EXPERIMENTS WITH PHOTO-ELECTRIC CELLS

NEWNES

PRACTICAL MECHANICS

MAKING YOUR OWN GRAMOPHONE RECORDS - HOW A WATCH WORKS
TELEVISION SYSTEMS - MONEY-MAKING IDEAS - MODEL MAKING
VALVE WIRELESS SET - LATHEWORK - THE CHEMISTRY OF PHOTOGRAPHY

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for every Listener

EDITED BY GARRY ALLIGHAN

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RADIO MAGAZINE

BRINGS HUMAN INTEREST TO THE PROGRAMMES

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Notes, Views and News

Is Television Imminent?

RADIO-TELEPHONY (as distinct from radio-telegraphy) is only a dozen years old, but its progress within that brief space of time has been remarkably rapid—so rapid in fact, that it tends to dwarf the progress made in other industries during that contemporary period. The science has literally bounded through the stages through which most other new sciences have but slowly passed—through the incubation period when the public considers the birth of the new idea with incredulity, to the acceptance of the principles by the scientific critics, the quiescent period of development, the exploitation of the idea by commercial interests, to the birth of a new national hobby, a thriving industry, and inevitably to the stage where it becomes a source of revenue to the National Exchequer and the subject of special legislation, Acts of Parliament, and local bye-laws. Radio to-day plays such an intimate part in our everyday lives, that it is difficult to imagine the world without it. It has largely replaced older methods of international communication, and enables ships, submarines and aircraft to maintain communication with each other and with land.

No Finality in Radio

BUT although it has *inevitably* reached the stage where the public accepts it as a commonplace, the present stage does not by any means spell *finality*. No science remains static, but is continually in a state of progression. Every scientific achievement eventually passes from the apparently miraculous (like the first operation under chloroform) to the commonplace, but it *never* achieves perfection. Snags and drawbacks are ever present, which scientists and technicians are ceaselessly at work to eliminate.

And with radio the greatest drawback is that we do not at present *see* by wireless (if we neglect for the moment the regular but brief television programmes which take place for four evenings in every week). The recreation of listening-in at present consists of the association of our senses with a voice; and it is the imagination of the listener which builds up the scene in the studio. You "see" a broadcast play by mental vision only, and the speaker is represented only by his voice. It is worthy of reflection that the film industry was developed the other way round—with silent films we could see, but could not hear the artistes. Now we have talking pictures. With radio we can hear but cannot see the announcer or artiste.

Television is Here

TELEVISION is the next inevitable step. It is already here in a reasonably successful form—and it would seem that, perhaps this year, we shall have combined radio-telephony and television of real entertainment value, and earlier in the evening than the present transmissions (from 11 p.m. to 11.30 p.m. on Mondays, Tuesdays, Wednesdays and Fridays). A great deal of experiment is going on behind the scenes with various systems; but it appears that the present 30-line system will continue for some time to come. It is known that several excellent high-definition 180-line systems on ultra-short waves are at present under test. No one can predict, nor state with certainty which system will eventually emerge triumphant. But one thing is crystal clear—television *must* arrive fairly soon; and it will arrive, as radio did, suddenly. It is our advice to readers to make themselves acquainted with the principles of television by building a simple instrument, such as our Tele-Discovisor (described in our issues dated October, November and December), and look-in during the present experimental television transmissions. It is a simple instrument to build and fascinating to operate.

It is certain that we shall not suffer from radio "blindness" for ever—for television is inevitable *and, maybe, imminent!*

THE MONTH'S SCIENCE SIFTINGS

Captain George Eyston has recently completed a racing car fitted with a London General Omnibus engine in which he will attempt to beat the world's speed record for heavy oil engines. The present record is 100·75 miles per hour, which was set up by Mr. C. L. Cummins, an American.

The largest telescope made in the British Empire has just been completed. Weighing over 60 tons, the huge telescope has been built at Messrs. Grubb, Parsons' Optical Works, at Newcastle-on-Tyne. It will be used at the Greenwich Observatory for investigation into the temperature of the stars.

A German all-metal Junkers monoplane is now operating on the London-Berlin air route, which has a wing spread of 146 ft., a cruising speed of 115 m.p.h., and has seating accommodation for forty-one persons, including the crew.

A firm is now engaged assembling a new type of aeroplane engine at a Kingswood (Bristol) factory. These engines will, it is claimed, bring flying within reach of the man in the street. It can without alteration be used for an aeroplane, motor-cycle, or grass cutter, and can be put to many other uses.

The Grid Scheme—A Danger to Aircraft

OUR note in the October issue that the erection of a network of pylons to carry the overhead cables for the new Power Grid Scheme constituted a danger to aircraft, was almost prophetic, for since that date several aerial disasters have occurred through aeroplanes flying into overhead cables and transmitting-aerial masts.

We suggest that these pylons should be illuminated by neon-gas lights which, it is known, are visible, from the air, for a radius of fifty miles.

The lack of vision of our forefathers in failing to anticipate, when building roads, the development of road transport, has resulted in the present road traffic chaos. It seems that, even in the air, where space is boundless, we are falling into the same errors, and exhibiting the same lack of foresight. Aerial transport is inevitable, and overhead cables therefore a menace.

Your Suggestions are Welcomed

WE invite, and welcome, suggestions from our readers. What special articles would you like? What articles do you dislike? Spare a few moments each month to express your opinion, or your wishes, in writing. We do not mind criticism—we *like* it! All letters are acknowledged. So, if you have a brickbat to hurl, a suggestion to make, or a question to ask, write *now*, whilst the urge exists.

Everyman's Wireless Book

READERS interested in wireless will also be interested to know that a companion volume to *our* presentation volume ("The Encyclopædia of Popular Mechanics") entitled "Everyman's Wireless Book," is now being offered to readers of our companion journal "Practical Wireless" (3*d.* every Wednesday). It is uniform in binding, size and style, and makes an ideal guide to the location and remedy of faults in, the operation and adjustment of, and the fundamental principles of, all types of wireless receiver. The text is illumined by hundreds of illustrations. Get this week's issue of "Practical Wireless" and qualify now!

It is a "wireless doctor" which every reader ought to have on his bookshelf—at once informative and interesting, can be picked up in an idle moment with the certainty that wherever it is opened there is some interesting fact or fault discussed.

IS THE ROBOT A PRACTICAL POSSIBILITY OF THE FUTURE?

Marvels of the MECHANICAL MAN

An Interesting Description of its Possibilities and Methods of Operation.

THE mechanical man has been a subject which novelists have exploited to the full. Recent demonstrations of these mechanical creations, Robots or Automatons, forcibly indicate to us that the idea is by no means so fantastic as would at first sight appear. There are many machines capable of doing work to-day which formerly could only be produced by many human beings. The machines which set the type from which these pages are reproduced are themselves almost uncannily human.

The Horseless Carriage

The motor car, or horseless carriage as it was formerly termed when old Mother Shipton forecast its invention, seemed an utter impossibility and was ridiculed universally by the Press of the period. When the motor car was, however, introduced it may surprise many readers to know that one of its earliest forms was that of a metal horse between the shafts of a carriage, the internal mechanism operating the metal legs and simulating almost exactly the walking or trotting motion of a horse. There are enormous motor-driven tractors in use in America to-day, on land where wheeled traffic could not possibly travel, which make use of a striding mechanism somewhat similar in action to a horse's legs.

So the mechanical man, when it was first introduced, met with the same derisive criticisms and sniggers from the ill-informed, possibly only because of its shape. But because an inventor seeks to imitate the shape of a human being as an enclosure for a particular mechanism it does not make the idea any less practicable. For example, we could make a robot mechanical lighter, whose hand, by pressure of a button, ignites the wick; a perfectly practicable idea. We already use cranes which lift weights in the same way; weighing machines are already in existence, which proclaim, by electrical and mechanical means, the weight of the customer who stands upon its platform.

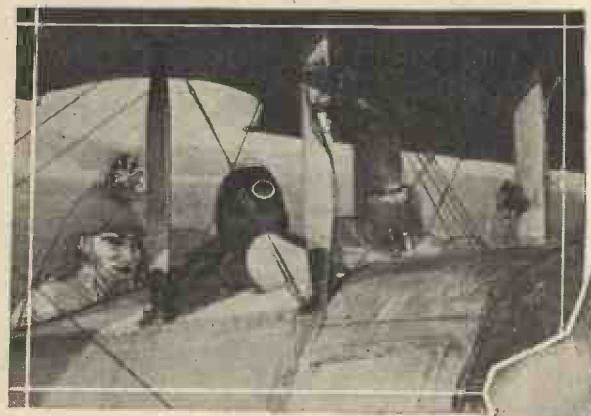


Fig. 1.—(above) Professor J. Popjie with his mechanical man seated in an aeroplane, in which the robot actually operated the dual controls, and (right), a robot making a gramophone record on a portable machine.

Modern Inventions Make the Robot Possible

The infra-red ray can be used to count with greater accuracy than human beings, as it is already doing in many printing works; it is possible to store speech on a steel tape or a wax record, and we can now by that means virtually listen to the voice of the dead. A man may broadcast in London and the entire world can listen to him. Television is already in operation and is on the threshold of important developments.

It is not such a fantastic notion therefore to concede that some mechanism in the form of a man may combine, in one homogeneous piece of apparatus, all of these modern scientific inventions. And why not? It is a simple mechanical proposition to make a device which walks, for walking machines are over one hundred years old. It is also a simple matter to make arms and hands raise weights; mechanical talking devices are almost child's play to-day, and the microphone, which is the electrical counterpart of the human ear, will respond to minute sound energies and set in motion various mechanisms. The only point which arises is whether the Robot need really take on the form of the human frame. "Horseless carriages" do not, excepting in the case mentioned earlier, employ mechanical horses, and it is a moot point whether the shape used for those Robots already produced will survive. Of course, it is spectacular and appeals to the public imagination, but it is not realised that

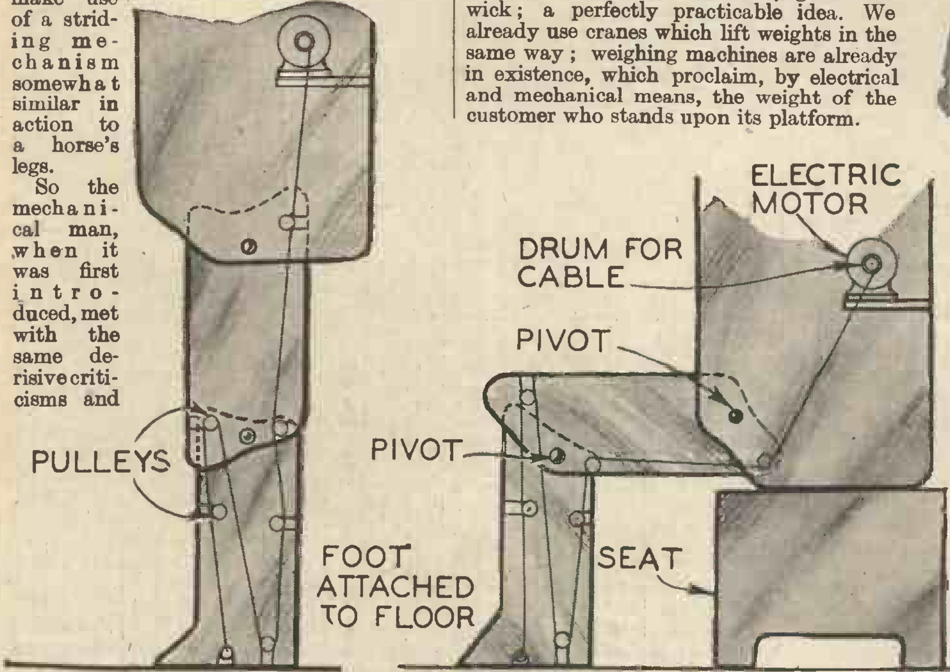


Fig. 2.—How the robot stands up. Note the small wire cable passing round pulleys. This is fixed to the foot and so pulls up the body when wound round the motor-operated drum.

all of the capabilities of the Robot have been performed daily for years past by devices of less appealing, if more practical, contour.

A Robot, in whatever form it ultimately is produced, can be made to do practically everything but think. This is a mechanical age, and it would be idle to deny that the tendency is more and more to make use of mechanical appliances to do work formerly executed by human beings. The man power of the world is comparatively small; the entire population of the world could be accommodated in a box having sides only half a mile in length. Our physical strength is growing less, for the increasing use of mechanical contrivances for travel is gradually causing us to lose the use of our legs. Our mental power is increasing. It is not absurd, hence, to conjecture of a time when man has become so weak that he will scarcely be able to move, and will be absolutely dependent upon some form of Robot for his existence. The idea has been exploited in a play, which had as its theme the entire conquest of mind over matter, but in the end matter predominated and killed the inventor!

Fig. 4.—Here is an inventor helping the robot to a pipe of tobacco.

Apparatus Employed

At various times during the past year or so a number of Robots have toured this country, and in most cases the principles have been very similar, although differently adapted. Principally to attract attention and appeal to the man-in-the-street, the exhibition Robot is always built up in a form similar to a human being, that is, with a body, head and limbs. Furthermore, the head is furnished with "eyes," "mouth" and "ears." In some cases the "eyes" are formed by lamps, which in the case of one well-known Robot (Eric) light up as soon as he hears a question put to him. In most cases one or both of the ears are fitted with small microphones, and the mouth is simply the camouflaged opening of a good loud-speaker of the same type as is used in the majority of home radio sets. To add to the illusion, the mouth is invariably made to move as speech is emitted. Sounds received by the microphones are made to operate relays which, according to the type of sound, give rise eventually to movement or cause the object to "speak." Dealing first with movement, the generally adopted methods employed are as described in the following paragraphs.

