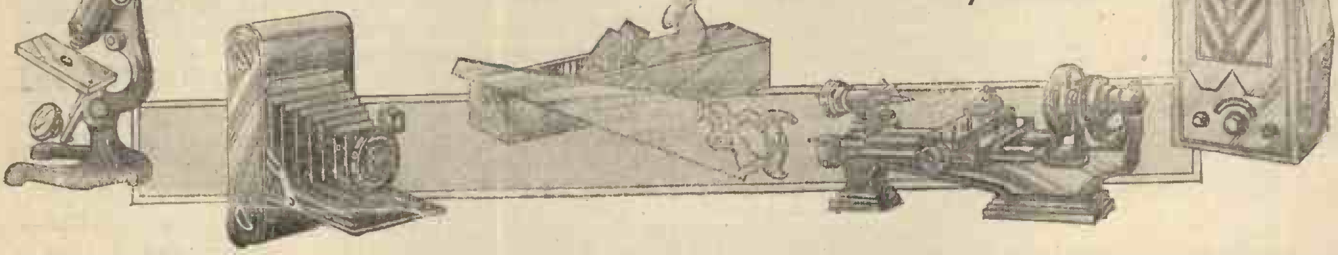
IF callipers are drilled and stamped with sizes as shown in sketch, clearance holes in one side and tapping in the other, their usefulness is greatly increased. Space the holes evenly. A. B. (Berks).



How to improve a pair of callipers.

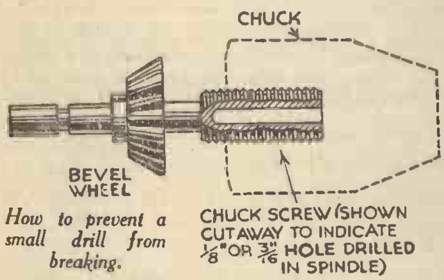
# HINTS ABOUT HOBBIES

Practical Ideas— —Contributed by Readers



### A Useful Drilling Hint

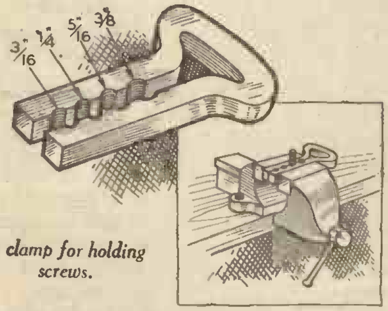
WHEN drilling small holes with a hand brace and the drill is new and long, it often happens that the drill breaks, through being unable to get a short grip. If a small hole is drilled in the spindle of the brace (preferably done in a lathe), it allows the smaller drill in question to go in further, thus allowing a shorter grip, making it more steady and less liable to break.—W.D. (Northumberland).




*How to prevent a small drill from breaking.*

### An Ingenious Screw Clamp

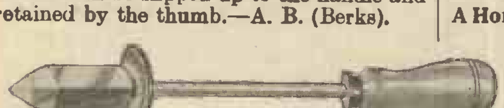
IT sometimes occurs when making a particular model that one or two screws have to be filed down or cut with a hacksaw. A simple device for holding them during this process is shown in the diagram. A piece of square steel bent to the shape shown, and tapped to the desired pitch, is all that is necessary. This attachment, when placed in the vice, will prevent distortion and damaging of the screw thread.—R. W. (Ireland).




*A clamp for holding screws.*

### A Soldering-Iron Rest

TO prevent a hot soldering iron from burning the surface on which it is placed, attach a large iron washer to the shank as shown in the sketch. This will act as a rest and keep the iron raised. When doing work on a small space the washer can be slipped up to the handle and retained by the thumb.—A. B. (Berks).



*An iron washer attached to the shank of a soldering iron makes a useful rest.*

**THAT HINT OF YOURS**

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

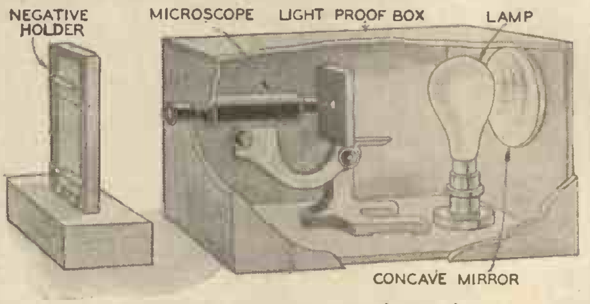
### Taking Microphotographs

A MICROSCOPE is placed horizontally in a light-proof box, with the eyepiece projecting through an aperture in the side. A light is used in conjunction with a concave mirror to focus a bright light on the slide. The object on the slide is then projected and focussed on a sheet of white paper, in place of a negative, in the negative holder. When the object is sharply defined the paper is removed and a negative inserted and exposed. The negative holder is on an adjustable slide to accommodate the various sizes of the field of view, using different power lenses.—H. L. (Gloucester).

### A Safety-Catch for a Box Camera

IN using a box camera with a side trigger it is quite a simple matter to spoil a picture by accidentally knocking the trigger when replacing the camera in a case. To prevent this keep two rubber bands of different lengths fixed to the handle studs of the camera as shown.

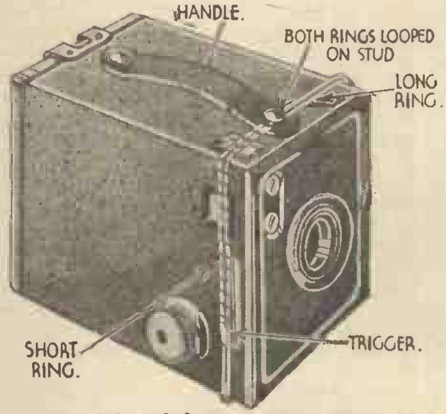
When the trigger is up (towards handle of camera), slip the short ring round it. When the trigger is down (away from the handle) take the longer ring round the camera and up to the trigger, so keeping it in the down position. Whichever ring is in use can be instantly slipped off as soon as the camera is required for a snapshot. The rings are easily replaceable, and by looping them round the carrying handle studs, are always ready for use and save many a double exposure.—G. H. (Surrey).




*The apparatus for taking microphotographs.*

### A Home-made Pump

THE device shown in the sketch shows how a simple pump arrangement can be made from two cycle valves, a block of hardwood, and a plunger. The block of wood is drilled and the two cycle valves inserted as shown in the sketch. The plunger is then attached to a lever fixed to the wooden base and the pump is completed. The action of the pump can easily be seen from the sketch.



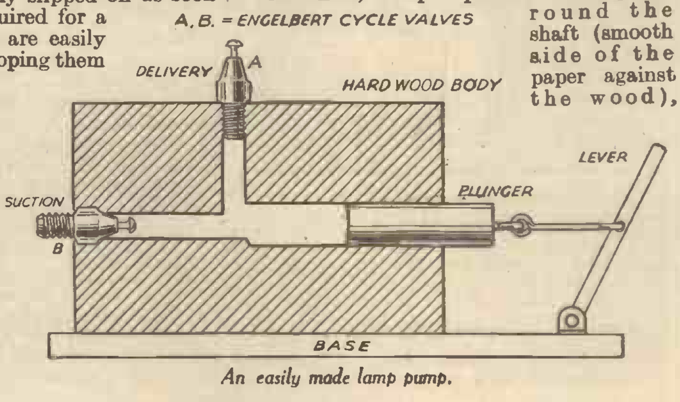

*A safety catch fitted to a box camera.*

### A Simple Lock-nut

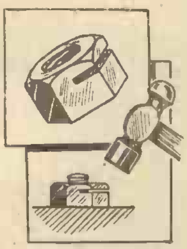
NUTS on bicycles and similar things which have a tendency to work loose can be quite effectively locked by cutting a hacksaw slot halfway through the nut as shown in the sketch. The nut should then be tightened in place and then hammered to close the slot. This nut cannot work loose, but it can nevertheless easily be removed with a spanner.

### Fixing a Hammer Shaft

TO keep a hammer head from coming off its shaft, wrap a piece of sand-paper round the shaft (smooth side of the paper against the wood),




*An easily made lamp pump.*

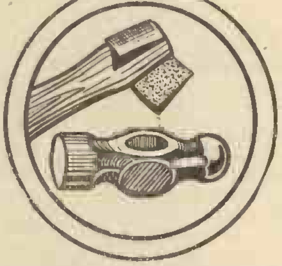


*A simple lock-nut.*

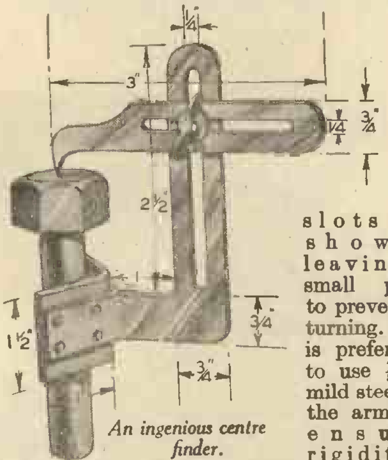
then drive on the hammer head. The sandpaper grips the shaft firmly and prevents it from working loose. It may also be securely fixed by screwing a screw of rather large size down into it. This will act as a wedge, but differs from a wedge in that it cannot work out. It ensures a very tight fit and does not tend to split the handle.

### An Ingenious Centre Finder

ALL that is required for making the device shown in the centre of this column is a small piece of true angle either steel or brass, two pieces of mild steel, and a small screw with a wing nut attached. File the screw to enable it to go into the slots as shown, leaving a small piece to prevent it turning. It is preferable to use ⅛ in. mild steel for the arms to ensure rigidity.—J. C. (Scotland).



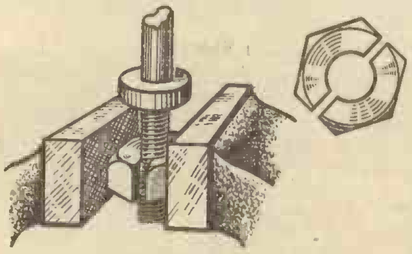
*A piece of glasspaper wrapped round the hammer shaft firmly fixes it.*




*An ingenious centre finder.*

### Holding Screw Threads in a Vice

IT is often necessary to hold a bolt or other screw part in a vice. This usually results in damage to the screw threads often to such an extent that the nut refuses to go on. Where lead covers for the vice-jaws are unobtainable, split a nut in half, place it round the screw part and then clamp it between the jaws of the vice. The part will be held quite firmly without damage to the thread.