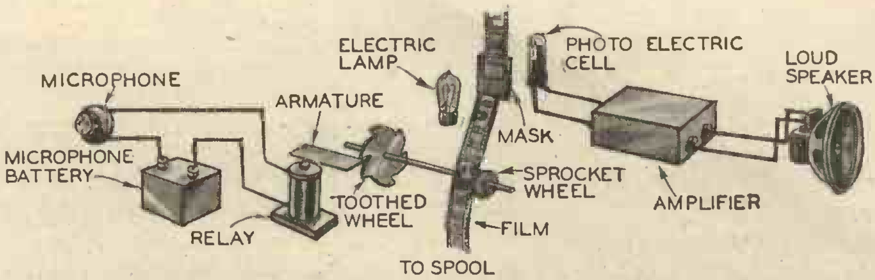


Fig. 3.—A schematic diagram of a typical robot system. When the microphone circuit is energised the armature (acting as a ratchet) is caused to rotate the toothed wheel and thence the sprocket or other mechanism.

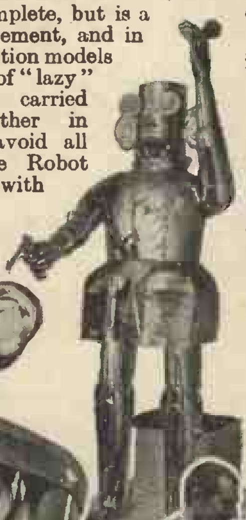
How the Robot stands up

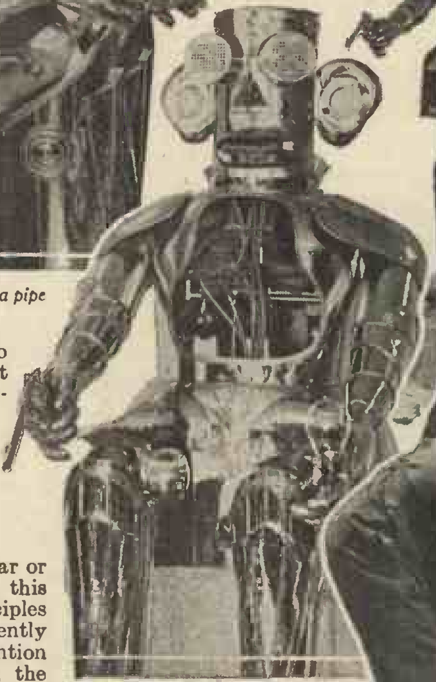
Fig. 2 gives a diagrammatic section of the leg and lower body portion of a Robot. It must be emphasised that this is not necessarily complete, but is a simplified movement, and in the best exhibition models the principle of "lazy" pulleys is carried much further in order to avoid all risk of the Robot collapsing with consequent damage to the delicate apparatus enclosed in the body. The foot is fixed to the floor or base of the pedestal upon which the Robot sits. The casing of foot and lower portion of the limb is continuous, so that this portion is quite rigid. At the knee, the upper portion of the leg, or thigh, is pivoted, and a further pivot is fitted between thigh and trunk. When the motor winds up the thin wire cable the lower end, being fixed, causes the body to rise as tension is put on to the wire. Upon reversing the movement with a suitable clutch to avoid the too sudden running out of the cable, the body is lowered, and through the medium of the pivots the legs fold back, giving a perfect sitting movement. The arms are moved in a similar manner, and it is only a matter of fitting a sufficiently large number of motors to enable the Robot to move independently its hands, ears, head, etc. It will generally be found that the head only rotates, a forward and backward movement being an unnecessary complication.

How the Robot Speaks

The method of providing speech for the mechanical man is actually quite simple, and the gramophone principle is employed in one form or another. In a simple Robot, a record may be made to rotate when the motor is switched on, and an electric sound-

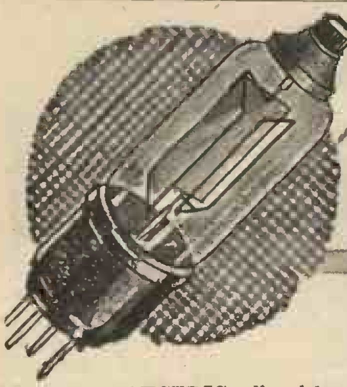
(Continued on page 218).





The mechanical man can be made to do almost everything (except think) by pre-arrangement. It can talk, walk, answer questions, etc.

The enormous weight of the robot (it is 9 feet high) can be gauged from this picture.



Interesting Experiments with PHOTO-ELECTRIC CELLS

Practical information regarding the use of photo-electric cells for a variety of interesting purposes is given in this article, along with details for making a suitable amplifier and relay

By FRANK PRESTON

PHOTO-ELECTRIC cells, although they have not been made for any great length of time, have found innumerable applications in commerce, and they lend themselves very well to experimental use by the amateur. It need scarcely be explained that photo-electric cells are devices by means of which electrical apparatus can be switched on merely by varying the intensity of light falling on them. Not only are the cells sensitive to ordinary "white" light, however, but they are made in types which may be actuated by lights of different colours, and even by ultra-violet and infra-red rays which are not visible to the human eye. Because of this they can be employed to produce many amazing and seemingly wonderful results. For example, by fitting a photo-cell to the door of a safe connections could be made whereby a bell would ring, a door close, or the shutter of a camera open immediately a light were shone on the safe door. By making different connections a photo-cell could be used to count the number of articles passing along an endless belt in a factory where mass production methods were employed. Then, again, arrangements could easily be made whereby electric lights were switched on as soon as the daylight fell below a predetermined intensity. There are many other interesting applications of which every reader is doubtless aware, and attention need only be called to those shop window demonstrations where passers-by pass a hand over a certain lighted portion of the window to set a model locomotive into motion or cause portions of the window display to be illuminated. The methods of accomplishing all these amazing results will be fully discussed later, but for the time being it will be more interesting to consider the function of photo-electric cells in general and the system of connecting them to their associated apparatus.

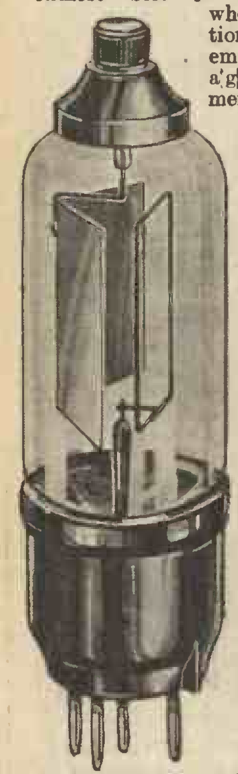
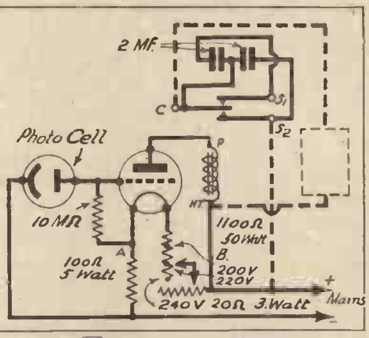


Fig. 1.—A detailed sketch of a photo-electric cell.

How the Photo-Cell Functions

Essentially, a photo-cell consists of an anode and a cathode which are placed inside a glass envelope generally fitted with a four-pin cap like that of a wireless valve (see the perspective sketch, Fig. 1). The cathode consists of an extremely thin film (thought to be of only atomic thickness) of cæsium, potassium, or other element deposited on a suitably prepared silver conductor, whilst the anode takes the form of an open wire framework. When light falls on the cathode it emits electrons in the same way as does the filament or cathode of a wireless valve, even though there is no polarising voltage applied to it. The electron emission is of very low intensity and reaches only a few microamperes, so that in order to make use of it some form of amplifying device is called for. It is now accepted that the most efficient amplifier of electric currents is the wireless valve, and, therefore, this is generally used for the purpose, although there are available certain forms of gas-filled relays.



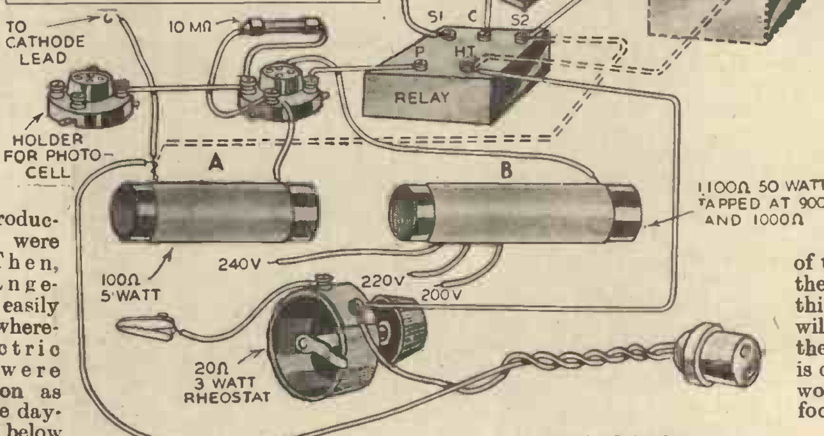


Fig. 2.—Theoretical and pictorial circuits for a simple battery-operated photo-cell amplifier; the relay is shown as a plain box for simplicity.

An Amplifier Circuit

A simple photo-cell amplifier circuit is given in Fig. 7, where an ordinary 2-volt power-valve is used in conjunction with its associated batteries and a relay. The voltage of the grid bias battery is at least twice as high as that normally required by the valve when used in a wireless set, and is such that if it were applied to the grid of the valve there would be no flow of anode current. But, it will be seen, the photo-cell is inserted between the negative side of the G.B. battery and the grid. Because of this the G.B. potential will not be applied to the grid unless the cell is conductive; in other words, unless light is focussed on to it.

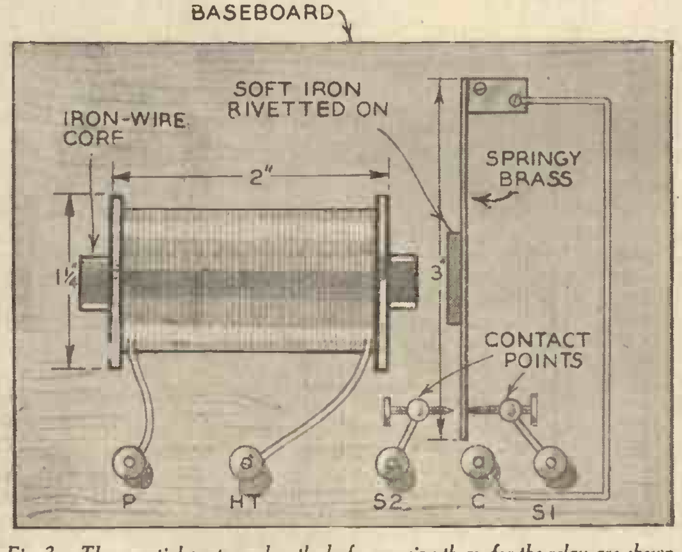


Fig. 3.—The essential parts, and method of arranging them, for the relay are shown in this sketch.

When the cell is in darkness the grid will be slightly positive, due to the fact that it is connected to the positive side of the L.T. battery through a 10-megohm grid leak, and consequent y there will be a flow of current through the anode circuit. On the other hand, when the cell (or, more correctly, the cathode of the cell) is illuminated, the full G.B. potential will be applied and this will prevent the flow of anode current.

A relay is connected in the anode circuit of the valve, so that any current flowing must pass through it. Now when current flows through the windings of the relay an iron core is magnetised and this attracts an armature (C in Fig. 7), which then makes contact with the point marked S2. It will now be clearly understood that if points C and S2 were inserted in an electric circuit current would flow through that circuit when the cell was in darkness, but the current would cease immediately any illumination was applied to the cell. Alternatively, if the points marked C and S1 were used instead, current would only flow when the cell was illuminated. The brief explanation just given will suffice for the reader who wishes to investigate the interesting possibilities of photo-electric cells and we can now turn our attention to more practical considerations. The connections given in Fig. 7 require little explanation, and the few components shown can soon be mounted up on a suitable baseboard. Perhaps it should be explained that the anode of the photo-cell is joined to the "plate" pin on the valve base, but the cathode is connected to the terminal situated on top of the glass envelope; that explains why only one connection is made to the photo-cell valve-holder. The valve may be of any small power type, such as the Hivac type P220, Cossor 220P, Mullard P.M.2A, or any similar type in other makes.