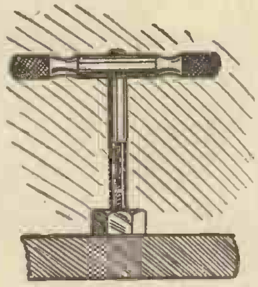
*How to hold screw parts in a vice.*

### A Stone for Sharpening Tools

FOR the handyman who is not conveniently near a joiner's shop where he can use a grinds tone, the use of an oil stone for sharpening tools such as plain blades, chisels, etc., often is a slow task. Here is a simple remedy. Obtain a block of wood and also a strip of zinc 2 in. wide by 11 in. long. Place the zinc along the top of the wood and bend over the overlap at each end. Fasten the zinc with three nails at each end, place a small quantity of olive oil on the zinc, also some fine carborundum powder (obtainable at any garage), and the "stone" is ready for use. It is used the same way as an oil stone but cuts very much quicker. A few slips of oil stone are always handy, and if various grades of coarseness are kept by you, the touching up of the tools is facilitated.

### Starting a Screw Tap

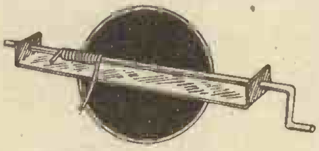
THOSE model engineers who cannot start a screw tap truly should use a nut of the same thread as the tap and hold it firmly over the hole to be tapped until the first three threads are cut. This will ensure that the threads are at right angles to the work.



*How to start a screw tap.*

### Making Coil Springs

TAKE a piece of iron about 12 in. long, 1 in. wide and ⅛ in. thick, turn up the ends as shown in the sketch, bore holes for the crank and bore holes in the end of the crank to receive the ends of the spring wire. The device can be fastened to the bench with screws, or held firmly in a vice and springs of any length up to 12 in. may thus quickly be made. By having a number of spindles of various sizes handy, springs of various diameters can be made.



*A device for making springs.*

### Imitation Silver Plating

IF a small quantity of mercury is placed in a small stone vessel—a jam pot or honey pot will do—and a quantity of nitric acid added to it—the pot being slightly warmed—the mercury will dissolve, and a brown gas will be given off. The resultant solution can be used for a very interesting little experiment.

Take any old brass or copper article, say, a fire shovel or candlestick, and paint on to it a little of the solution. Immediately this is done, a brilliant silvery plated appearance will result, due to a film of mercury having been deposited on the metal article.

It is not advisable to treat articles of value with this solution.

The amount of mercury to use at first should cover a space the size of a sixpence and the amount of nitrate acid about half a small wineglassful. There should be slightly more mercury than will dissolve in the acid. This part of the experiment should be carried out in the open air.

The plated appearance of the articles treated will last for some time if not subjected to too much heat, such as near a fire. Such heat will cause the plated appearance to disappear.—E. C. (Essex).

# A TOTALLY ENCLOSED ELECTRIC MOTOR

## A Simple yet Powerful Motor on Novel Lines

By "ELECTRA"

MOST model electric motors have the great disadvantage of not resembling their prototypes; the appearance of a miniature workshop is greatly increased if a motor such as the one described here is used for the power supply. The prototype of this model may be seen in almost any large factory, as it was designed to work under difficult conditions and occupy a small space. The "works" of the model are readily accessible, as the complete brush gear and commutator is visible on removing the lid.

To make the model, obtain a good round tin about 3 inches in diameter and 1 inch deep. It is impossible to give readers many dimensions in this article, as the tins will differ so much, the original was 3¼ inches in diameter and 1½ inches deep, and was a 2-oz. tobacco tin. In the centre of the tin and lid solder a small square of $\frac{1}{16}$-inch brass and drill them to take a ⅛-inch wire rod, the shaft of the model. These holes should be in the exact centres of the tin and lid (see Fig. 2).


*Fig. 1.—Details of the pole pieces.*

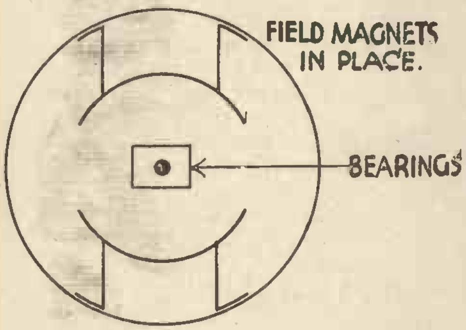



*Fig. 2.—Showing the field magnets in place.*

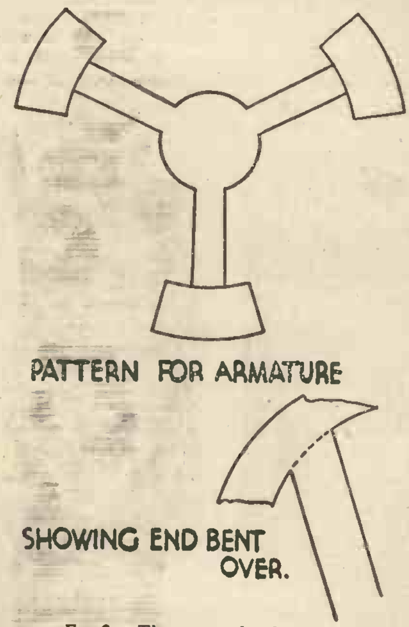



*Fig. 3.—The pattern for the armature.*

### The Field Magnets

These consist of strips of tin ½ inch less in width than the depth of the tin, they are bent as in Fig. 1, and soldered as in Fig. 2.

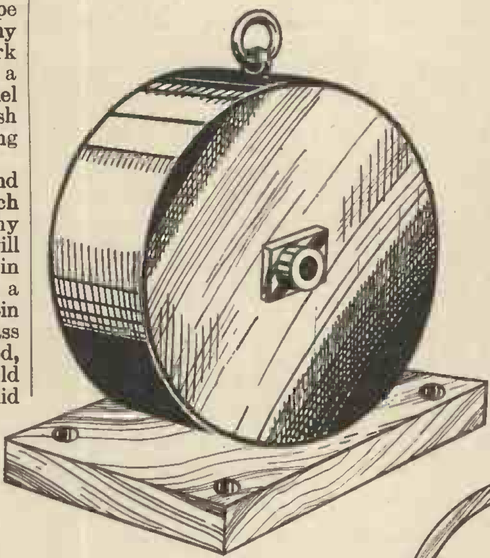


*Fig. 8.—The completed motor.*

The magnets should be wrapped with a few turns of brown paper so that the sharp edges of the metal will not destroy the insulation on the wire. Wind each pole of the field with the same amount of No. 26 D.C.C. wire, putting on as much as possible; the coils should be wound in the same direction and the end of one connected to the beginning of the other—this produces a north and south pole and should be tested by connecting the ends to a pocket lamp refill with a small pocket compass between—the compass needle should point from one pole to the other and remain steady.

### The Armature

This is cut from tinned iron plate, the thicker the better, although a cocoa tin will supply excellent material. The tripolar armature renders the model self-starting. Cut the armature to the pattern of Fig. 3 and bend the ends over at right angles to the main arms, drill it with a suitable hole and solder it on to a 2-inch length of wire rod. Wrap the armature with insulating tape and wind each limb to its maximum capacity with the same wire as used on the field magnets; each coil is wound in the same direction, and the beginning of one is connected to the end of the one just preceding it.

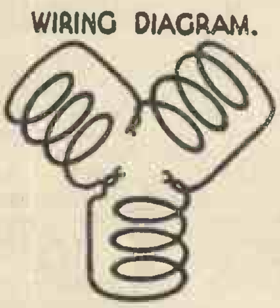



*Fig. 4.—The wiring diagram for the coils.*

The commutator is very simple to make, as it is of the disc type. Cut a circle of hard wood about 1 inch in diameter and drill it to fit tightly on to the armature shaft. Cut three pieces of sheet brass and secure them symmetrically to the disc, using small wood screws. Two screws should be used for each segment and should have their heads countersunk to the level of the metal so that the brushes will pass easily over them (see Fig. 5). Push the commutator close up to the armature and solder the wires to different segments; the wires from the end of coil one and the beginning of coil two are soldered to segment one and similarly with the other two sectors.

The brush requires skill to make, as it must be insulated from the main frame of the model. This is best done by screwing a large disc of three-ply wood inside the lid, on which all the parts are mounted. The brushes are strips, ⅛ inch wide, of springy brass, and must bear quite lightly on the commutator. Two terminals, one of which is insulated from the tin, are fixed to the lid. Secure one brush by means of a *small* round-headed wood screw, taking care that the point does not go right through the wood and touch the metal. The other brush should be secured to a terminal. This terminal is insulated from the tin in the following manner: drill a hole in the wood to take the shank of the terminal, drill a hole in the metal larger than the shank so that the two do not touch, place a large cardboard washer on the terminal and push it through the hole in the wood, place the brush on the other end and screw the nut up as tightly as possible. The model is now electrically complete and should be connected up as in Fig. 7. One end of the field coil is soldered to the tin and the other to the brush that is not connected to a terminal.

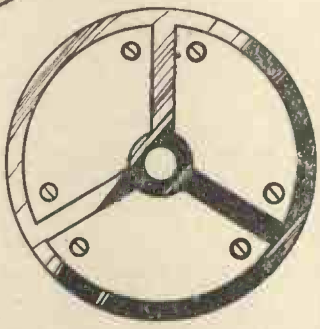


*Fig. 5.—An end view of the commutator.*

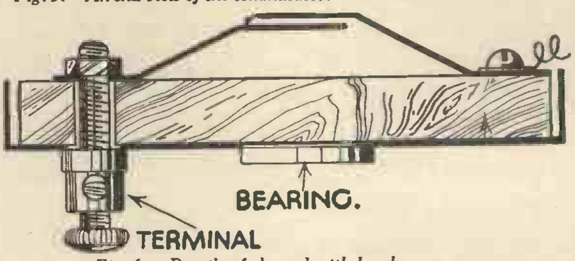



*Fig. 6.—Details of the end with brush gear.*

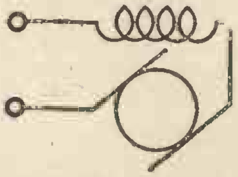


*Fig. 7.—How the apparatus is wired.*

To finish the motor, solder it to a thick metal base.

End play is prevented in the shaft by soldering a small washer on the shaft, and close to the tin.

PRACTICAL ELECTRICITY FOR BEGINNERS—II

# BICHROMATE CELLS AND DRY CELLS

By "ELECTRON"

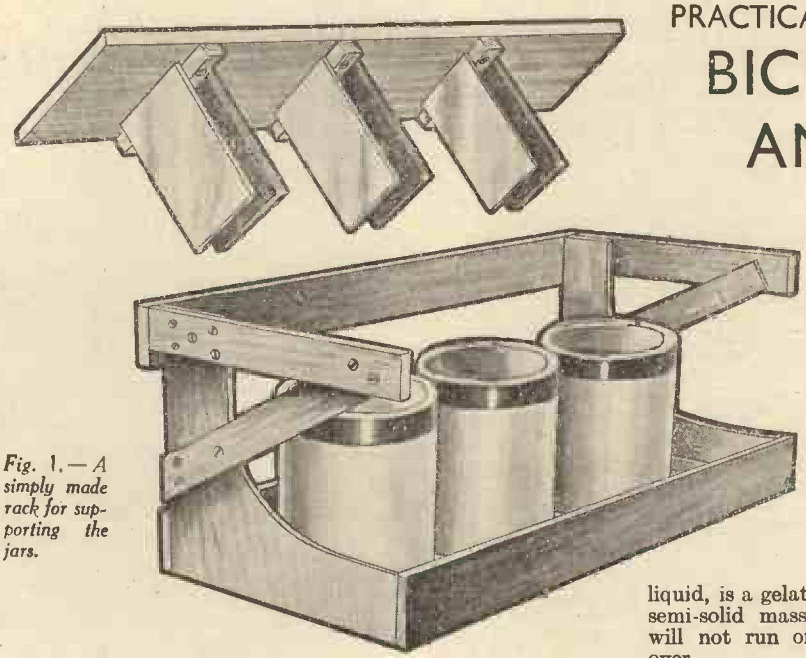


*Fig. 1.—A simply made rack for supporting the jars.*

WHEN two or more cells (in which sulphuric acid, bichromate of potash, or other electrolyte solutions are used) are coupled in series, it would be well to arrange the copper and zinc, or the zinc and carbon, poles on a board, so that all of them may be lowered together into the solution contained in the several jars. A simple arrangement of this kind is shown in Fig. 1, where a rack is built for the jars and, at the top of the end boards, a projecting piece of wood, supported by a bracket, is secured. A narrow piece of board almost the length of the jar rack is fitted with the battery poles, as shown. The carbon and zinc, or copper and zinc, poles are attached to small strips of wood, and these strips in turn are fastened to the under side of the board with brass screws. The poles of the cells are then connected up in series, and when the battery is in use the poles are immersed in the solution contained in the jars. When the battery is at rest, the narrow board should be lifted up and placed on the projecting arms of the rack, so that the liquid on the poles may drain into the jars directly underneath.

### A Plunge Battery

A more simple plunge battery is shown in Fig. 2. A cell rack is made of wood and given two or three coats of shellac. The narrow board on which the battery poles are attached is hung on chains or flexible wires, which in turn are secured to an iron shaft running the entire length of the cell rack. This shaft is of ½-in. round iron, and is held in place at one end by a pin and washer, while at the other the end is filed with a square shoulder, and a handle and crank are fitted to it, so that the shaft may be turned. A small hole, made at the side of the crank when it is hanging down, will receive a hard wood peg, or a steel nail, and this will prevent the crank from slipping when the board holding the poles is raised. The battery poles are to be connected in series along the top of the portable board.

Dry cells are extensively used nowadays, since their cleanliness, high efficiency, and low internal resistance make them preferable to the Leclanché and other open-circuit batteries for light work. In the dry cell the electrolyte, instead of being a liquid, is a gelatinous or semi-solid mass, which will not run or splash over.

Dry cells may be made of almost any size for convenience of handling, but those commonly used vary from 1 to 4 in. in diameter and from 4 to 10 in. high. For bells and general electrical work, a cell 2½ in. in diameter and 7 in. high will be found a convenient size to make and handle.

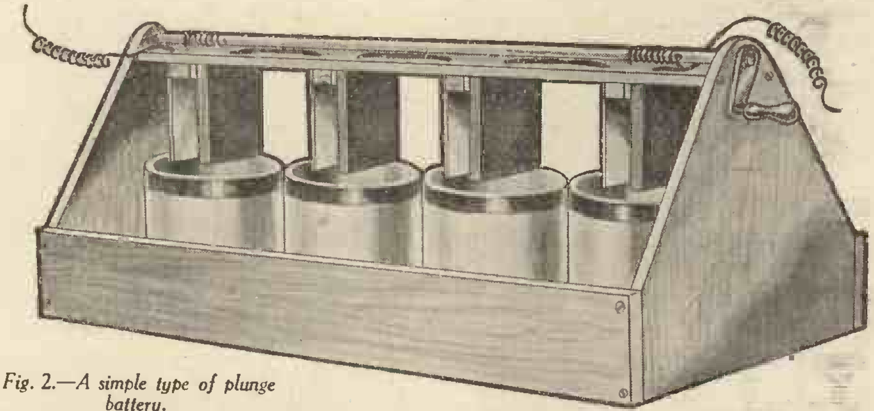


*Fig. 2.—A simple type of plunge battery.*

### A Dry Cell

The component parts of a dry cell are the cell itself (which is made of zinc and acts as the positive pole), the carbon, the electrolyte or active exitant element, and the pitch or tar cap to hold the electrolyte and carbon in place.

From a tinsmith obtain some pieces of sheet zinc, and roll them into cylindrical form, as shown in Fig. 3. The sheets should measure 7 in. × 8 in., and when formed the edges are to be lapped and soldered. From a smaller piece of zinc cut round bottoms, fit them in the cylinders and solder securely.

From an electrical dealer obtain some battery carbons, 1½ in. wide by ½ or ⅜ in. thick and 8 in. long. These should be provided with a terminal at the top so as to make wire connection with the carbon. A strip of zinc or brass should be soldered to the outside upper edge of the zinc cup to which wire may be connected. When the parts are ready for assembly, make a wooden mould a trifle larger than the carbon. This is intended to act as a temporary plunger, and is inserted at first, in place of the carbon pole.

Insert the plunger in the zinc cup and support it so that it will be at least ½ in. above the bottom and centred at the middle of the cup. The electrolyte is then placed in the cup, and, when it has set a little, the wooden plunger is removed and the carbon inserted in its place.

The composition of the electrolyte is as follows: Ammonium chloride, 1 part; zinc chloride, 1 part; plaster of paris, 3 parts; flour, ¾ part; water, 2 parts.

Mix these together and place the compound within the zinc cups, so that the mass settles down and packs closely about the plunger. The space left unfilled about the carbon should be filled with a mixture composed as follows: Ammonium chloride, 1 part; zinc chloride, 1 part; manganese binoxide, 1 part; granulated carbon, 1 part; flour, 1 part; plaster of paris, 3 parts; water, 2 parts.

Do not fill the zinc cup to the top, but leave 1 in. of space, so that ½ in. of sealing material may be added. See that the inside top edge of the zinc cup is clean; then melt some tar or pitch and pour it over the top of the electrolyte. Drive an awl down through the capping material when it is nearly set, and leave the holes open for the escapement of gases.

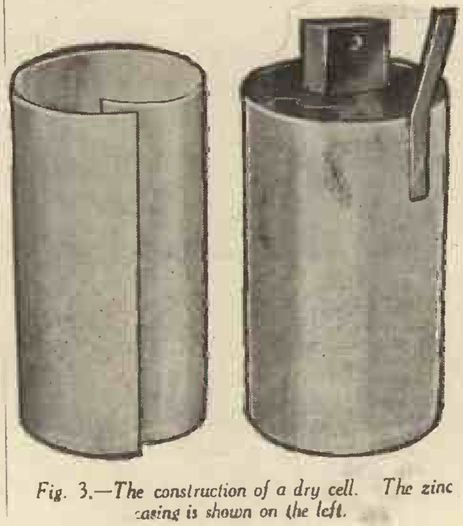


*Fig. 3.—The construction of a dry cell. The zinc casing is shown on the left.*

## WHAT THE CLUBS ARE DOING

*Club Reports for inclusion in this feature should not exceed 250 words in length, and should be received not later than the 12th of each month for inculsion in the subsequent month's issue.*

### THE PARK MODEL AIRCRAFT LEAGUE

AT the third annual general meeting held at the Streatham Hall, on February 2nd last, the following officers were elected for the ensuing year. Committee: G. S. Broadway, President and Chairman; D. J. Jordan, Vice-President; H. H. Love, Hon. Treasurer, 112 Alfriston Road, Clapham, S.W.11; G. L. Rolfe, Hon Organising Secretary, 58a Burnbury Road, Balham, S.W.12; F. H. Dillistone, Hon. Secretary, 112 Rodenhurst Road, Clapham, S.W.4; and Messrs H. W. Beckett, K. H. Carnell, R. A. Foot, H. W. L. Higgins, A. J. Langton, D. H. May and F. J. Saul. Flying Meetings are held regularly on Mitcham and Tooting Commons, which are readily accessible over a wide area. Visitors will always be welcomed. Full details with regard to membership may be obtained from the Hon. Secretary.

### THE INSTITUTE OF SCIENTIFIC RESEARCH

THIS club, though possessing a rather ambitious name, is really a small science society for boys between the ages of 13 and 18. It chiefly deals with chemistry, physics and radio, and has at its disposal two laboratories and extensive apparatus. Visits are frequently paid to places of interest—a power station is being visited shortly—and lectures are sometimes given at meetings, which are held once a fortnight. This club has only recently been formed, and would welcome new members. Persons interested requiring further information should call or write to D. W. F. Mayer, 20 Hollin Park Road, Roundhay, Leeds, 8.

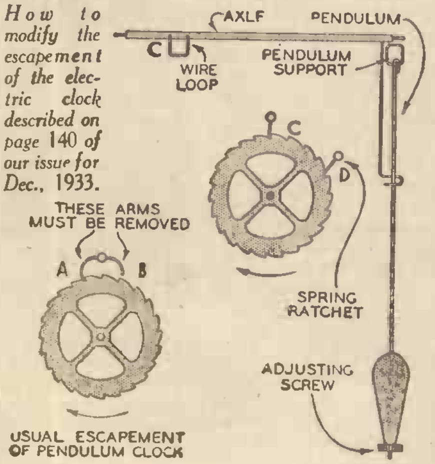
### A Battery-Operated Electric Clock

IN our issue for December last an article appeared under the above title. As a number of readers wrote in asking for the information given below, we have had special drawings made showing how the driving force may be derived from the pendulum.

It is necessary to make a few simple alterations to the clock mechanism, in order that the driving force shall be derived from the pendulum. In the average pendulum clock an escapement is fitted similar to that shown in the sketch. The arms marked A and B must be removed and a loop of fine springy wire soldered in its place, as shown at C. It is also necessary to fit a small spring ratchet, shown at D, in order that the loop C shall not turn the escapement cog in the reverse direction on the return swing of the pendulum.

Clearly when the pendulum is swinging the loop C will engage with a tooth of the cog and move the cog until the ratchet falls into the space between the next two teeth. The pendulum then swings in the reverse direction, and the springy loop C will move over the next tooth and fall behind it and the operation will recommence.

The best position for the loop C must be found by experiment.