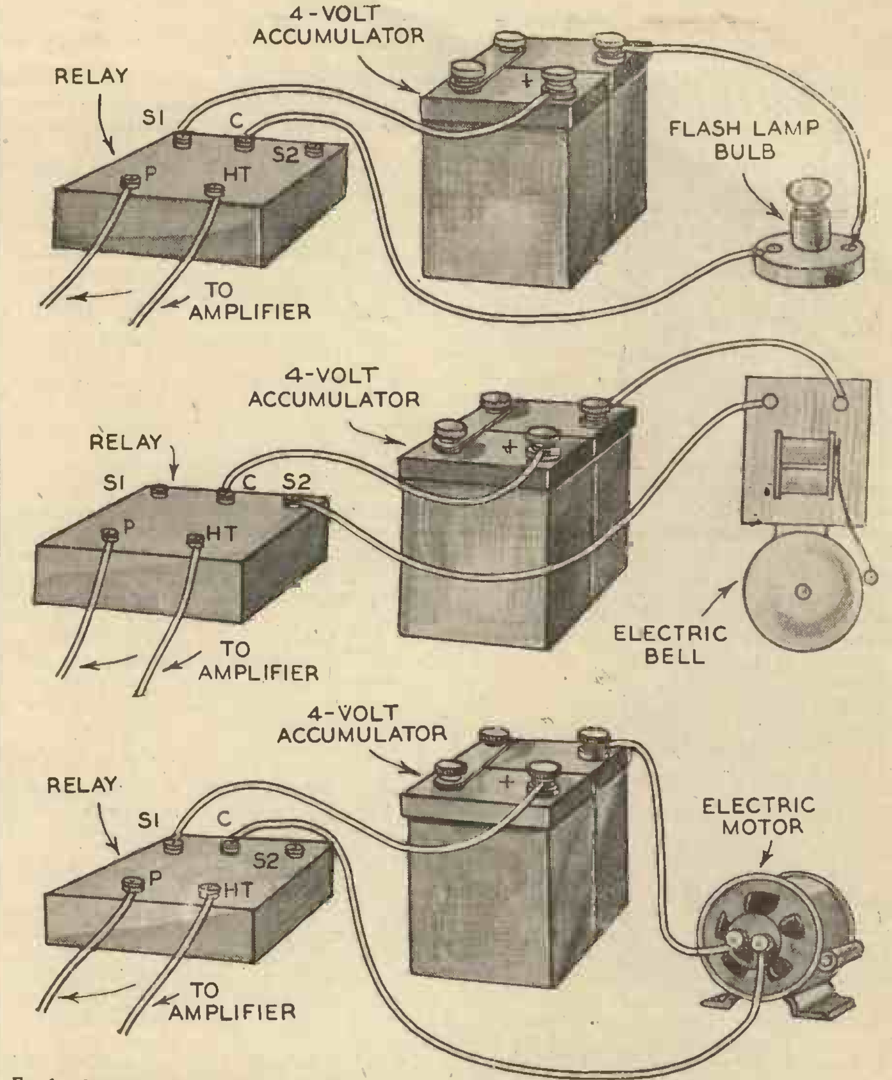
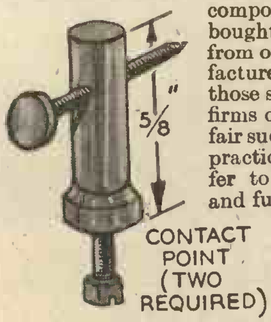


Fig. 6.—Methods of connecting the relay for the operation of different kinds of electrical apparatus. In the two top sketches the bell and light respectively are switched on when all light is cut off from the cell. In the lower sketch the connections are such that the motor is switched on when the cell is illuminated.

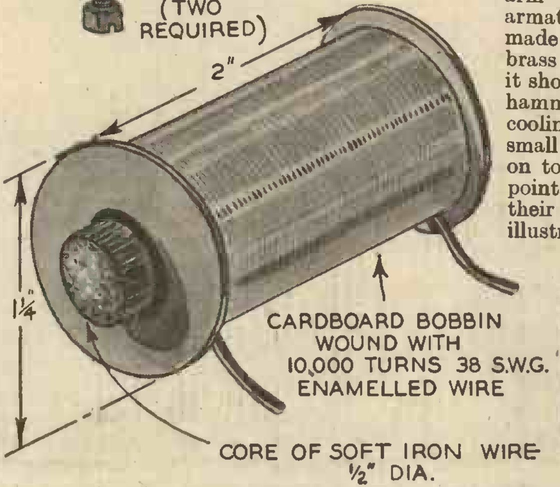
Making the Relay

The relay is the next item calling for an explanation, and this is shown in the pictorial wiring diagram simply as a rectangular box, although its essential parts are shown in the theoretical circuit. A suitable component can be bought readily enough from one or two manufacturers, and some of those sold by Ex-W.D. firms can be used with fair success. The truly practical man will prefer to make his own, and full constructional details are given in Figs. 3 and 4.



It will be seen from these drawings that an electromagnet is made up by fitting a cardboard or paxolin bobbin on to a bundle of soft-iron wires which form a core. The bobbin is wound by putting on 10,000 turns of 38-gauge enamelled wire, and can then be attached to a baseboard by means of a strap made from a strip of brass, fibre or other non-magnetic material. A contact arm—which is combined with the armature—is next required, and this is made from a strip of sheet brass. The brass must be springy, and if it is not it should be heated to redness and then hammered on a hard surface whilst cooling. The armature consists of a small piece of soft iron, and it is riveted on to the contact arm. Two contact points are shown, and their main features are illustrated, but very few readers will care to go to the trouble of making them when it is explained that they can be obtained from old electric bells or shocking coils. It is preferable that the points of the contact screws and also corresponding spots on the contact arm should be made of platinum or silver to prevent burning, due to the small sparks which will inevitably be produced, but this is not by any means essential provided that the relay is not to be kept in constant use.

In mounting the contact arm and screw points, the former should be so placed that the armature is as near as possible to the core of the magnet without actually touching. S1 should be adjusted so that it makes good contact with the arm, and S2 should be set to the position at which the arm touches it just before the armature touches the end of the magnet.



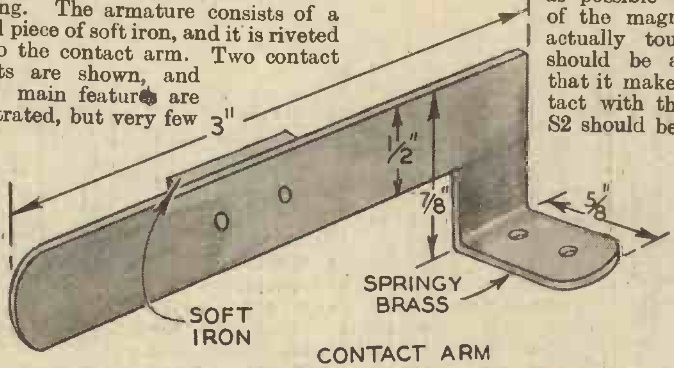


Fig. 4.—Constructional details of the parts required for the relay described.

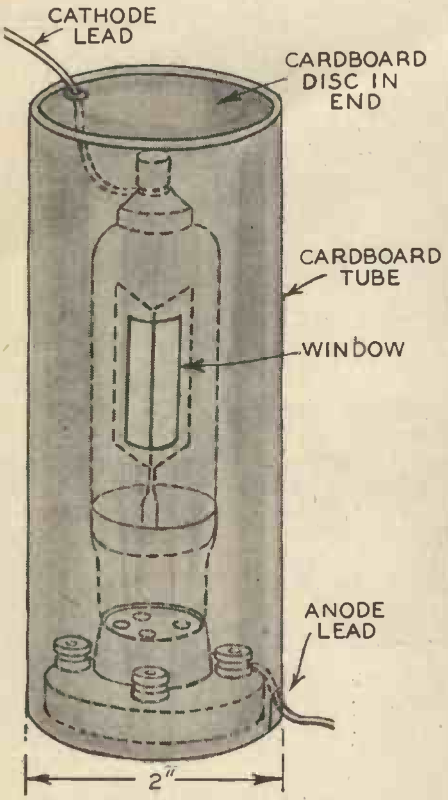


Fig. 5.—Details of a suitable screen for keeping indirect light rays from the photo-cell and varying the light intensity.

Shielding the Cell from Indirect Light

The photo-electric cell must next be considered, since it is practically essential that it should be shielded from all light except the narrow beam which will be directed on to its cathode through the "window" formed by the wire anode. This can best be provided for by making a tube about 2 in. diameter to fit round it, as shown in Fig. 5. The rectangular "window" should be at the same height as that in the cell, and it is also a good plan to arrange for the tube to be rotated so that the amount of light passing to the cathode can easily be varied to suit all conditions of illumination.

Fig. 6 shows a few alternative schemes which may easily be tried out with the aid of a 4-volt electric bell, flash-lamp bulb, electric motor and a 4-volt accumulator. It might be mentioned at this point that when using up to 6 volts or so in the relay circuit it is not quite so essential that platinum contacts should be used, but if the mains are being used for supply purposes it would be unwise to attempt to use a relay not fitted with contacts of that kind.

Mains Working

When the experimenter is limited to batteries as a source of power supply for both the amplifier and the external circuit, there are not quite so many spectacular experiments that can be tackled, but where the mains are available the scope is truly unlimited. The circuit arrangement for a mains-driven amplifier is given in Fig. 2; this is of the very simplest, though by no means least effective, and can be used for nearly every purpose to which a photo-cell lends itself. The valve is an ordinary 2-volt battery one like that specified for the battery amplifier, and the mains voltage is broken down to the correct figure for feeding the filament by means of two series resistances; that marked A provides the necessary "automatic" grid bias, and that marked B provides the voltage-drop which is applied to the anode. A 20-ohm variable resistance is also included in circuit to compensate for slight mains-voltage fluctuations, and this should be adjusted until the voltage across the valve filament is just 2. The resistances must be large ones, because they have to handle a fair amount of power; consequently the figures given for the wattage rating should be adhered to. In principle there is no difference whatever between the mains and battery-operated amplifiers, and the connections to the relay are identical in both cases. In describing the second amplifier as mains-operated no mention was made of the kind of mains supply (A.C. or D.C.), so it should be explained that it can be operated from either kind of supply equally well, due to the fact that the valve and photo-cell act as their own rectifiers on A.C.

Interesting Applications

It will be of interest to mention a rather complicated scheme that was worked out a few years ago when the writer was giving a lecture-demonstration on photo-cells and their applications. A "dummy" safe was rigged up and a photo-cell was concealed in the door and connected to the amplifier. The relay was connected in circuit with an electric bell, two electric motors, an electric lamp and a short length of fuse wire, and was arranged to operate when the cell was illuminated. After briefly explaining the action of the amplifier, all the lights in the room were extinguished and I took on the *rôle* of a "burglar" searching the room with an electric torch. As soon as the light from this fell on the "safe" door the relay contacts closed to give a startling effect: the bell rang outside the room, the electric lamp lit up, one motor wound a cord round its spindle, so pulling an external bolt on the door, the second motor operated a cam which opened the shutter of a loaded camera at the same instant as the fuse "blew" and ignited a charge of flash powder.

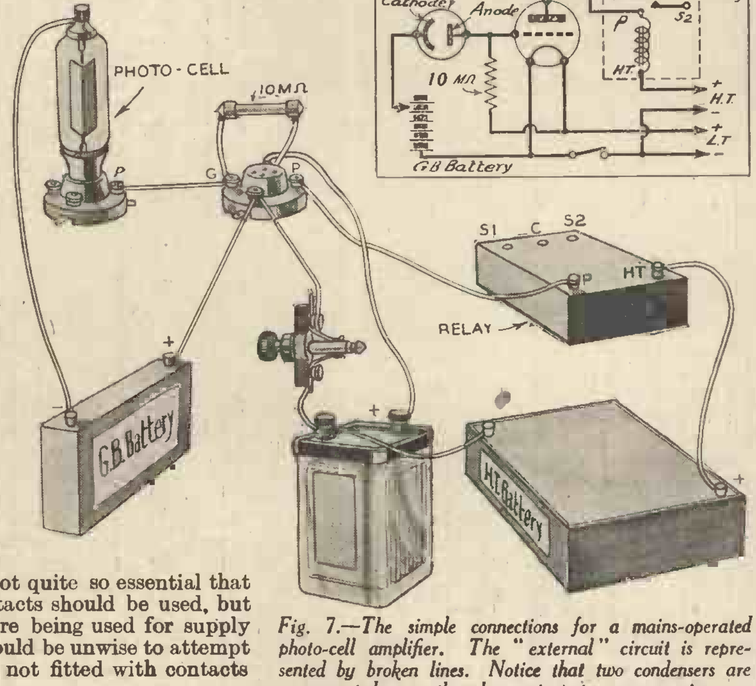


Fig. 7.—The simple connections for a mains-operated photo-cell amplifier. The "external" circuit is represented by broken lines. Notice that two condensers are connected across the relay contacts to prevent arcing.

WATER YOU CANNOT CUT

Three Hundred Foot Fountain on Swiss Lake

HALF way along a jetty projecting into the Lake of Geneva, and almost immediately opposite the offices of the League of Nations Secretariat. stands one of the most remarkable fountains in the world. When it is not playing it passes unnoticed, for all that can be seen is a stubby nozzle and a pair of searchlight drums. On Sundays, public holidays and a few other occasions, however, interested watchers wait for the appearance of a thick jet of water which slowly rises until, in a few minutes, it reaches the amazing height of 300 ft.!

The Remarkable Fountain at Geneva.

So great is the force required to raise the water to this height that, where it leaves the jet, the water behaves as if it were steel. The solid green column can be given the hardest blow with a stick without any impression being made upon it. Even a slash with a keen sword blade will be resisted, and more than likely if the blow is hard enough the sword will be broken.

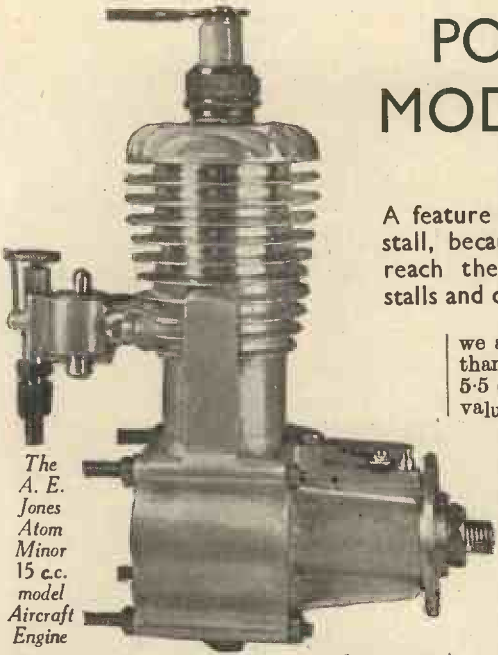
At night the searchlights play upon the column, giving it, from a distance, a fairy-like appearance. First white then coloured light is thrown upon it, the wind-blown spray standing out against the dark sky in one vast coloured plume.

In daytime the spray frequently catches the sunlight in a rainbow effect. Beautiful as it is, the fountain is usually a disappointment to amateur photographers, the white spray merging into a white sky in the finished print. This photograph was taken with a yellow filter to suppress the blue of the sky.

POWER-DRIVEN MODEL AIRCRAFT

By E. W. TWINING

A feature of this type of model is that it cannot stall, because before the main plane, or planes, reach the stalling point the elevating surface stalls and drops to resume its normal flying angle.



The A. E. Jones Atom Minor 15 c.c. model Aircraft Engine

BEFORE passing to the general arrangement of this machine I should like to give the reader some data regarding the method of arriving at its aerodynamical form. It is, of course, well known that in aircraft of this type the centre of gravity falls at a point in front of the leading edge of the main planes and not upon the centre of pressure of these. In all tailed aeroplanes without a front elevator the centre of gravity and centre of pressure of the main wings coincide, but in the 1–2P–O type there are no horizontal non-lifting surfaces. The small leading plane is loaded and, therefore, does a portion of the work of sustaining the machine. In order to give the necessary automatic longitudinal stability the leading plane is given a greater angle of incidence than the main plane. It is for this reason that this type cannot stall, because before the main plane, or planes, reach the stalling point the elevating surface stalls and drops to resume its normal flying angle. In the model we are now dealing with the centre of pressure of the leading plane, which for convenience I am going to continue to call the elevator, will be placed at a distance of 28 in. forward of the main centre of pressure of the main plane. The centre of gravity of the whole machine will fall at a point 7 in. in front of the latter; that is to say, 21 in. behind the c.p. of the elevator. Now the weight of the whole machine is going to be 3·6 lb., which will require with ordinary planes, at 2·5° angle of incidence, 7·8 sq. ft. of surface. This is the area which we put into the O–2P–1 model described in the November issue. If the incidence angles of both the elevator and of the main planes were going to be the same and the wing sections of both were identical, then their respective areas would be in direct proportion to their distance fore and aft from the centre of gravity: in the case of the present model 21 in. and 7 in. To make up 7·8 sq. ft., the area of the elevator would have to be 1·95 sq. ft. and of the main planes 5·85 sq. ft.

Effect of Increased Elevator Angle

As we are increasing the angle of incidence of the elevator (as a matter of fact we are going to increase it to rather more than double that of the main wings, *i.e.*, 5·5 degrees) we shall get a higher value for the absolute lift coefficient K1. We are going to use the R.A.F.3 section again in this machine, and a reference to a table of coefficients for this wing shows that whereas at 2·5 degrees K1 equals ·279, at 5·5 degrees the value of K1 is ·395. Obviously, then, we arrive at the important fact that to get the same lifting effect we can use a smaller surface and the area required for the elevator will be only 1·5 sq. ft. For the main wings we can retain the 5·85 sq. ft.

The A.E. Jones Atom Minor 15c.c. Marine Engine.

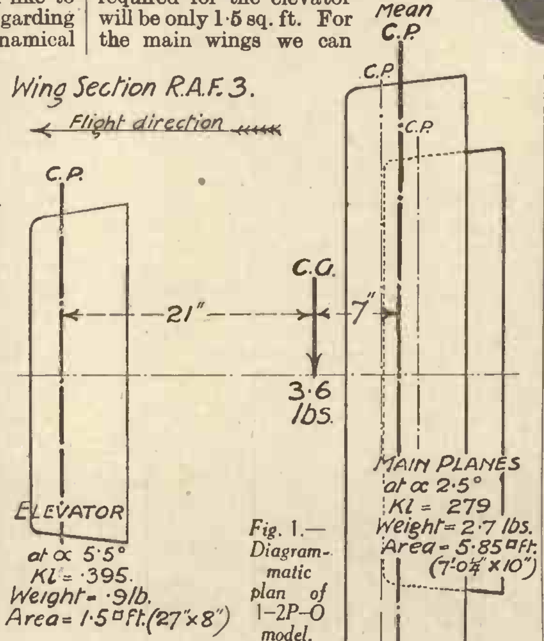


Fig. 1.—Diagrammatic plan of 1–2P–O model.

Smaller Wing Span and Area

The net result of all these facts, therefore, is that this 1–2P–O machine can be smaller than the other model, since whereas we had to get 7·8 ft. into the main wings only in the other one, necessitating big spans, we can, although we keep the chord to 10 in., reduce the sum of the span of the upper and lower planes to 7 ft. linear. We can divide this very conveniently into 4 ft. for the top and 3 ft. for the lower, which gives us a much more portable machine to handle and transport. In Fig. 1 is given a little diagram, which is drawn to scale, showing the outstanding points brought out in the foregoing. From the data shown we see that adding the area of the elevator and main wings together we get a total which will, owing to the increased lift of the elevator, enable us to provide 7·35 superficial ft. to do the same work as did the 7·8 sq. ft. in the O–2P–1 machine of similar weight.

The General Arrangement

Coming now to the lay-out of the machine in general, Fig. 2 is a side elevation. In this case I think the side view will be better than the plan to present to the reader first. Here it will be seen that the elevator is made to carry the nose of a fuselage, and the main wings are mounted upon a com-

(*Continued on page 246.*)

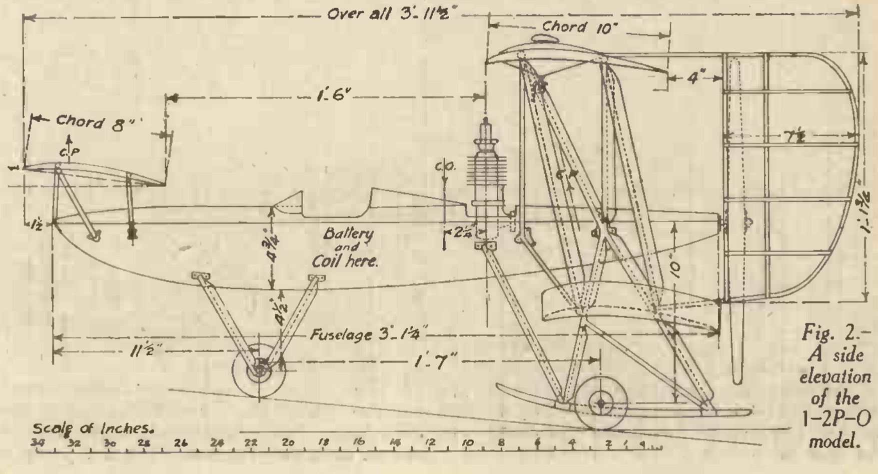
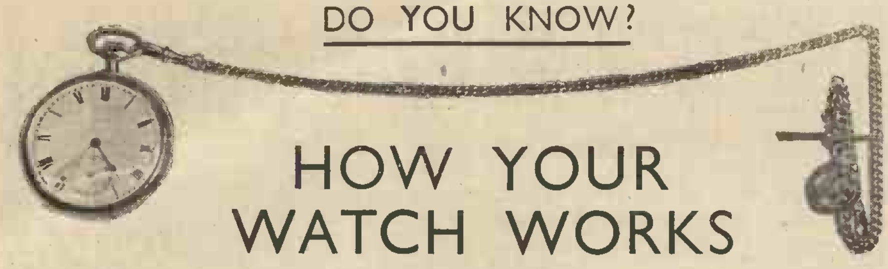


Fig. 2.—A side elevation of the 1–2P–O model.

DO YOU KNOW?



HOW YOUR WATCH WORKS

By F. J. CAMM

MECHANICAL instruments for measuring time are known to have existed thousands of years before the Christian era. The old clepsydra, or water clock, in which water was allowed slowly to drip from a container and so alter the level of a body floating on its surface (the position of which was noted by crude markings on the inside walls of the container) was one of the earliest. This was followed by candles, the rate of burning of which was the measure of time, and indicated by marks on the side of the candle itself. It was much later that the sundial, in which the movement of a shadow cast by a gnomon indicated the time, was introduced. Sidereal time, strange to say, is of much later origin, for although early philosophers like Pythagoras had studied the movements of planetary bodies, no one apparently had noticed the all-important fact that the sun always rose in the east and set in the west, and that it took a certain period of time for certain celestial bodies to make their regular appearance.

Our unit of time is that taken by the earth in making one revolution on its axis—twenty-four hours. The hour, of course, is an arbitrary unit, which we sub-divide into sixty minutes and each minute into sixty seconds.

Clocks driven by weights were the next step, and it is only a few centuries ago that spring-driven clocks were introduced. Watches are of even more recent origin, and in their earliest form were almost as large as some of the small clocks sold to-day. Accurate time-keeping in those days was considered to be anything within ten to fifteen minutes a day, timepieces usually being set by the curfew at 8 p.m. There have been thousands of different styles of watches and clocks, but they all work on the same fundamental principle. The small mechanism which you wear on your wrist or carry in your pocket nowadays is a mass-produced article, and so precise has machinery become that thousands of watches are made every day within very fine limits of time-keeping accuracy. Final adjustments to bring the watch to time are always made by hand.

I have taken for the purpose of this article a watch movement of Ingersoll make, the illustrations of which (specially prepared for PRACTICAL MECHANICS) are shown here.

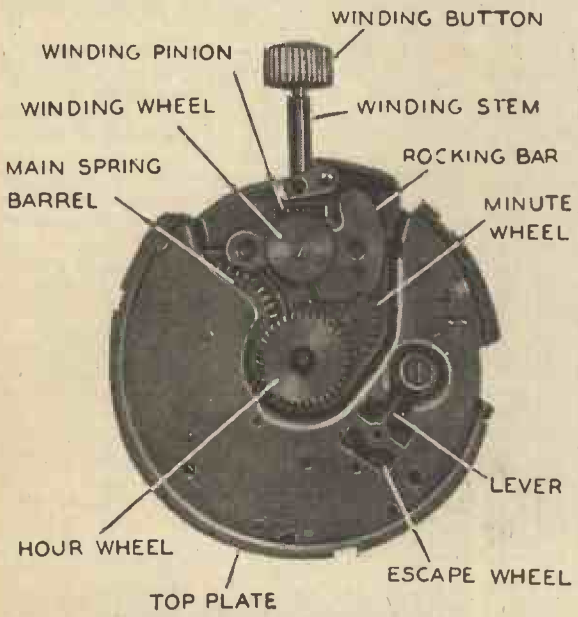


Fig. 2.—View of watch behind the dial.

Watch Sizes

Watch sizes are of one of two standards, the English system being based in "sizes" and the Swiss system in "lignes." A No. 0 size movement (that is, the size over the plates of the works) is $1\frac{5}{30}$ in., a No. 1 size is $1\frac{6}{30}$ in., and No. 2 size $1\frac{7}{30}$th, and so on. The ligne is a Swiss unit of measurement, 11 lignes being approximately equal to 1 in. The usual size of a pocket watch is a 16 size in English measurement, and a 24 ligne in Swiss measurement.

Interesting Facts

Most modern watches make five ticks every second, and the little table below shows the great amount of work the balance wheel has to do :—

300 ticks per minute.
18,000 ticks per hour.
432,000 ticks perday.
157,680,000 ticks per year.

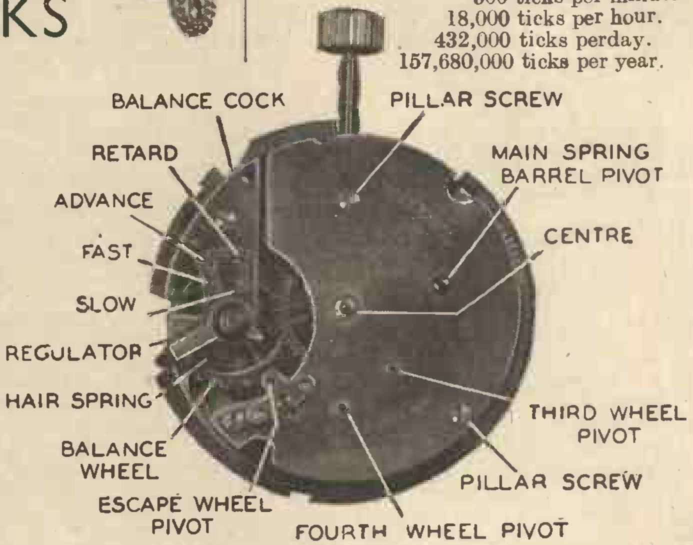


Fig. 3.—Back view of a watch movement.