*How to modify the escapement of the electric clock described on page 140 of our issue for Dec., 1933.*

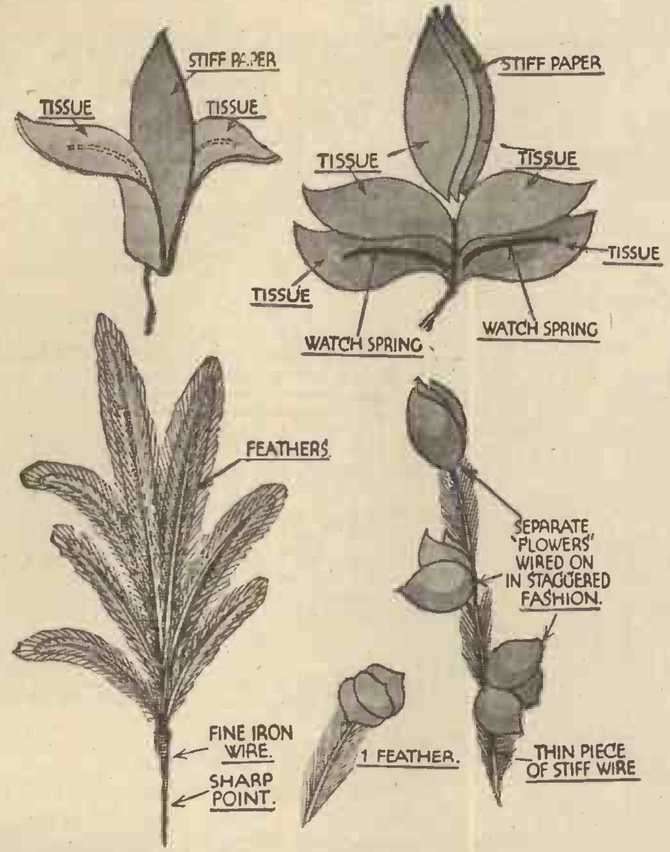



*Fig. 1.—How to make feather and paper flowers.*

# COLLAPSIBLE EFFECTS FOR CONJURING

The production of articles from apparently empty places forms one of the most fascinating conjuring tricks, and the method of making suitable articles is here described by

W. J. DELANEY

THE conjurer of yesterday included as his most important trick the production of a live kicking rabbit from an opera hat, the hat being brought on to the stage in a closed condition and then sprung open in full view of the audience. From the hat an endless variety of articles was produced, and finally the rabbit. Such an item always has the most effect on an audience of any age, and much speculation arises as to "where they come from." It is obvious to any thinking person that the articles produced must collapse in some way, although it might be found difficult to make a rabbit collapse so that it could be concealed in a hat. The law now forbids the use of live animals, etc., for such purposes, and the conjurer is forced to employ a rabbit skin fitted over a spring-wire shape, or a rubber imitation of the real article.

**Rubber Toys**

A visit to any good toy shop will enable you to find dozens of interesting rubber imitations of well-known articles, usually with a squeaker or whistle fitted so that when the object is pressed flat it squeaks or emits some other sound. Such items as bananas, cakes, tablets of soap, etc., are very common. With these articles it is only necessary to pull out the squeaker and you have a splendid prop. I have found, however, that in many cases the hole left after removal of the squeaker is too small to permit of the object assuming its normal size in quick time, and I usually cut the hole with a pair of small buttonhole scissors. The size should be adjusted so that when pressed absolutely flat so that all air is excluded, the article will spring out to full size *immediately* it is released. The bananas form a novel production, and always arouse laughter if produced from a borrowed hat. They should be pressed flat in bundles of three, and then rolled carefully and held in position with a very thin strip of yellow paper, gummed for about ½ in. at the end. In this condition the parcel is easily palmed or otherwise introduced into the borrowed article, and a squeeze or pressure with the thumb will tear the paper band, upon which the bananas will spring out to full size.

There are also a number of rubber toys which have to be blown out, upon which they assume very large dimensions. These may be used for production purposes by placing inside the article a small quantity of suitable powder which will gas freely when a small phial of water is broken into it, or in any other well-known manner.

**"Nests" of Goods**

The Japanese are very adept at making articles which decrease gradually in size and are then packed in a set. In some toy shops it is possible to obtain what is apparently a toy soldier about 6 in. high. If stood on the table it actually covers six more soldiers all standing one over the other in the form of shells. There are other similar objects which may be similarly produced from a borrowed article. It is preferable in these cases, however, to disguise each successive object or produce them "out of order," so that it does not become apparent that they are nested. A popular article for "hikers" is the collapsible aluminium drinking cup, and this may be painted or covered with cloth or paper to disguise it as some other object for the purpose of production. It may be painted red, for instance, and a cardboard disc cemented across the upper end covered with black paint or soil, and a feather flower fixed to the centre. This will be produced as a flower growing in a flower-pot and is a very effective piece of apparatus.

**Feather Goods**

Bouquets and other imitation flowers may be easily made from paper and feathers, and the following instructions will enable a large number of articles to be made up at low cost. Obtain a large quantity of mixed feathers from a poulterer, and soak them in several changes of clean cold water. Get them thoroughly soaked, and keep changing the water until every particle of dirt and every insect has gone. Now obtain some of the popular powder dyes such as are used by the ladies for dyeing silks. You do not need more than four colours, as for stage use contrast is of more importance than a multitude of "shades." Yellow, red, green and purple will enable a very complete range to be produced, and by suitably combining the finished articles in batches of similar colour the effect is very pleasing. Take the feathers whilst still wet, and dip them in the dyes, trying to keep the feathers grouped according to their shape and the type of flower which you desire to make up. Thus, a long thin feather would not be dyed yellow, as there is no flower which is suitable of imitation with such a petal. Green would, however, be suitable, as the feather would then be useful as a leaf. As the feathers are dyed they should be dropped gently on a stretched cloth arranged in a warm room. Cheese cloth, nailed across a wooden frame so that the air can pass through will be found most suitable, and the feathers will dry quickly and cleanly. When dry, carefully cut the feathers to resemble petals, leaves, etc., and bind together in bunches, using fine florists' wire with a touch of good adhesive on the "stalks." Where curved feathers are used, arrange these so that the curve is outwards,

(*Continued on page* 292.)

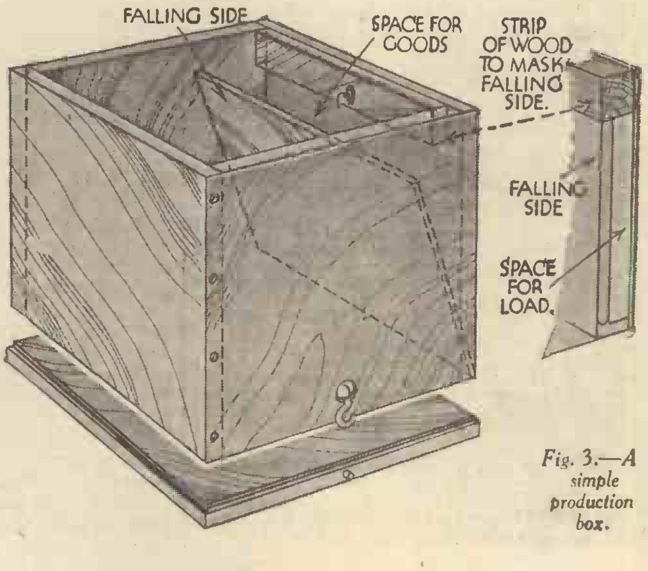



*Fig. 3.—A simple production box.*

COLLAPSIBLE EFFECTS FOR CONJURING

(*Continued from page* 291)

and then the "flower" may be pressed flat and upon being released will spring open.

Paper flowers may be constructed from thin coloured tissue and pieces of watch-spring. The spring should be cut into pieces about 1 in. long, and a number of petals should be cut from different shades of paper, as shown in Fig. 1. From good quality notepaper cut petals of similar size, and stick this in between two pieces of tissue, as shown in the illustration. Two other petals should now be stuck together with a piece of the spring between them, sticking small strips of paper over the portion containing the spring if there is any tendency for the latter to pierce the thin tissue. Each flower should consist of a centre portion with a curved piece attached to each side, and to add to the illusion a thin piece of green crochet cotton should be fixed between the lower edges. The flowers may be left in this condition, to be later bundled into twelve's for production, or they may be tied together to form small clusters. It will be clear that in their normal condition the outer petals are curved, giving an effect something similar to a fleur-de-lis, and to pack them flat they are simply held by the stalk and the fingers are drawn upwards, another flower being added to the now flattened one, and so on, the final packet being secured with cotton.

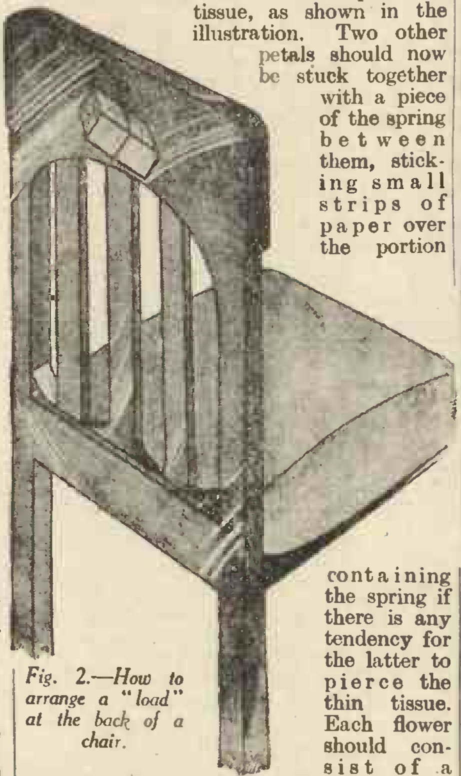
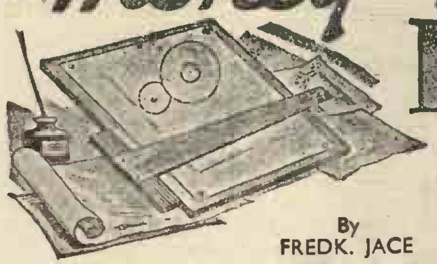


*Fig. 2.—How to arrange a "load" at the back of a chair.*

To introduce these loads into borrowed articles should not be found a difficult matter. One simple scheme is to drive a pin into the back of a chair, as shown in Fig. 2, and to suspend the load by a wire loop from this pin. A hat is borrowed and the hand holding the hat is placed behind the chair back, whilst the other hand takes the front of the seat (a perfectly normal way of handling a chair) in order to place it nearer the front of the stage. Under cover of this movement the load is scooped into the hat as the latter is raised, and the load produced. A very good production box may be constructed as shown in Fig. 3, the actual dimensions being left to the individual requirements. The space to accommodate the loads is obtained by having a false back, not a false bottom, as this is too well known. The back is held in position by a small nail, bent to form a hook. By removing the bottom, or having it hinged at one end, the audience may be "convinced" that the box is empty and free from trickery.

# Money Making IDEAS



Practical Facts, Formulæ and Recipes which may be turned to profitable account. Address all correspondence relating thereto to: The Editor PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton St., Strand, W.C.2.

By FREDK. JACE

### A Freezing Mixture

WITH very little apparatus of the simplest kind readers can make an efficient freezing mixture in the following manner. Liquefy some sulphur dioxide; and then by evaporating it a temperature of about 40 degrees below zero can be obtained. Another useful freezing mixture can be obtained by placing alternative layers of salt and ice in a bucket as shown.