The average size of a balance wheel is 0·62 in., so that in each vibration it will travel 2·343 in. In one hour it will travel 43,812 in., or 3,651 ft., and in a complete day will travel 87,624 ft., or 16·95 miles. If you had to walk that distance and failed to do so merely by 10 ft., it would be a matter of no moment, but if your watch fails by this amount it would be equivalent to a loss of $9\frac{4}{5}$ths seconds a day, or nearly five minutes a month.

The time-keeping of a watch depends not, as many suppose, on the main spring, but on the hair spring. The exact length of this has to be gauged to a nicety, for if it is only $\frac{1}{100}$ in. too long or too short, the watch will lose or gain a considerable amount per day. The term "hair" spring originated from the fact that a straight pig's hair was originally used to actuate the balance wheel.

Let us start from the main-spring barrel. This is a cup-shaped gear wheel, about $\frac{3}{4}$ in. in diameter, into which a steel main spring,

(Continued on page 216.)

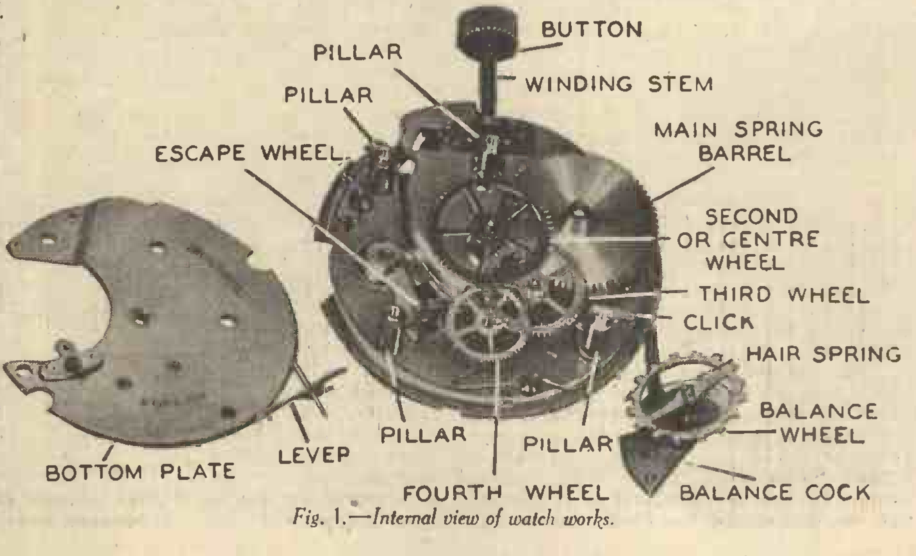


Fig. 1.—Internal view of watch works.

TELEVISION SYSTEMS—Simply Explained

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

Considerable misapprehension seems to exist concerning the various television systems which are being developed. The author details several of the important ones in this interesting article.

UNLIKE radio, where one wireless set can be made suitable for receiving every radio transmission, the science of television is built up from a variety of systems, each of which differs from the others in certain details. It is therefore impossible at this stage of the development to make one television receiver so universal in character that it can receive and show intelligible images from every system.

The B.B.C. Service

The B.B.C. system is the same as the Baird system, which provided an experimental service up to the time the B.B.C. took it over. A mechanical scanning device consisting in the earlier days of a rotating perforated disc, but superseded later by a rotating mirror drum, associated with a powerful source of light and an optical system, causes a spot of light to move over the artist or scene to be televised in a regular manner. In the case under discussion, this spot movement is vertically from bottom to top, and thirty spots arranged to scan one after the other produce a resultant light area of thirty vertical strips side by side, the rectangular shape being such that the vertical height is 2½ times the width of the area.

The spot is made to move over its predetermined path very rapidly—there are 12½ complete scans in one second—and at every instant of its journey it illuminates a tiny section of the scene or object being televised, a small proportion of the light being reflected. As the surfaces over which the spot pass vary in character and colour, the reflected light will correspondingly vary. One or more groups of photo-electric cells are therefore so positioned in the studio that they "pick up" or are influenced by this reflected light, and as they possess the property of converting light into equivalent terms of electrical current, a continuously varying signal is passed to the amplifiers.

In the illustration in the heading we see the artist—a cartoonist—while the machine on the left is the spot light television transmitter which can be moved on rails to follow any movement of the artist. Housed in a vertical stand to the right of the machine is a bank of photo-electric cells with a signal cable passing to the amplifier rack, which is the cupboard-like structure.

The signals obtained in this way are broadcast into space just the same as an ordinary sound signal, being received by a wireless set, and passed to the television receiver. The receiver can take one of many forms—disc, mirror drum, mirror screw, cathode ray, etc., and as an example of the first-named has been described in detail in earlier issues of PRACTICAL MECHANICS, there will be no need to deal with the receiving side fully.

The only requirements are a source of light which can be modulated—that is, made to glow dark or bright—by the incoming television signal, and a method for reassembling these resultant tiny light areas so that they produce an image in light resembling the scene or subject previously disintegrated at the transmitting end. Obviously, the mechanisms must be in synchronism, and in this spot light method of transmission a special signal of constant frequency (375 cycles per second) is superimposed on the picture signal, and at the receiving end this is filtered out to govern the action of a cogged-wheel synchroniser forming part of the receiving apparatus.

Further Spot Light Systems

The spot light system of television is a very important one, and constituted a big step forward in the development of the science when it replaced the earlier flood light methods. It has been adopted by many countries both on the Continent and in the United States. The prime differences in operation when compared with the B.B.C. service lie in the path traversed by the small light area, and also in the method of synchronising. For example, in Germany the apparatus used by the German Post Office was made by Fernseh A.G., and horizontal scanning was used in preference to the vertical scanning of this country. The picture area for scanning is a rectangle, the spot movement being from left to right, with the strip movement from bottom to top.

Furthermore, the picture ratio was four horizontal to three vertical, and a spot light television transmitter built on these lines was demonstrated in Berlin. A powerful arc light source is employed, while the scanning is carried out with a perforated disc. The head and shoulders of the subject being televised appeared in an aperture of the partition dividing the studio from the transmitting and control room.

A synchronising signal is sent out from the transmitting end in a manner similar to that first described, but at the receiving end this is made to control an oscillator which develops power for driving the scanning mechanism.

In the television broadcasting used by the authorities in Rome, a scheme almost identical in character was employed.

A name which has long been associated with television is that of Denes von Mihaly, a Hungarian inventor. In the early days he used a disc and neon lamp at the receiving end, while the synchronising pulses were made to drive a phonic wheel. With some of the first models shown he conceived the idea of rotating the disc in a horizontal plane, and viewing the image through a periscopic device.

From later information, however, it would appear that the inventor has now abandoned this arrangement, and in its stead he has developed a very ingenious yet simple mechanical scanner. It is based really on the theory of relative motion. Whereas in the case of the mirror drum receiver, the whole drum, complete with

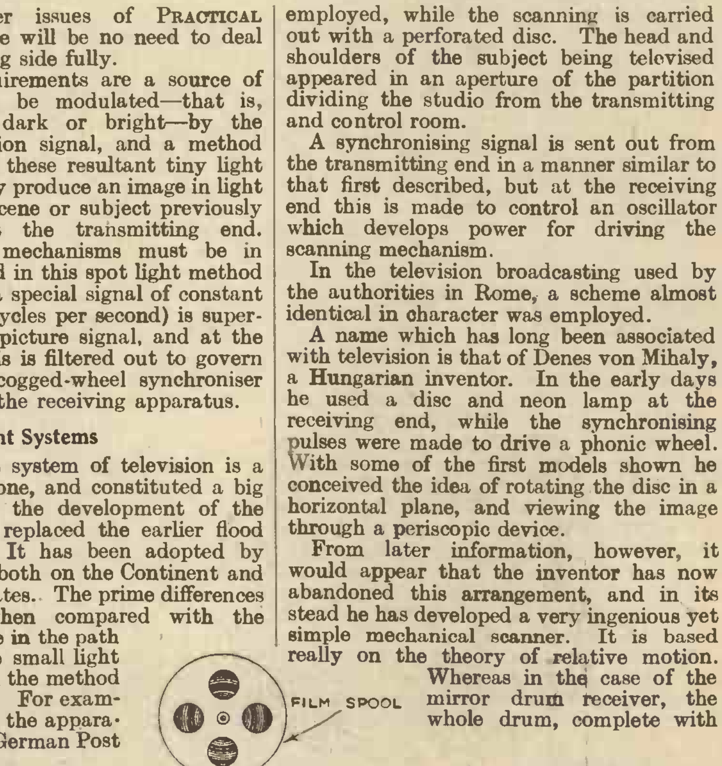


Fig. 1.—A simple schematic diagram showing how a 120-line mechanical tele-cine transmitter works, employing cathode ray tube reception.

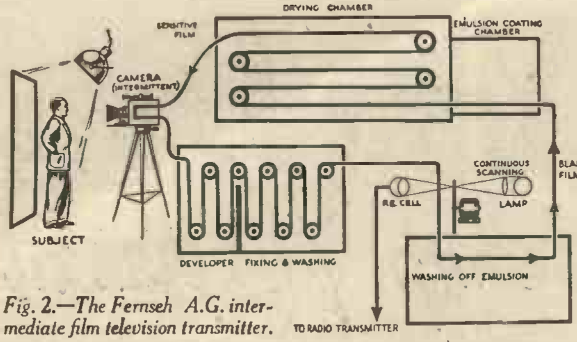


Fig. 2.—The Fernseh A.G. intermediate film television transmitter.

its accurately positioned mirrors on the surface, revolves and reflects the light from the modulated light source on to a stationary mirror, and thence on to a screen, in the Mihaly receiver the process is reversed. That is to say, the light beam which is modulated by the incoming television signals is swept by a small mirror rotating at a uniform speed at the axis of a hollow drum across a number of mirrors fixed on the inside surface of the stationary drum. This breaks up the light into strips, and the resultant beam is focussed on to a screen for observation. One marked superiority over the more usual rotating drum is the lightness and thus more easily synchronised moving member of the scanning operation.

Tele-Ciné Systems

The first man to give a demonstration and produce images comparable with those produced by mechanical methods, yet using cathode ray oscillograph tubes at *both* the transmitting and receiving ends, was Baron von Ardenne. Instead of making his electron beam produce the image on the cathode ray tube's fluorescent screen with a constant velocity, but varying intensity stream of electrons, he successfully developed a cathode ray stream of constant intensity but variable velocity. The apparatus gave really astonishing results, but its biggest drawback was that only cinema films could be transmitted. This same inventor has lately been directing his attention towards methods of enlarging the television image of a cathode ray tube, and has devised a scheme for projecting the cathode ray beam from a plate within the tube on to an external screen. Details concerning this are not yet available, but no doubt we shall hear more regarding it in the near future.

Reference can also be made to the high definition cathode ray tube tele-ciné images shown for the first time at the British Association Meeting at Leicester in September, 1933. The whole scheme is drawn in simplified form in Fig. 1, and the demonstration showed a 120-line picture, 5 in. square, on the screen of a cathode ray tube. This picture was then magnified by a lens combination to give the appearance of a picture 8 in. square suitable for a small audience.

Sound films were transmitted by means of a continuously moving film projector, the film as it moved through the gate of the projector being scanned by a disc having a circle of 60 holes in its periphery, and rotating at a speed of 3,000 revolutions per minute. Each portion of the film was scanned by two revolutions of the disc, and in consequence the combination produced a 120-line scan and twenty-five pictures per second.

The variations of the light passing through the scanning holes, due to the picture on the film, were converted by a photo-electric cell into voltage variations and transmitted to the cathode ray receiver, these variations modulating the brilliancy of the spot light on the screen of the cathode ray tube. At the same time synchronising impulses were transmitted from the film projector to secure the necessary formation of the picture on the cathode ray screen, this picture being obtained by making the cathode ray spot on the screen traverse the screen horizontally in 120 adjacent lines, the picture in this form repeating itself twenty-five times a second. At the same time the sound was picked up on the edge of the film in the transmitter and reproduced through a loud speaker above the cathode ray tube. The two controls available at the cathode ray receiver give, firstly, a variation in overall brightness of the picture, and, secondly, a variation in the range of gradation so that the picture could be controlled at any time for brightness and for contrast.

Intermediate Film Working

Many other systems are being developed, and show varying degrees of promise, but space will only permit a reference to one other scheme, and this is the important intermediate film method shown in Berlin in the autumn of 1933 by Fernseh A.G. A pictorial diagram of the transmitter is given in Fig. 2. First of all the subject to be televised is filmed with an intermittent camera, and the film is then developed, fixed and washed rapidly, being finally scanned by a disc in a manner similar to that just described. The resultant signals are sent to the receiving end, the film meantime (actually part of an endless loop, as shown) being de-emulsified (to remove picture), re-emulsified and dried ready for a repetition of the process.

At the receiving end (Fig. 3) using a Kerr cell arrangement, a record of the received image is made on the film and the film is then developed, fixed, washed and dried. It then passes through an intermittent film projector so that the received images can be thrown on to a screen to be watched by a large audience. Following this we have the process of de-emulsifying, re-emulsifying and drying.

As the time interval between the original exposure and final showing on the screen is only a matter of some seconds, it will be appreciated that the system lends itself admirably to the televising of both flood-lit studio scenes or normal daylight events of sport or interest.