### Preventing Tarnish on Silver

BRUSH alcohol in which a little collodion has been dissolved over silver ware to keep it from tarnishing. The thin invisible coating the solution leaves can readily be removed by dipping the articles in hot water.

### Making Crayons and Chalks

THE only piece of apparatus needed for making coloured crayons and chalks consists of a sheet of stout glass, resting on a board, and another piece of board as a pressure roller. The materials are powdered pipeclay and china clay, curd soap, and, of course, the colouring matter, the latter usually natural earths.

A good mixture is equal parts of china clay and pipeclay; this should be well stirred and then the colouring matter intimately mixed with it. For a black crayon mix 1½ parts of lampblack to every 10 parts of clay, and add ½ part of prussian blue. For coloured crayons or chalks, mix sufficient of the following dry colours to obtain the desired tint. For red, venetian red or carmine; for blue, prussian blue, artificial ultramarine; for yellow, yellow ochre, chrome yellow. From these colours you can get others by judicious mixing. Obtain an ounce of curd soap, shred it finely and dissolve in a pint of water; this is the mixing fluid. Mix this with the pipeclay and colours until a thick mass results, then leave it for two or three days. Knead it well and roll into a ball until it is of the consistency of stiff dough with the minimum of moisture still present.

Place the ball on the glass plate and, by the aid of the wood pressure roller, roll it into lengths and cut into pieces. The crayons should now be laid on a board, each separated from the other, and allowed to dry in a warm room. They will take some little while to dry properly. Many of the crayons sold in the shops are made with a wax basis, using the same colouring matter as for the clay types. They are easily made. For the wax use ceresine of japan wax.

Only melt just a sufficiency of wax for one particular colour. Put the wax in a tin or jar, place the tin into a vessel of water and put over the fire until the wax is melted.

Add plenty of colouring matter and take the vessel off the fire. Lift the tin out and keep the contents stirred until the wax commences to set. Unless you do this the colour will settle to the bottom. Turn the mass out of the tin on to the glass plate and roll into lengths, then cut off and leave to set hard.

### Cream-Colour Paint for Table Oilcloths

USE white lead or zinc white ground in oil, with 4 oz. of patent driers to the pound, and enough boiled linseed oil to make it flow. This paint should be applied in a warm room and dried rapidly while hung in a room heated by flues running along the floor. The cloth should previously be coated with a thick boiled starch or with glue size.

### Etching on Glass—Correction

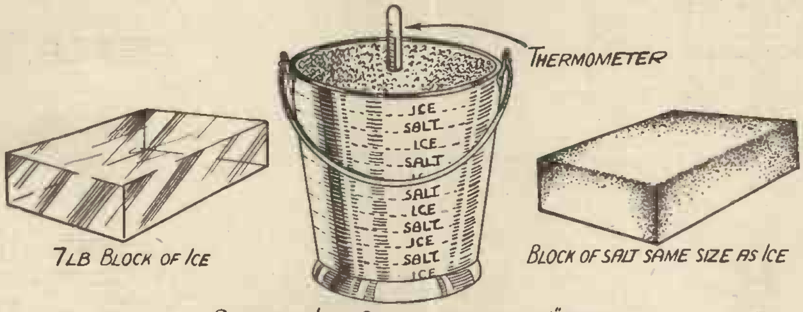
ON page 176 of our January issue we stated that when concentrated sulphuric acid acts on fluor-spar *fluorine* is evolved. Unfortunately, this was a printer's error, and should have read *hydrofluoric acid gas*, and not *fluorine*, is evolved.

### Renovating Linoleum

THE following treatment revives the colours and improves the appearance. Spread out the linoleum flat, wash thoroughly with soda and water to remove the dirt and grease, and allow to dry thoroughly. The linoleum should then be well stretched and tacked down all round the edges. Now apply two thin coats of varnish, made by mixing together 3 pints of elastic oak varnish and ½ pint of japan gold size. Let the first coat dry thoroughly before applying the next; about fourteen days should be allowed to elapse before placing anything heavy on the linoleum. The addition of gold size makes the varnish harder and causes it to dry more rapidly. The above proportion should not be exceeded, otherwise the varnish will crack. By re-varnishing the linoleum every year it will last an indefinite time.

### Preserving Birds' Eggs

THE only good method of preserving birds' eggs in their natural colours is to keep them in the dark, when they will suffer little from fading. Never use varnish to the shell; it imparts a gloss which is not natural. House your specimens in a cabinet with drawers, and not in a case with a glass lid exposed to the light. The drawers should be divided by partitions into squares or oblongs according to the size and shape of egg or eggs they are intended to contain; the eggs may be laid on cedar sawdust, which is an effectual preservation against insects.




*The apparatus for making a useful freezing mixture.*

### Japanese Dwarf Trees

THE dwarf trees, which share with cherry blossom the floral fame of Japan, are a speciality of that country. The tiny trees—some but 6 in. to 18 in. high—are the result of many years of patient training. The Japanese gardeners grow them from seed, in small pots to confine the roots, and stunt the growth of the tree, thus keeping back nature; the trees are given very little light and water. This appears to be the only method, but the Japanese gardeners are experienced in this cultivation of dwarf trees, and it is doubtful if you could attain success with such an experiment. In Japan some of these tiny trees are valuable. I have read of a willow, 6 in. high, selling for 7,000 yen (£700). In Japan the dwarfs are kept in the shade by means of light canvas or blinds.

### Casting Brass in Iron Moulds

SMALL brass castings may readily be made in iron moulds if due care is taken to allow the air to escape from the mould. Sand is, however, the most common means, since, being porous in nature, it allows all the heated gases generated during pouring to be absorbed. To prevent the castings adhering, the moulds would have to be dressed each time with a mixture composed of melted Russian tallow and a little charcoal. This should be applied sparingly with a brush, a little best flour charcoal being afterwards sifted over from a muslin bag.

# ASTRONOMY FOR AMATEURS

## RING MOUNTAINS OF THE MOON

By N. de NULLY

AT 7 a.m. on the 21st inst. the sun will enter the Zodiacal sign Aries (the Ram). This will mark the Spring Equinox, when the days and nights will be of equal length all over the world. Moreover, as at that time the sun will reach the celestial equator, winter will officially end and spring commence. In districts free from glare and smoke the Zodiacal Light may be looked for in the middle of the month. When visible, it appears soon after sunset as a huge cone of pale luminosity, pointing upwards in a slanting direction from that part of the horizon where the sun disappears.

### The Moon

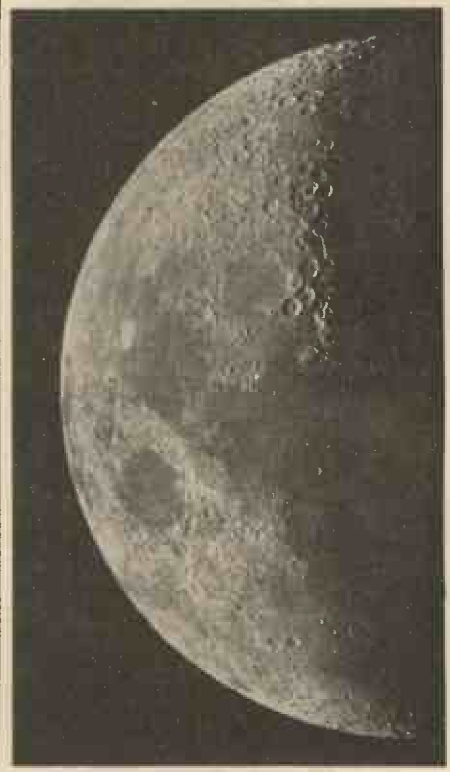
After the full phase on the 1st inst., an examination of the surface features may be recommenced. As sunlight begins to draw off the disc, the chain of great walled plains mentioned last January will again come into sharp relief, but under afternoon illumination. The evening of the 2nd inst. will probably show them to best advantage, and their sites may be discerned on the photograph as white patches parallel with the upper sector of the rim. Farther down, so to speak, lies the dusky expanse of the Mare Crisium; while rocky highlands, pitted with "craters," stretch from this so-called "sea" to the north polar regions (at the bottom of the picture). Conspicuous among the circular cavities are two, named Atlas and Hercules, which can be recognised by their proximity to each other. Both are 50 miles across, and many peaks on their enclosing ridges tower as high as 11,000 ft.

In the much broken area of the southern hemisphere (the upper half) a striking group of three ring mountains can be observed emerging from the inky darkness of the lunar night. The lowest (but, of course, the most northerly) is Theophilus, over 60 miles in diameter, with mighty ramparts rising at places to 18,000 ft. Its well-defined central cone stands nearly 6,000 ft. above the interior and covers an area of 300 square miles. The massive border of Theophilus encroaches considerably upon that of its next-door neighbour, Cyrillus, which is about the same size and notable for its undulating ridges, suggestive of congealed streams of ancient lava flows. Catherina, the most southerly formation of the three, and also the largest, is less regular in outline with lower walls. Another smaller "crater" is situated on the slopes between Cyrillus and Catherina. Space does not permit of a more extended description of this part of the lunar disc, so the amateur must explore it for himself. The photograph (which is, of course, inverted as seen in an astronomical telescope) depicts the phase of the moon as it will appear on the 22nd inst.; and all the detail shown will be visible in a good instrument having a 3-in. object glass, or even a smaller one, if atmospheric conditions are favourable.

The origin of the moon's unique surface irregularities is variously ascribed to meteoric bombardments or the bursting of gigantic gas bubbles while still in a heated plastic state, or to subsequent volcanic action.

### The Planets

Mercury, Mars and Saturn are of little practical interest to amateurs just now. Venus is a "Morning Star," and will once more be at maximum brilliance on the 11th inst., when it will rise slightly south of east at 4.30 a.m. Jupiter is coming into convenient view, and, at the beginning of the month, will rise in the east at 9 p.m., getting gradually earlier until, at the end of March, it will rise at 7.30 p.m. The planet will pass the bright star, Spica, in the constellation Virgo (the Virgin) on the night of the 12th inst. Jupiter's equatorial "belts" and four principal satellites may, on clear evenings, be easily seen through a small astronomical telescope. The following eclipse phenomena of the planet's moons are scheduled to occur between dusk and midnight this month, viz., disappearance of Sat. II at 10.22 p.m. on the 13th; disappearance of Sat. III at 9.8 p.m. on the 15th, and its reappearance at 11.31 p.m. the same night. Disappearance of Sat. I at 11.24 p.m. on the 20th. Eyepieces magnifying about 50 diameters will be sufficient to observe the eclipses; but powers of 100 to 150 will be needed to show the belts as anything more than dark stripes.