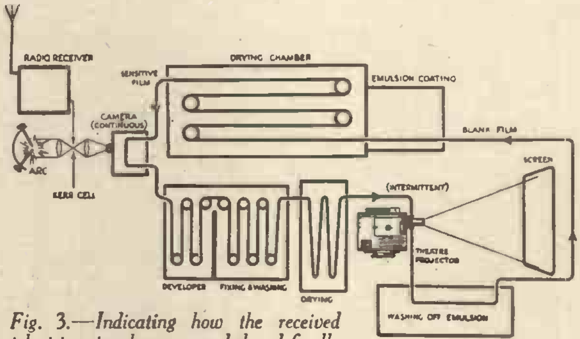
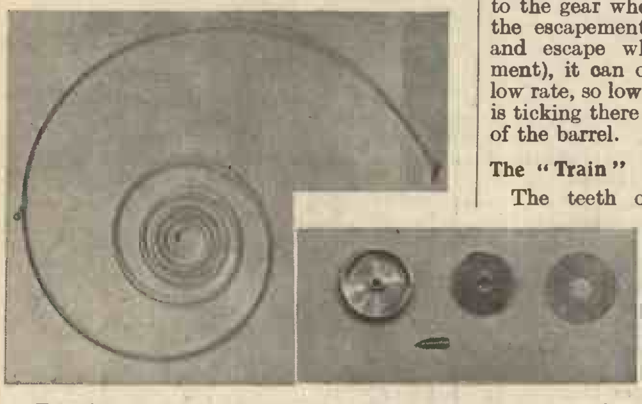


Fig. 3.—Indicating how the received television signals are recorded and finally projected on to a large screen.

HOW YOUR WATCH WORKS

(*Continued from page* 214.)

22 in. long and about ⅛ in. wide, is wound. The winding mechanism (all watches to-day are keyless and do not need a separate key), is clearly seen in the pictures. When the watch is wound the central pivot to which the mainspring is attached at its inner end is caused to revolve, and a check action known as the "click" prevents the pivot from unwinding. The tension or power thus stored in the barrel can only release itself by turning the barrel itself, the central pivot remaining stationary. This, as a fact, is what actually takes place, but due to the gear wheels and the check action of the escapement (the balance wheel, lever and escape wheel represent the escapement), it can only do so at an extremely low rate, so low in fact that when the watch is ticking there is no perceptible movement of the barrel.



This illustration shows the mainspring (22 ins. long) and the parts of the mainspring barrel.

The "Train"

The teeth on the mainspring barrel mesh into the teeth of a pinion attached to the second (not the seconds) wheel and the outer teeth on the second wheel itself mesh with a pinion attached to the third wheel. The teeth on the third wheel mesh with the pinion on the fourth wheel, the teeth on the fourth wheel (the seconds-hand wheel) meshing with the pinion on the escape wheel, and the teeth of the escape wheel alternately coming into contact with the pallets on the lever, which are rocked to and fro and thus impart oscillating motion to the balance wheel.

The complete series of wheels is known as the "train." The various wheels mentioned here are all illustrated in Fig. 1. Fig. 2 shows how the winding stem when pulled out shifts the winding train of gears into a fresh position so that the hands may be altered, the spindle to which the hands are attached being held in the centre wheel by friction only. A watch is really a most efficient piece of mechanism, no other piece of machinery, in fact, works with so little attention. Treat it with care, have it cleaned regularly (about once a year), wind it first thing every morning so that the power is greatest during the period when it has to withstand the greatest shock, and, most important of all, carefully regulate so that it keeps reasonably accurate time. Move the regulator only a fraction each time an adjustment is made, and wait for at least two days before making further adjustments.

Making Your Own Gramophone Records

A PRACTICAL ARTICLE ON HOME RECORDING

By
G. W. NICHOLSON

TWO or three years ago the home recording craze swept the country, but the only type of record available at the time for work of this nature was one made either of aluminium or an alloy containing a percentage of this metal. The craze, however, did not take on very well, for the trouble of replaying the records with fibre needles and poor reproduction, passed off home recording as an interesting novelty, serving no really useful purpose.

This year, however, home recording has been brought to perfection by means of a marvellous new home recording disc. It has an aluminium base coated with a plastic surface which is extremely easy to cut. When recording is complete, the disc is then baked in an oven for two hours, after which it is ready for playing on any type of gramophone from a portable to a radiogram. This record is flexible, unbreakable and can be played with steel needles, giving reproduction which compares very favourably with standard recordings. The disc is moderately priced, being 3*s*. for the 10-in. size with a cutting needle. This disc possesses none of the disadvantages of previous home-recording mediums, yet brings the art of home record-making within the reach of all. As most of my readers are of a mechanical and practical nature, I will explain how permanent records of the family, famous radio stars, and even greater people in the public eye can simply and effectively be made *in the* home with very little trouble, or for that matter, little equipment.

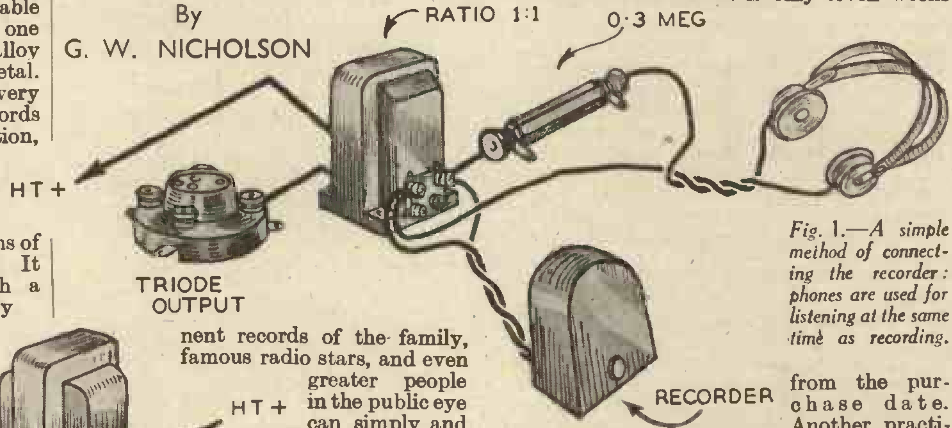


Fig. 1.—A simple method of connecting the recorder: phones are used for listening at the same time as recording.

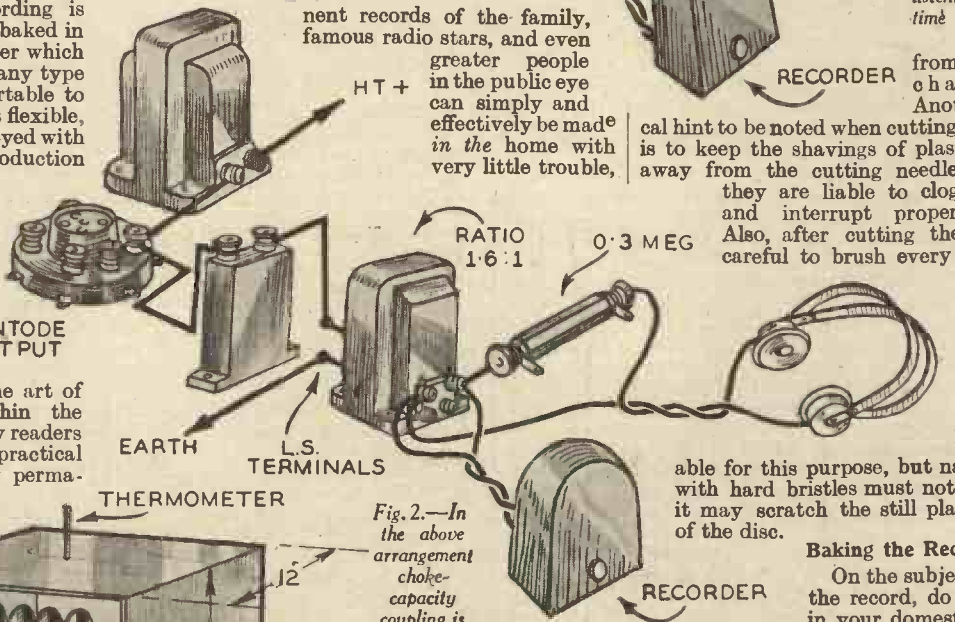


Fig. 2.—In the above arrangement choke-capacity coupling is used between the output valve and the recorder.

The Amplifier

Naturally, the main unit in home-recording work is the amplifier, either a separate unit or the utilisation of the present wireless set (see Figs. 1 and 2). For this purpose ½ watt is the minimum output necessary for making records at home, while an amplifier with an output of the order of about 1 to 1½ watts will be found to give extremely satisfactory results. A very important point to be noted when using these recording discs is to be sure not to buy them more than two or three days before the time of use, as the material hardens, and hence after a time cannot be cut; in fact the "shelf-life" of these records is only seven weeks from the purchase date. Another practical hint to be noted when cutting the records is to keep the shavings of plastic material away from the cutting needle, otherwise they are liable to clog its course and interrupt proper grooving. Also, after cutting the record be careful to brush every particle of dust out of the grooves, for the more dust—the more ground scratch. Any brush will be suitable for this purpose, but naturally one with hard bristles must not be used, as it may scratch the still plastic surface of the disc.

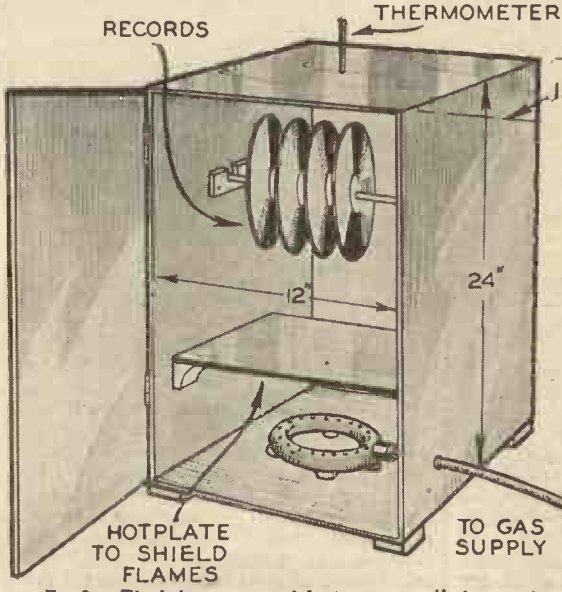


Fig. 3.—The baking oven used for "processing" the records.

Baking the Record

On the subject of baking the record, do *not* bake it in your domestic oven, for the fumes emitted when the disc is baked will permanently taint the oven. Rather build up a gas oven such as the one illustrated in Fig. 3. Galvanised sheet iron will be found an ideal medium for the purpose, and can be bought quite cheaply. The record must be baked in the oven for two hours at a temperature of 80°C., although a 10° C. limit either way does not

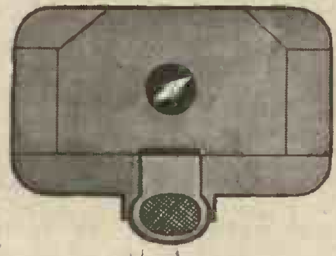


Fig. 4.—Showing the position of the needle.

make any material difference in the hardness of the recording. For this purpose, it is a good idea to incorporate a thermometer when building up the oven.

As to the actual cutting of the record there is a choice of apparatus for cutting

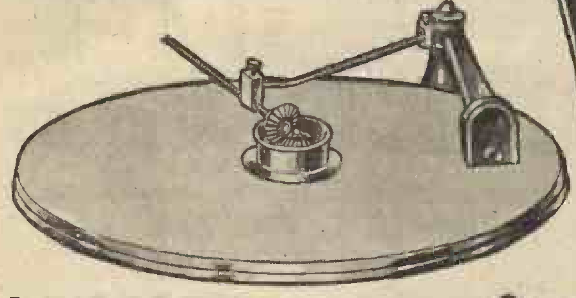


Fig. 7.—Method of using the control tracking arrangement.

the grooves when recording. The first works by means of a grooving device working from the centre turntable spindle, while the other is a rigid fitting which is driven by means of a belt-drive from a fixed pulley on the centre turntable spindle. These two methods are shown in Figs. 6 and 7. Both systems are quite satisfactory, and the method of connecting the output of the amplifier to the recorder is shown in the accompanying diagrams. It should be noted that good results of high-class quality can only be obtained when the cutting needle is inserted into the cutter with the point facing diagonally across the case as shown in Fig. 4.

Fig. 5.—Showing the recorder in position.

Recording Direct from Radio

When recording direct from the radio, the set is tuned into the station and strength of signal regulated by listening in on the "monitoring" headphones as shown. By this simple device volume can be determined and quality of reproduction roughly judged. When recording through the microphone this is then connected to the pick-up terminals, whilst the record is wired across the output as diagrammatically illustrated. One of the essentials to good recording is a good microphone, and hence it is to one's ultimate advantage to buy a high-class instrument which gives good quality and a suitable response curve.

Home recording is great fun, for the new recording disc mentioned in this article brings the immense scope of home recording within the reach of all. When the numerous uses of the system are considered there is no doubt this new hobby will rapidly develop.

Musikon Ltd., who for the past four years have been designing and producing sound recording and reproduction apparatus, are now able to supply a flexible, unbreakable, home recording permanent record which incorporates a number of remarkable properties and advantages.

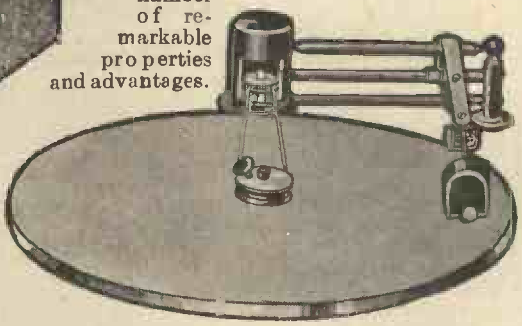


Fig. 6.—Apparatus for cutting records from the centre to the outside, or vice versa.

MARVELS OF THE MECHANICAL MAN

(*Continued from page 209.*)

box, or pick-up, traversing the record can, through a suitable amplifier, reproduce the recorded sounds through the medium of the loudspeaker in the Robot's head. Obviously, the amount of material which can be accommodated on a record is not very great, and, furthermore, if the Robot is to answer any question put to it, the pick-up has to be deposited on the sound track of the record at a spot delivering a suitable reply. With one record only, the number of questions which can be replied to is limited. However the sound-on-film method employed in the talkie installations provides a very much greater scope, and the only difficulty is found in providing sufficient relays to enable the film to be drawn through the "gate" to the various positions in order to deliver the correct speech. This means that the Robot, as probably many people have now found out, can only reply to a set number of questions, and for exhibition purposes these take the nature of the dates of well-known events, the time of day, the Robot's name, etc. So far, the Robot's delivery of speech is no more remarkable than the well-known weighing-machines which are now seen all over the country, and which tell you your weight when you stand on the platform and place a coin in the slot. The principal novelty rests in the manner in which the replies are given to questions asked by spectators. There is more actual novelty than mystery in this, however, when it is remembered that the question, in the majority of cases, may be given in any language, or even in nonsensical gibberish, provided the *intonation* follows certain predetermined lines.

A very ingenious toy which is now obtainable will assist in explaining this little mystery. Very popular some years ago in America, and introduced to this country some time ago, was a toy consisting of a small kennel mounted on a base, the whole being constructed from ordinary tin-plate. Standing just inside the kennel is a ferocious-looking bulldog. Over the kennel entrance is printed in large letters the name of the dog, for instance, Fido. When you stand close to the kennel and call out "Fido," the dog jumps right out of the kennel, sliding along the tin base. At first this seems remarkable, until, perchance, you are demonstrating the toy to a friend and happen to speak rather loudly near the kennel and are surprised to see the dog jump out. Perhaps after a little experimenting you will find that the dog will come out if you call out "Tin-tacks" or any other word. With the majority of Robots, "How old are you?" will elicit the reply, "Three years" or any other prearranged period, but this same reply would be given if you asked, "How *bold* are you?" The microphone receives the vibrations of the question, and a pre-selector, designed to operate somewhat after the manner of the automatic telephone, actuated generally by an ordinary electric relay, rotates the sound-film, or recording disc, until the desired answer is brought into position, and the amplifier is then brought into action to deliver the reply. Fig. 3 shows a schematic lay-out of a microphone, relay, sound film arrangement. In this diagram (see p. 209), if the number "One" is spoken into the microphone, or, in other words, a single impulse is received, the relay is operated during the course of which the arm of the relay bears against one of the teeth of the cogged wheel, A, and so rotates the sprocket wheel and turns the film through a certain movement. It will be appreciated, of course, that instead of film the relay could switch in an electric motor for a certain period, etc. Two impulses at the microphone circuit would rotate the toothed wheel two sections, and so on.

The light-sensitive device bearing this name has already been explained in these pages, and by including one of these cells in the head of the Robot it is possible to arrange that anyone passing in front of it will bring some piece of mechanism into action and either make the Robot call out or even cause him to operate some external apparatus. Thus a bell may be placed at the side of the Robot, and a person adopting the *role* of a burglar may walk past the Robot, whereupon he will pick up and ring the bell. The General Electric Company of America have devoted considerable money and time to the design of Robots for commercial purposes, and although these have not been built in human form (as they are for utility and not exhibition purposes) they may be found fulfilling many functions in the G.E.C. works. Such routine jobs as opening up the works at a given hour (a time-operated device), blowing the cease-work hooter, starting up machinery, cutting off electric power in the event of a fault developing in a machine, sounding a fire alarm in the event of fire (a temperature-operated device), and many similar schemes are actual practical examples of Robots.

HOW TO MAKE A VARIABLE RESISTANCE

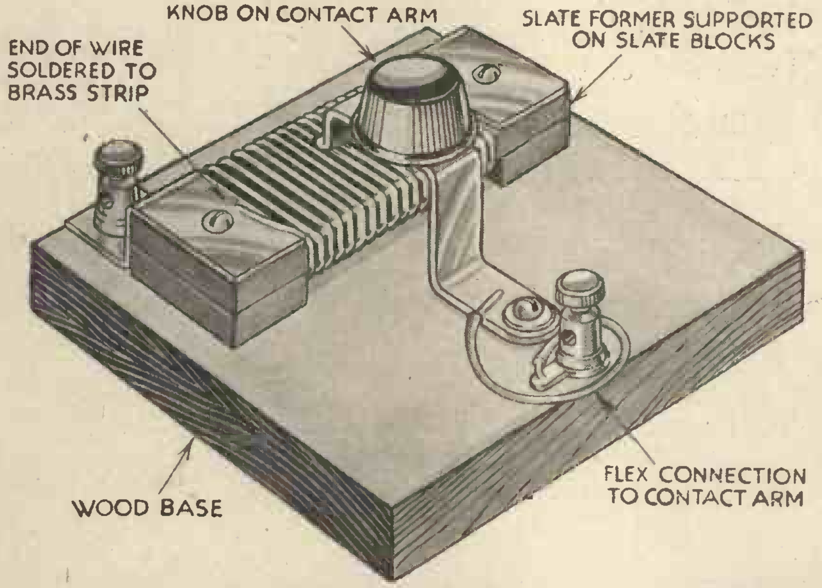
By "ELECTRA"

VARIABLE resistances are most useful to the amateur electrician, since they may be used in a variety of experiments. They are very useful in charging circuits for regulating the current and thus ensure that the battery receives its correct charge.

The best wire to use is bare Eureka and for a resistance of 10 ohms, that will carry a maximum current of about 1 ampere, 1 yard of No. 26 S.W.G. will be required. This resistance, which has the wire wound on a slate former, may be overloaded for short periods without fear of damage. Obtain an ordinary piece of slate, that which is used on house roofs is ideal, and cut from it a strip by means of a hacksaw. To accommodate the turns of wire cut, on all the four longer edges of the slate, a row of nicks by using a smooth three-cornered file. Drill a hole at each end of the bar to take a thin $1\frac{1}{2}$-inch brass round-headed wood screw and cut two small blocks of slate and drill them to take the same screws as the bar so that the bar will be supported above the base; this allows for easy cooling of the wire and preserves the base from injury if the wire becomes red hot. Cut two pieces from $\frac{1}{16}$-inch brass, the same size as the two slate supports, and drill them to take the brass screws; solder one end of the resistance wire to the piece of brass and wind the wire tightly on to the slate so that no adjacent turns touch. When the strip has been fully wound solder the end of the wire to the other end-piece. To facilitate the winding of the slate it is a good plan to temporarily bolt the brass strips to the slate.

The base should be square and of $\frac{1}{2}$-inch wood, and measuring, each way, about 1 inch more than the length of the slate strip. The contact arm is cut from $\frac{1}{16}$-inch brass and is bent as shown below; the knob may be taken from an old wireless component, or the end of a clothes peg or half a cotton reel will do quite well. Two terminals are required and should be screwed into the base—one is connected to the contact arm through a short length of flex, and the other is connected to a brass end-piece. To test the resistance connect it in series with a 2-volt battery and a 4-watt lamp; notice how the light is dimmed as the arm is moved.

Two examples of the use of the resistance are given below; if the resistance of the circuit is 14 ohms, then the current may be reduced to $\frac{1}{7}$th of an ampere when a 10-ohm resistance is used in conjunction with a 2-volt battery; similarly, if it is desired to charge one 2-volt accumulator from a 12-volt dynamo, then the current may be reduced to 1 ampere. In all experiments where a variable resistance is used make sure that all the resistance is "in" before switching on the current.



The complete resistance. Note the compact and neat layout which gives it a commercial appearance.

The PRACTICAL MECHANICS Wireless Experimenter

THE 1934 STRAIGHT THREE

A splendid, cheap and easily constructed three-valver of the Detector and 2 L.F. type

THERE is little doubt that the most popular type of home-made receiver is the three-valver, and when the three valves are arranged in the form of a detector and two low-frequency stages, excellent all-round results are obtained. If you are without a wireless receiver, you should certainly make up this set, which employs this time-honoured circuit, a feature of it being that the tuning and reaction controls are actuated by two concentric knobs, a decided convenience when tuning in. This tuning and reaction condenser combined is marketed by the British Radiogram Company, and it is both efficient and cheap. The coil used is one of the modern shielded type, and although providing only a single tuned circuit, there is ample selectivity for most purposes and an entire absence of direct pick-up from the local stations.

Showing how the cabinet may be used as two separate cabinets by lifting off the top section.

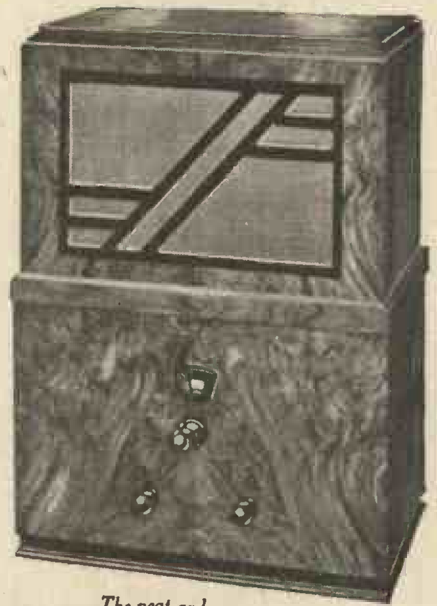
The Components

Owing to the minimum number of components used, the wiring will be found practically "fool-proof." The tuning-in of stations will also be found "fool-proof," and owing to the type of inter-valve couplings which have been included, the quality of the reception will satisfy even the most critical listener. Having described the special features of the receiver, we may now get down to the description of its construction, and even the beginner will find no difficulty in following the instructions given herewith.

The Construction

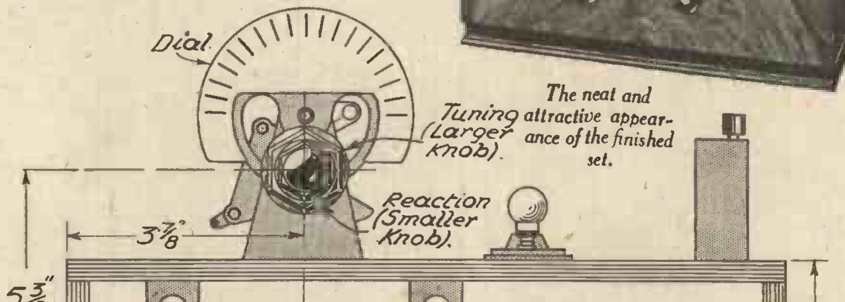
A Metaplex chassis, 12 in. × 10 in., with 3½-in. runners is used, and this should be prepared first by drilling three 1-in. holes for the valveholders; a glance at the wiring plan will show their positions, and two slots should be cut in the rear runner for the two terminal strips. Now lay out the rest of the components in the positions shown in the wiring plan. Note the arrangement of the two inter-valve couplings before screwing them down, so that the wiring will be correctly carried out. Do not drive in a single screw until you are quite certain that each component is in its correct position, and the right way round. It is now ready for wiring.

In any receiver it is always preferable to wire up in a systematic manner, rather than by just putting in a wire here, and another wire there. The low-tension parts can be wired first, and then wires carrying high voltages, and so on. As each wire is put into place, cross out the corresponding wire in the wiring plan. By working in this manner one is assured of putting each wire in its correct position, and when the job is finished no wires will be found to have been omitted. Note that one terminal on the Transcoupler is not used in this particular circuit arrangement. When finished, the set should be fitted into the Peto Scott De Luxe Cabinet specified, which is actually two complete cabinets which can be fitted together or used separately, one for the set and one for the loud speaker. A template is supplied with the condenser, which facilitates the marking and cutting out of the dial window and the position of the condenser spindle. The holes for the filament and wavechange switches should then be marked out and bored, and the set can then be fitted into place. The set has been so designed that the batteries may be incorporated inside the cabinet with the receiver, thus making it neat and compact.

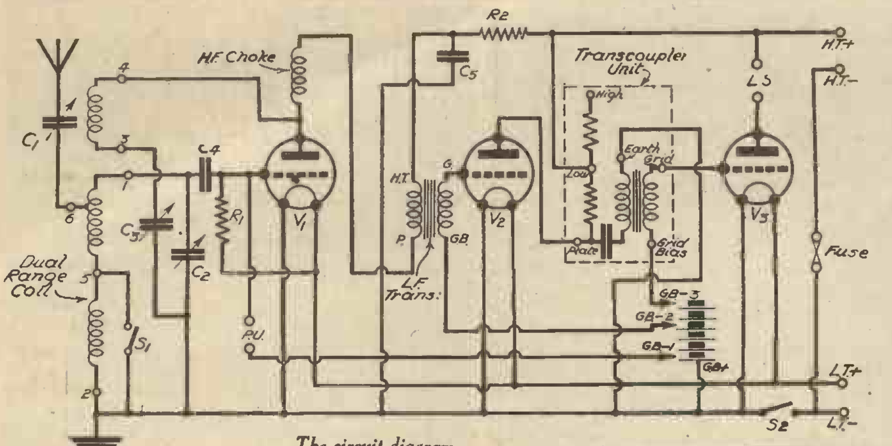


The neat and attractive appearance of the finished set.