*The moon when six days old. (From a photograph taken by M. Puiseux with the 24-inch reflecting telescope at the Paris Observatory.)*

On clear moonless nights between the 6th and the 16th the sky will present a splendid panorama of bright stars. The constellations Auriga, Taurus, Orion and Canis Major continue to be displayed in the south-west. Above the last-named and almost due south, is Canis Minor (the Lesser Dog), with its chief star, Procyon. Higher up, nearly overhead, is Gemini (the Twins), marked by the prominent pair, Castor and Pollux. In the seemingly single point of light, Castor, we have a system of six suns. A 3-in. telescope will divide the star into two and the spectroscope pronounces each of these components to be also double. In addition, there is an even more minute pair, and each couple revolves around a common centre of gravity.

# AROUND THE TRADE

*BRIEF ITEMS AND TOPICAL THOUGHTS CONCERNING MANUFACTURES AND THEIR PRODUCTS*

## Soldering Difficulties Removed

THE proprietors of Fluxite, West Lane Works, Rotherhithe, London, S.E.16, have a very handy book on the subject which removes many of the difficulties which have hitherto been associated with the problem of soldering. Although it costs 9*d*., it will save its cost in a very short time in the experience you will gain from it. This book is included in the Fluxite pocket soldering set, price 7*s*. 6*d*. Tins of Fluxite are also obtainable at 4*d*., 8*d*., 1*s*. 4*d*. and 2*s*. 8*d*.

## Luminous Paint

AIRCRAFT products, 87 New Oxford Street, W.C.1, have recently introduced to the market a luminous paint which is sold at the reasonable price of 1*s*. 9*d*. a bottle. It can be used to paint your watch and clock dials, door bell pushes, light switches, match boxes, keyholes, rear cycle mudguards, and numerous other things you want to see in the dark. It is extra strong, and when applied gives a phosphorous enamel effect. Quite simple to use, a 1*s*. 9*d*. bottle contains enough paint for 100 jobs. If you desire more than one bottle you can obtain three bottles for 5*s*. post free.

## For the Workshop

MESSRS. Ward and Pollard, Orchard Works, High Street, Plumstead, S.E.18, have recently issued a pamphlet introducing their D.T. (Duplex Tailstock) 3½-in. centre backgeared lathe, Model "B." This lathe is a fine piece of workmanship, designed for use in small workshops, and is manufactured from first-class materials to close limits of accuracy. The bed is of substantial proportions with no apertures for chips to collect. A feature of the tailstock is that it can be used as an ordinary screw-feed or as a sensitive lever-feed tailstock, conversion from one to the other taking a few seconds. A set-over adjustment is provided for turning long tapers. The headstock is adjustable to allow the full width of the gap to be utilised, and the slides and backgear have a number of ingenious features. The lathe costs £5 10*s*. and is excellent value for money. Write to the above firm, who are only too willing to provide full details of the lathe.

## FIRST ANNUAL "SKYBIRD" LEAGUE CLUB RALLY

THE First Annual Club Rally of the "Skybird" League and competition for Scale Model Aircraft has been arranged in co-operation with Messrs. Hamleys, of Regent Street, whose Directors have kindly offered to give the space at their Regent Street Store from March 19th until April 7th. Full particulars are being sent to all Club Leaders.

A handsome silver cup and other prizes will be offered for annual competition, and these will be held by the Winning Club for one year. Cash prizes will also be awarded and these will go to the assistance of Club funds

Capt. W. E. Johns has kindly consented to assist in the judging.

The photograph shows the "Skybird's" Anti-

*The "Skybird's" anti-aircraft gun in action.*

Aircraft Gun in action. This latest accessory costs 1*s*. 9*d*. for the gun and crew of five. The angle of this gun can be varied by means of the adjusting wheels at the side. Some of the new models now ready are No. 16. Armstrong Whitworth A.W. XV. "Atalanta." This model has a span of 15 in., the largest in the series. The four cast model Armstrong-Siddeley "Serval" engines are a unique feature. Price 10*s*. 6*d*. No. 17. De Havilland "Gipsy III Moth." The new standard model "Moth" makes a fine addition to the range. Price 2*s*. No. 18. Percival "Gull." The very fast light aeroplane which has obtained such rapid popularity. This model has the unique novelty of folding wings. Price 2*s*. 6*d*.

# REPLIES TO QUERIES & ENQUIRIES

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page 300. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

## Arc Lamps for Producing X-Rays

**"SIR,—Can you inform me how to construct an arc light which is capable of giving X-rays. There is no need to go into great detail, but I should like to know whether it is just a matter of carbons and resistance in a straightforward circuit. (R. G., Epsom.)**

We regret that we know of no arc lamp for producing X-rays. These rays are usually obtained from a special vacuum tube in conjunction with an induction coil.

## Cementing a Photographic Lens

**"Sir,—Is it reasonably possible for a cementing photographic lens to be separated in order to remove what appears to be a 'damp' stain from its inner surfaces. If so, what cement should be used to re-cement the pieces, and is it supplied only at the edge or over the entire surface of the join?" (S. P., Somerset.)**

If the lens is a valuable one we would advise you to return it to the makers for their attention.

If, however, you decide to attempt the job yourself, try soaking the lens in methylated spirit overnight, and then try and pull the glasses apart with the fingers. If this fails heat the lens gradually in an oven and then try and separate the glasses. These two methods may be tried alternately, but don't put the hot glass into methylated spirit or it will crack.

To re-cement the lens clean the glasses carefully and warm them. While warm, drop a single spot of Canada Balsam into the concave lens and press the other lens into place. The balsam should spread all over the surface and squeeze out at the edges. Leave under pressure for about a day, using either a weight or a screw clamp padded with cork.

## Visibility of Saturn's Rings

**"Sir,—Can you tell me the minimum magnification of an astronomical telescope before observing clearly the rings of the planet Saturn? I should also be very glad if you would tell me round about what price such an instrument would cost." (J. H., Woolwich.)**

A magnifying power of about 30 diameters seems to be the minimum on a 2-inch astronomical telescope that will clearly show the rings as such, and also Titan, the brightest moon. Much, however, will depend on the keenness of the observer's vision, the clarity of the atmosphere, and the quality of the optical parts of the telescope. It really needs an instrument with a 3-in. achromatic object glass or a reflecting telescope with a 4-in. or 6-in. mirror, using powers of 100 to 150, to yield satisfying views. Either should be purchasable for from £5 to £10, and the best value is often obtainable from reputable dealers in second-hand optical goods. A 2-in. would cost less but be inadequate for practical purposes.

## Experiments with an Electro-Magnet

**"Sir,—I desire to experiment with an electric magnet of the solenoid type. I require it for a 12-volt circuit and a current of about 2 to 3 amperes. I should like to know the following details in connection with it: (1) What gauge and what insulation covering should be on the wire? (2) What should the bobbin be made of? (3) How much wire shall I require? (4) Where can I purchase the above component parts?" (R. L., Boscombe.)**

Four pounds of No. 16 D.C.C. wire are required, and this should be wound on brass formers of No. 26 gauge material. The magnet consists of two rods, ¾ in. in diameter and 6 in. long, of wrought iron, which are screwed into a yoke of the same material measuring 3 × 7 × ¾ in.; this should be mounted on a suitable wooden base. The coils are wound in opposite directions and the ends left free, so that the coils may be connected in series or parallel, or only one used at a time. The pole pieces should be filed smooth and flat, so that specially-shaped ends may be used. The components may be purchased from the Grafton Electric Co., 54 Grafton Street, London, W.1.

## A Wireless Query

**"Sir,—I have a five-valve set, and if I use an aerial where should the lead-in be attached?" (G. R., no address.)**

We are in receipt of your letter, but as you do not give any particulars of your receiver, it is difficult to give you the assistance we should like. It can be stated as a general rule, however, that the aerial should be connected through a ·0003-mfd. preset condenser to the grid terminal on the first valveholder.

## Making Gramophone Records

**"Sir,—Could you give me any information on how I can make up a solution fairly cheaply that could be poured into a mould and then placed in an oven with gentle heat that would harden this to about the hardness and texture of a gramophone record. The moulds will give sizes about 9 in. by ¼ in. thick, and I should like the result to be not too brittle. If you cannot give it in semi-liquid form, could you give it in a plastic form? When hardening it should not contract to any extent. Colour is not important." (F. Y., Sunderland.)**

Some twelve months ago I put in a considerable amount of time in research on this subject, my object being the same apparently as querist's—the production of a permanent sound track on a disc subsequently to be case-hardened. I investigated the possibilities of aldehyde resins, bakelite, the "plastics," "Celostoid," cellulose esters, hydrates, silica and even tar, eventually giving up the job, convinced that an elaborate moulding and pressing plant would be absolutely necessary.

It is now possible to buy blank discs, which can be cut almost as easily as wax, and which may be then hardened by baking in an oven for a prescribed length of time. The result is a record of great hardness and permanency. I can speak from experience of these as we have given them exhaustive tests.

Permarec blank discs. Sold by Musikon Ltd. They are 10 in. in diameter and retail at 3*s*. each.

## A Chemistry Query

**"Sir,—Can you tell me the names and a few substances with boiling points of approximately 250°, 300°, 350° and 400° F. at normal pressure? As I require an even temperature for certain chemistry experiments I am conducting, please let me have the names of substances which are easy to obtain and not expensive." (E. W., Hastings.)**

250° F. (129° C.).—An aqueous saturated solution of sodium acetate. The boiling point is 124° C.

300° F. (149° C.).—Xylene, 96 parts. Toluene, 4 parts. Boiling point is 140° C.

350° F. (177° C.).—An aqueous saturated solution of calcium chloride. Boiling point is 179° C.

400° F. (204° C.).—Glycerine. Decomposition point about 200° C.

## Making a Gas Mask

**"Sir,—In January's issue of 'Practical Mechanics' a correspondent (S. C., Oldham) asks how to make a gas mask. Can you answer the following queries regarding same? (1) Does the filter remove the highly-toxic gases, such as phosgene 'mustard gas' or tear gas? (2) What material is the actual mask? (3) Is it necessary to keep filter of charcoal or chemicals airtight before and after use? (R. W., Eastbourne.)**

The gas mask would be of questionable efficiency in combating the gases mentioned. It is designed as requested by "S. C." for use in a laboratory, and would be quite effective in coping with average suffocating gases found therein.

The material used should be of non-porous fabric—fabric coated with rubber latex is ideal. In shape it may be fashioned so that it fits completely over the head, being retained in position by either tapes or elastic encircling the neck. On the other hand, the mask may be of the respirator type, *i.e.*, covering nose and mouth. Exhaled air is passed out *via* a rubber flap valve.

There is no necessity to enclose the filter when the mask is not in use, as it contains no volatile substances.

## Making Infra-Red Plates

**"Sir,—Can you tell me how photographic plates which are sensitive to infra-red light are prepared, and also how they are developed? Could an infra-red light filter be used in conjunction with an ordinary plate instead of a special plate?" (S. W., Romford.)**

The process of manufacturing infra-red plates is too complicated a matter to describe in an answer to a query, but it may be said that the chief difference in the preparation of an ordinary photographic plate and one sensitive to the infra-red rays is the inclusion in the emulsion of a recently discovered dye which makes the emulsion sensitive to these rays.

Development of infra-red plates is carried out in exactly the same way as ordinary panchromatic plates, except that it is possible to obtain a fairly bright green safelight for use in a dark-room lamp, and thus to some extent the progress of development can be watched. This special safelight for infra-red plate development is obtainable from either Ilford or Kodak.

It is useless to employ an infra-red filter in conjunction with an ordinary plate, as this is not sensitive to infra-red rays.

# Patent Advice

By A. MILWARD

**The services of a professional Patent Expert are available free to every reader. He will advise you on the validity, novelty, and value of any idea you may have. No charge is made for this service, but the Query Coupon appearing in our advertisement pages must be enclosed with every query.**

## SOME EARLY PATENTS FOR INVENTIONS

(*continued*)

IN the manufacture of iron, which dates back many hundreds of years B.C. and was almost exclusively manufactured in Sussex during the fourteenth and fifteenth centuries because of the abundance of timber there, it was the practice to employ charcoal in smelting the iron. In the reign of Elizabeth the large consumption of timber for making charcoal had become such a serious matter that an Act of Parliament was passed prohibiting the further extension of iron works in an endeavour to conserve the growing timber of the country, particularly for use in ship building, so that any invention which would prevent deforestation would clearly be of benefit to the community. The necessity of conserving the timber of the country gave opportunity to the inventor, who appeared in 1611 in the person of one Simon Sturtevant. Sturtevant claimed amongst other things to have discovered how to smelt iron without employing "char-coale" and petitioned James I. for a Patent to be granted him for "*working, melting and effecting of iron, steele and other mettles with Sea-coale or Pit-coale, the principall end of which invention is that the woods and timbers of our country might be saved, maintained and served from the great consumption and waste of our common furnaces and iron-milnes which as they now ordinarily built and framed can burne, spend and consume no other fewell than char-coale, the which device, if it may be effected accordingly (as I make no doubt but by God's blessing I shall) will prove to bee the best and most profitable business and invention that ever was known or invented in England these many years.*"

### An Estimate of Profit

It will be observed that even this early inventor had the sanguine temperament which even to-day is the attribute of the modern inventor, moreover his expectation of profits would even credit a present-day company promotor, as witness the following naïve estimate of profit: "*They are planted already in England and Wales 800 milnes for the making of Iron, for there are foure hundred milnes in Surry, Kent and Sussex as the townsmen of Haslemore have testified and numbered unto mee; there are also 200 milnes in Wales and 20 in Nottinghamshire, as the author hath been credibly informed. Now wee may well suppose that all England, Scotland and Ireland (besides the aforenamed shires) will make up the number of 180 milnes more, being in all 800 milnes. Moreover, one milne alone spendeth yearly in char-coale 500 pound and more as diverse clarks and workmen in iron businesses have credibly testified which in pit-coale will be done with the charges of 30 or 40 pounds after the inventioners manner and invention or at the most with 50 pound where carriage is farre and chargeable so that the invention in the 800 iron milnes will save and gaine—declaro—the owners of those milnes 320 thousand pounds yearly over and above their ordinary and annual gaines. Besides this three hundred and twenty thousand pounds, an estimate of a further ten thousand pounds is expected to be made from using the invention in connection with 'lead, tinne, copper, brasse and glass-mettle' and besides this, there are the profits to be made from twenty other inventions comprised in the patent.*"

James I. accordingly granted a Patent on February 29th, 1611, to Simon Sturtevant for thirty-one years, subject to the profits being divided into thirty-three parts, ten of which were to go to the King (James I.), five parts to Prince Henry (eldest son of James I.), two parts to Prince Charles (Duke of York, second son of James I.), one part to Viscount Rochester, one part to Simon Sturtevant, and fourteen parts to the "disbursers of the money for the tryall and effecting of the said inventions." It will be noted that in these early days the inventor has to be satisfied with a very small proportion of the profits.

### A Fresh Grant to J. Rovenson

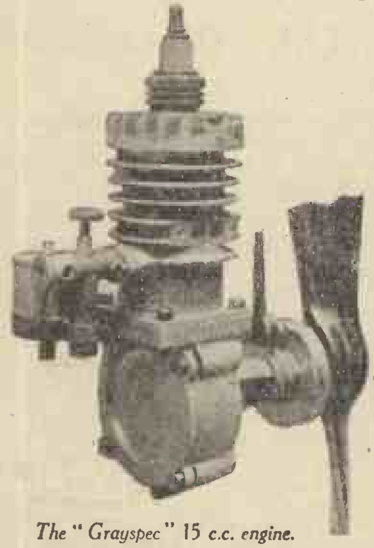
Although this Patent was originally granted for thirty-one years in 1611, it was cancelled in 1612 when a fresh grant for thirty-one years was made by James I. to John Rovenson for the making of iron and other materials with Sea-cole and Pit-cole. From this Patent (the profits from which were to be appointed as in the first grant, *i.e.*, only one part of thirty-three parts to the patentee, John Rovenson), it appears that the original Patent granted to Simon Sturtevant was made "*voyd, by reason of his standing out-lawed at the time of the grant, and so still continuing and by his neglect and not performance of his workes.*"

This Patent, like that granted to S. Sturtevant, was not confined to the manufacture of iron or the use of "sea-cole" for various purposes, it also included a new kind of "artificial cloth" for windmill sails made of linen or wool, or both mixed together, a new method of weaving so that the cloth was of a different colour on its two sides, devices for pulling up roots of trees and sawing timber, devices for halving the power required for the draft of carts, ploughs and boats, "*certain new deviced carriages, carts or waines to bee made to go or travell alone,*" apparently the description of a motor road vehicle, a new digging device which with the "*labour of two men shall perform as much as twenty men*"; "*presse and mould for making of presse wares,*" new kilns and furnaces, "*a new devised luminary of glasse filled with water and a candle placed to give light through it, which giveth a very great light a great distance off with small charge.*"

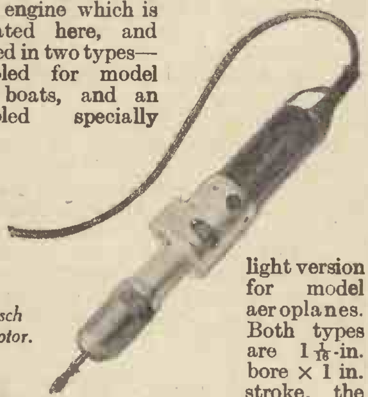

A Review of the Latest Devices for The Amateur Mechanic. *The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

### The "Grayspec" 15 c.c. Petrol Engine

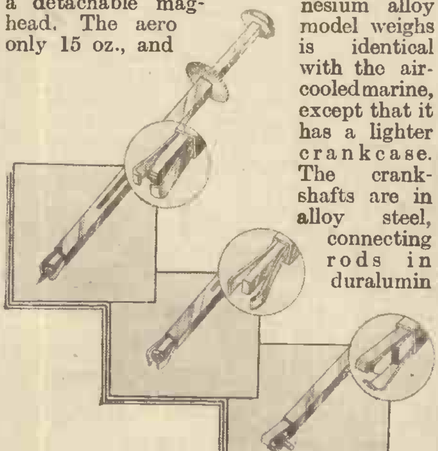
BEARING in mind the great amount of interest evinced in miniature petrol engines the attention of the reader is drawn to the 15 c.c. two-stroke "Grayspec" petrol engine which is illustrated here, and supplied in two types—air-cooled for model speed boats, and an air-cooled specially light version for model aeroplanes. Both types are $1\frac{1}{16}$-in. bore × 1 in. stroke, the marine model being intended for fast and racing boats, and having the cylinder in magnesium alloy with iron liner and a detachable magnesium alloy head. The aero model weighs only 15 oz., and is identical with the air-cooled marine, except that it has a lighter crankcase. The crankshafts are in alloy steel, connecting rods in duralumin with roller bearing big-ends or plain bush bearing, as desired. In both types piston and crankcase are in magnesium alloy. Complete sets of parts are available, or complete engines, and the carburetter can be supplied either with or without float chamber. The engines run left-hand facing the propeller, and the weight of the engine without ignition coil, condenser, carburetter and propeller is 14 oz., whilst the weight of the coil is 7½ oz., and the weight of the condenser 1 oz. The castings of the complete model are reasonable in price, and for full particulars apply to E. Gray & Sons, Ltd., 18-20, Clerkenwell Road, London, E.C. [37]



*The "Grayspec" 15 c.c. engine.*



*The Bosch hand motor.*



*Screw and nut setters.*

### Universal Electric Hand Motor

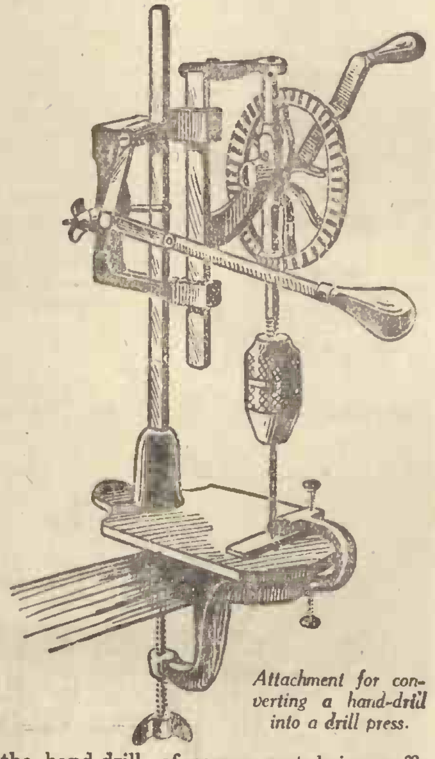
A HANDY and light electric hand motor has recently been marketed by the well-known firm of Bosch. It can be used for numerous purposes, such as finishing off dyes and moulds, machining patterns, fettling castings and welds, removing burrs, cutting oil grooves, etc. A complete range of tools and accessories for a wide variety of purposes is also supplied. [38]

### Handy Screwdriver

A HANDY and neat form of screw-setter has recently been marketed at the low price of 2*s.* 6*d.* It consists of a square barrel with a knurled grip and a square section steel plunger to the lower end of which is secured two spring grips which grasp the screw whilst the driver blade seats firmly in the screw slot. It may also be used for nuts. It is thus a one-hand tool and particularly useful when operating on screws and nuts which are situated in awkward places. [39]

### A Drill Press Adaptor

AMATEUR mechanics and model makers generally at some time or another feel the need for a small drill press, the hand-drill, of course, not being sufficiently accurate to enable holes to be drilled exactly upright. The attachment illustrated enables an ordinary hand-press to be converted into a pillar drill in a few seconds. The feed is supplied by means of a lever and the table enables work up to 7½ inches thick to be operated upon.



*Attachment for converting a hand-drill into a drill press.*

# The Latest Novelties

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

### Silver Soldering and Brazing Tool

THE illustration shows a self-blowing blow-pipe which will be found extremely useful by the handyman and the mechanic for silver soldering and brazing. It operates from any gas tube, and will be found of immense use in model making, and also for engineers, metal-workers, tool-makers, garage men, etc. It is made in three sizes, inclusive of a blow-pipe—12*s.* 6*d.*, 7*s.* 6*d.*, and 5*s.* [39]

*Auto - blowpipe for brazing and silver soldering.*

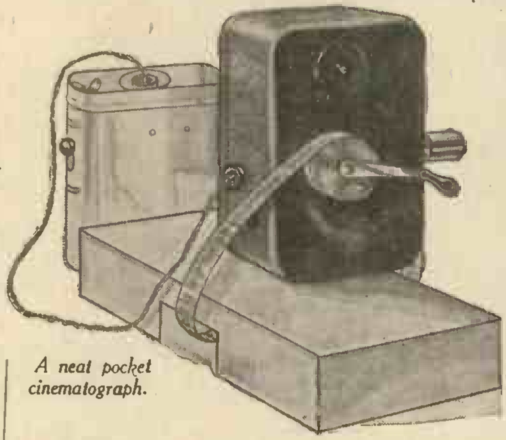
### Dark-room Timer for Photographers

A DEVICE which photographers will appreciate, particularly panchromatic and colour-plate workers, is the new kind of luminous watch illustrated on this page. The large figures on the outer edge indicate seconds, and on the inner scale from 0 to 10 minutes. A pressure of the knob at the top starts the two luminous hands from zero, a second pressure stops them, and a further pressure returns them to zero again. [40]

*Luminous stop-watch for the dark room.*

### An All-in-One Tool

A HANDY universal tool which may be used for slotting, scraping, slitting, sawing, bearing-scraping, filing, belt repairs, etc., is illustrated at the foot of this page. It consists of a well finished and pleasing shaped handle and a series of blades, scrapers, and a file. It is of immense use for undercutting the mica of commutators, has a hack-saw for finishing metal surfaces, scraping bearings, etc., etc. The handyman should particularly welcome it as it is a compact general outfit housed in a metal container 6 in. × 1¾ in. × 1 in. It costs 5*s.* [41]



*A neat pocket cinematograph.*

### A Micro-Cinematograph

AN ingenious micro-cinematograph which is hand-operated but illuminated by means of a flash-lamp battery has recently been marketed at the extremely low price of 18*s.* 6*d.* It takes films of the 9·5 mm. style, and the one which we tested gave reasonably brilliant pictures. Not only may it be used for projection, but also for viewing films in daylight. It is well made, and can easily be slipped into the pocket. It measures only 4 in. × 2¼ in. × 1 in. [42]

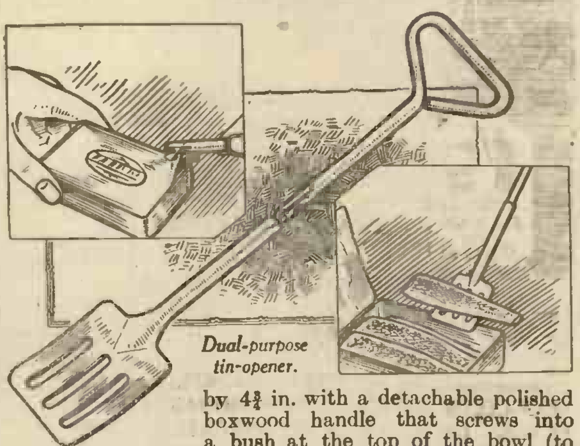
*Ingenious new bottle stopper which hermetically seals the bottle.*

### New Style of Bottle Stopper

AN ingenious new bottle stopper which hermetically seals any bottle is shown here. It is made in a variety of sizes to suit differing neck diameters, and when inserted in the bottle a turn of the screw completely seals the bottle. [43]

### Improving the Tin Opener

SEVERAL firms marketing tinned foods are now supplying a grooved spoon in addition to the ordinary slotted tin-opener, so that the food may be eaten when on a picnic. The spoon portion has a tubular shank into which the tin-opener end slides. It is illustrated below. [44]



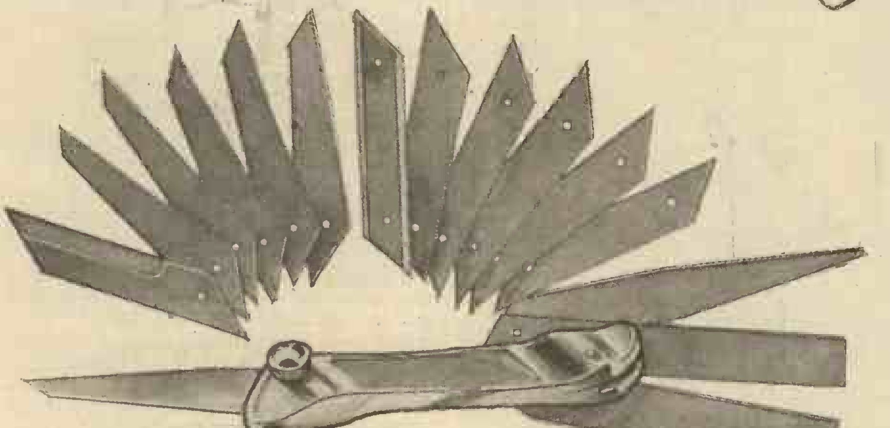
*Dual-purpose tin-opener.*

### An Electric Cooker

A SIMPLE and cheap electric cooker consisting of a polished aluminium bowl 9 in. in diameter by 4¾ in. with a detachable polished boxwood handle that screws into a bush at the top of the bowl (to grip the element spindle for regulating cooking) is now on the market. The heating unit is a one-piece double-plated disc 5½ in. in diameter, the back plate having a spindle rising from the centre 1 in. thick, at the top of which is a bayonet connection. The whole is cadmium plated, the cooking surface being highly polished. The connecting lead is a 4-ft. length of rubber flex fitted with a bakelite plug adapter at one end and a highly plated bayonet holder at the other for connecting to the element. It costs 21*s.* A novel feature of this cooker is that it can be used for violet ray treatment by attaching a special lamp. [45]

### Atom Minor develops ·315 B.H.P.

JUST as we go to press we learn from Mr. A. E. Jones that one of his 15 c.c. petrol engines, under a witnessed test, developed, under a brake test, the amazing power of ·315 h.p.



*A handy combination tool set.*

# Catalogues and Publications Received

## OUR FREE CATALOGUE SERVICE

*To save readers trouble, we undertake to send on catalogues of any of our advertisers. Merely state on a postcard the number (or numbers) appearing at the end of the paragraphs below and address it to "Catalogue," PRACTICAL MECHANICS, Geo. Newnes Ltd., 8/11 Southampton Street, Strand, London, W.C.2. Where advertisers make a charge, or require postage, this should be sent with applications for catalogues. No other correspondence whatsoever should be enclosed.*

### Telescopes and Microscopes

MESSRS. BROADHURST, CLARKSON & CO., 63, Farringdon Road, London, E.C. 1, the well-known optical manufacturers, have recently produced a number of novelties and bargains that will appeal to readers. Of special interest is an astronomical telescope for the beginner, List No. B99, which is marketed at the reasonable price of 70s. Their pencil pocket microscopes are both novel and efficient, the prices ranging from 3s. 9d. upwards. All accessories for the microscope and everything optical is obtainable from the above firm. Write at once for their free price list, which is obtainable upon application. **[31.]**

### Radio Cabinets for All

IF you require the latest designs of radio cabinets, write at once for the fine illustrated catalogue, price 3*d*. post free, published by Chas. A. Osborn, The Regent Works, Arlington Street, New North Road, N. 1. The above firm, who are well known in the radio trade, make their cabinets from well-seasoned timber from the best stocks which can be obtained. Cabinets are obtainable as a kit of parts ready to assemble, assembled ready to polish, or assembled and polished ready for use. Radio-Gramophone cabinets in varying designs, cabinets with electric clocks fitted, radio cabinets, and special loud-speaker baffles that help to give perfect reproduction from your speaker, are listed at reasonable prices to suit all pockets. Obtain their catalogue without delay. **[32.]**

### Electradex Radios

ELECTRADEX Radios, 218 Upper Thames Street, E.C. 4, a name well known in the radio trade, have recently issued a fine 76-page, fully indexed catalogue. They have a large range of meters of all types, photo-cells, aerial and earth devices, amplifiers, dynamos, and many other wireless gadgets, all obtainable at popular prices. So widespread is the use of the photo-cell to-day in spite of its high price, that many wireless experimenters will welcome the opportunity of obtaining one cheaply. The Dix-onemeter is the greatest improvement in present multi-range measuring instruments. It enables every kind of D.C. measurement for wireless and electrical engineering to be carried out with great accuracy. Write at once for this fine illustrated catalogue, which gives full details of their large range of stock. The catalogue costs 4*d*., post free, which sum must be included with your application, if such is sent to us. **[33.]**

### Economic Electric Co.

THE above firm, who are well known as manufacturers of electrical devices, have recently issued a new 32-page, fully illustrated catalogue. No matter what electrical device you may require, a glance at the index issued with this booklet will enable you to find it at once. This book contains a complete range of wood bell pushes, telephone spares, cycle dynamos, shocking coils, cells, lamp holders, dynamo parts, etc., all of which are obtainable at reasonable prices. **[34.]**

### The Scientific "Blue Book"

A USEFUL and practical handbook, price 6*d*., has recently been published by the Scientific Supply Stores (Wireless) Ltd., 126 Newington Causeway, Elephant and Castle, S.E. 1, dealing with the microphone and its many applications. The book contains a large number of diagrams covering many experiments and uses for the microphone. Once the book has been studied and the many suggested experiments tried out, the reader will be well equipped for further researches into "acoustics," as the science is called. Various types of microphones and other pieces of apparatus used in connection with the experiments are listed at the back of the handbook and are obtainable at popular prices. **[35.]**

### The Model Maker's Friend

WE have recently received a copy of the *Xactus News*, which is a finely illustrated paper, costing 2*d*., and published by the well-known firm of Xactus, the model aeroplane manufacturers. The paper contains interesting articles on model boats, ju-jitsu, cartoon drawing, full-size aeroplanes, and a large number of useful hints and tips. The paper consists of 12 large pages full of interesting and topical subjects. The editor is willing to accept articles, hints, ideas, etc., for which payment will be made if accepted. The Editor welcomes criticisms and comments on matters that appear in the paper, also suggestions on articles that you would like to appear. It is the aim of the paper to cater for readers' tastes. It will be published every month, and is good value for 2*d*. Obtain your copy right away. **[36.]**



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