A three-quarter rear view of the 1934 Straight Three.



Details and measurements for fixing the condenser and switches.



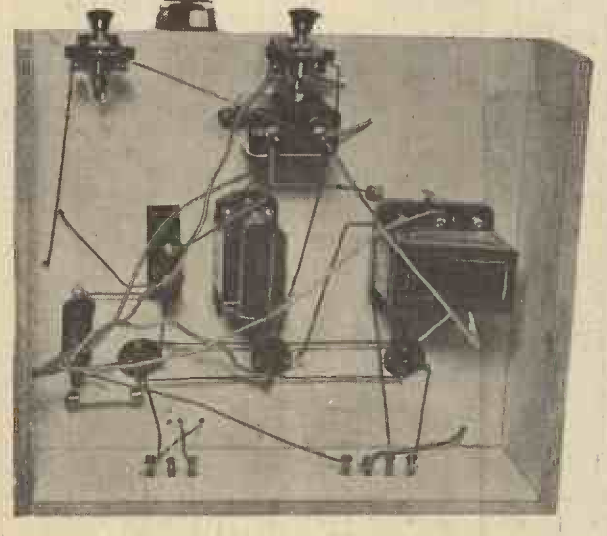
The circuit diagram.

connection to the tuning condenser although this component is provided with two terminals; the same thing also occurs in respect to the reaction condenser. The reason is that the moving vanes of both these components are automatically earth-connected through the mounting bracket and the metallised surface of the chassis.

Two fixed resistances are used—one is to decouple the anode circuit of the detector valve, and the other is the detector grid leak. The grid leak is connected up by means of the two wire ends with which it is provided, but these are insufficiently long in the case of the decoupling resistance so that they have to be lengthened by soldering short lengths of connecting wire to them. Soldered connections are also used for the valve-holder connections, the holders em-

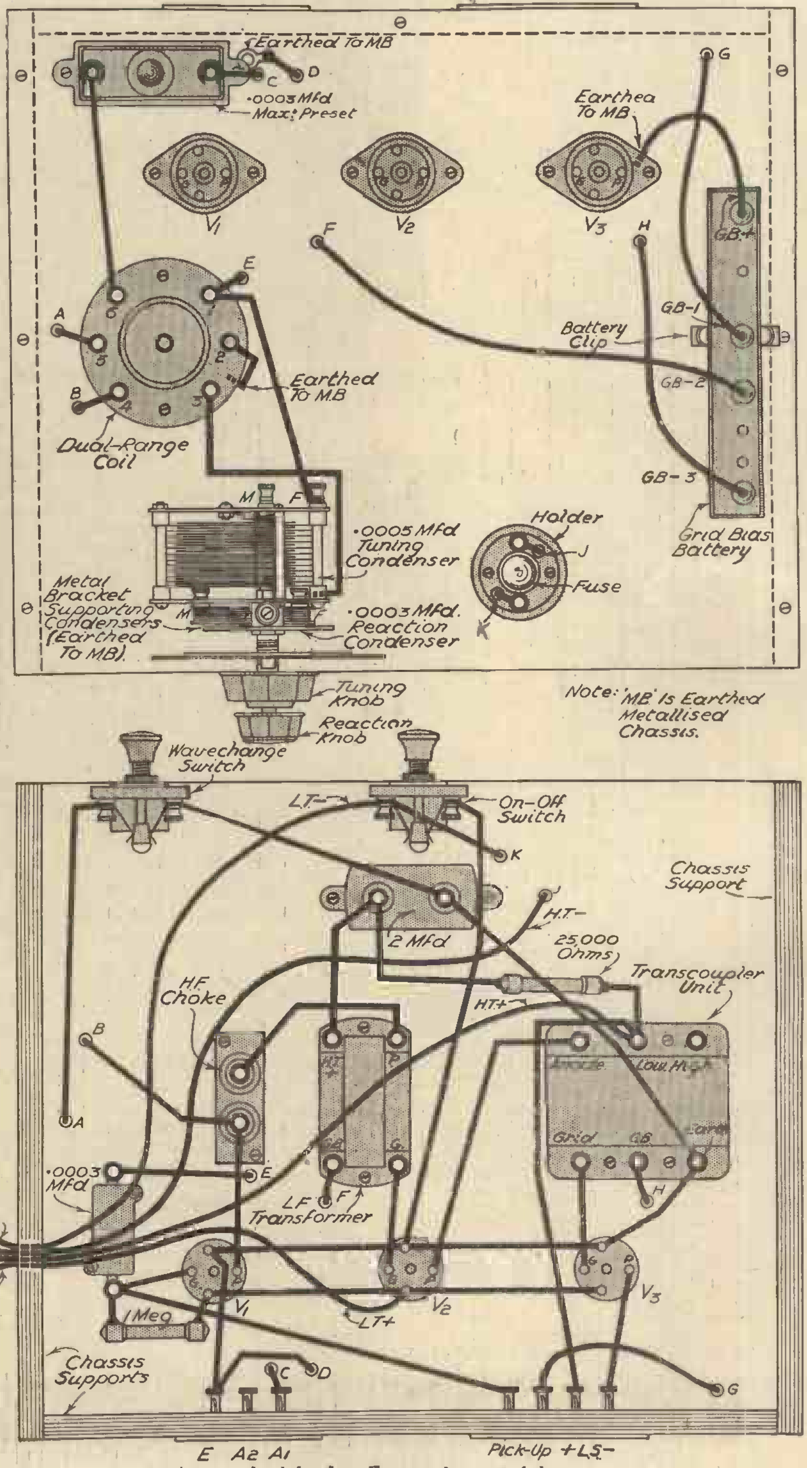
Additional Points in Regard to the Construction

Those readers who have had previous experience of receiver construction will find no difficulty in making this set by following the drawings and photographs reproduced. Readers who are new to wireless constructional work, however, might find some of the details rather puzzling. For example, it will be noticed that there is only one


A rear view of the receiver.

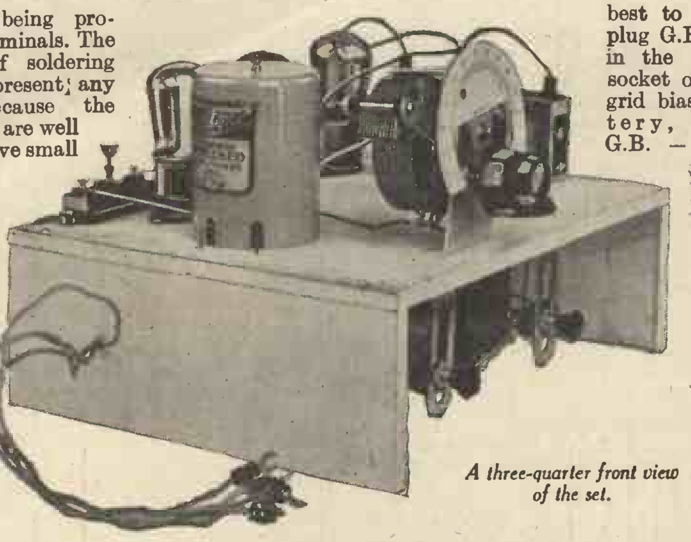
List of Components for the 1934 Straight Three

One Metaplex Chassis, 12 in. × 10 in., with 3½-in. runners.
One British Radiogram Tuning Control Unit, Type 68.
One Goltone G.G.R. Matched Screened Coil.
One 5 : 1 L.F. Transformer (B.R.G.).
One Transcoupler (Bulgin).
One ·0003 mfd. Fixed Condenser, Type 670 (Dubilier).
One ·0003 mfd. Pre-set Condenser (B.R.G.).
One 2 mfd. Fixed Condenser, Type B.B. (Dubilier).
One 1 watt 1 meg. Grid Leak (Dubilier).
One 25,000 Ohm Metallised Resistance (Dubilier).
One Baseboard Fuseholder and Fuse (Bulgin).
One Binocular H.F. Choke (Burne-Jones).
One G.B. Battery Clip (B.R.G.).
Three Four-pin Chassis Mounting Valveholders (W.B.).
One On-off Switch (B.R.G.).
One Wavechange Switch (B.R.G.).
One Coil Connecting Wire (B.R.G.).
One Hivac D210 Valve.
One Hivac L210 Valve.
One Hivac P.P.220 Valve.
One Four-way Battery Cord (Belling-Lee)
One Vince's 120-volt H.T. Battery.
One Vince's 9-volt G.B. Battery.
One Ediswan 2-volt 45 amp. Accumulator, Type ELM.4.
Two Terminal Strips (Clix).
Six Clix Solid Plugs; Aerial, Earth, L.S.+, L.S.–, P.U., P.U.
One W.B. Loud Speaker, Type PM4a.
Screws, Flex, 4 Wander Plugs (G.B.+, G.B.–1, G.B.–2, G.B.–3) (Peto Scott).
One Tin Flit.
One Peto Scott De Luxe Twin Cabinet



A top and sub-baseboard wiring diagram of the set.

ployed not being provided with terminals. The little task of soldering should not present any difficulty because the tags provided are well tinned and have small holes passing through them. The easiest method is to bend the bared end of the connecting wire and loop it through the appropriate hole, after which a spot of solder can easily be applied.



A three-quarter front view of the set.

The transcoupler has six terminals, but only five of these are employed, the sixth (marked "High") being left free. The reason for this is explained by the fact that the coupling unit is fitted with a tapped anode resistance, so that correct matching can be obtained for different types of valves. As the valve employed in the L.F. stage is of comparatively low impedance it is correctly matched by a single portion of the resistance provided, this having a value of 30,000 ohms.

Optimum G.B. Voltages

When first trying out the set it will be best to insert plug G.B. – 3 in the 9-volt socket of the grid bias battery, with G.B. – 2 in the 4½-volt socket and G.B. – 1 in the 1½-volt socket. These voltages will be approximately correct, but they might require to be varied slightly later on in order to obtain maximum efficiency from the receiver. Before making any alteration to the G.B. tappings, however, be sure to switch off the set and also (for additional safety) to disconnect the negative high tension lead. If this is not done there will be a risk of damaging the power valve, due to the fact that it would pass much too high a current when the grid bias supply was disconnected. It is, of course, impossible to find the optimum position for G.B. – 1 except when the pick-up is in use. Incidentally, it should be pointed out that the pick-up must not be left connected to the receiver when radio reception is required. Additionally, it might be pointed out that the tuning condenser must be so adjusted that it is not tuned to a station whilst the gramophone pick-up is in use, or else there will be "break-through" on record reproduction.

Selectivity Adjustments

This set will be found to be quite sufficiently selective for most purposes, excepting where the aerial is situated within a few miles of a Regional station. The degree of selectivity can also be controlled over fairly wide limits by altering the capacity of the pre-set aerial condenser mounted at the back of the chassis. Selectivity is increased—or tuning sharpened—by slacking off the adjusting knob, whilst signal strength is made greater by screwing the knob down.

Testing Out

Plug a Hivac D210 valve into the holder nearest the coil, a Hivac P.P.220 into the holder at the other end of the baseboard, and a Hivac L210 into the centre holder. The batteries should then be connected, and the grid bias values adjusted as previously stated in the second column. The rear knob on the tuning unit controls the station selection, and the front knob controls the reaction. Rotate the tuning knob, and you should soon be able to hear your local station, which you will find will occupy a very small space on the tuning dial. You may be in a good district, and be able to hear and separate two or three stations with this particular setting of the first dial, and by adjusting the reaction condenser you will be able to increase the strength of the stations. In this way quite a number of stations on both long and short wavelengths may be heard.

HOME-MADE TUNING COILS

By OUR RADIO EXPERT

This article tells you how to make all types of tuning coils at home

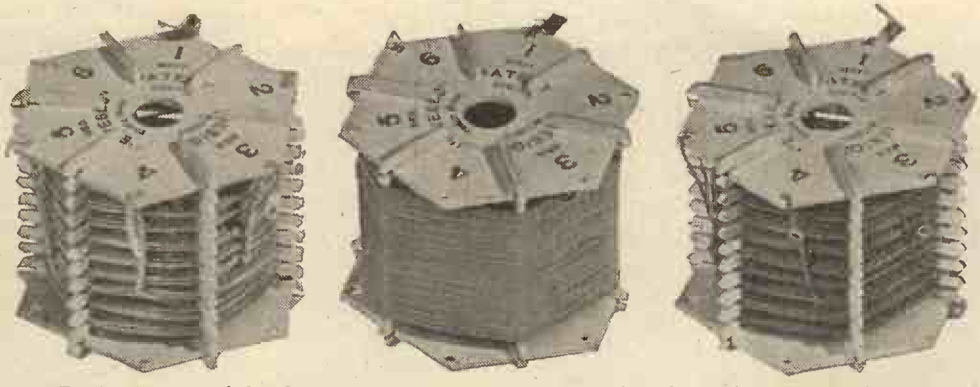


Fig. 1.—Three simple broadcast coils, made up according to the details in this article from Ewebec former.

What Governs the Efficiency

A TUNING coil, as every reader now knows, consists of a coil of wire, either wound on a former of some type or self-supporting. The electrical features possessed by the coil include high-frequency resistance, self-capacity, and inductance. The H.F. resistance is determined by the thickness of the wire; the self-capacity is governed by the spacing of the adjacent turns; and the inductance is governed principally by the number of turns. In addition to these features there is what is known as "dielectric losses." This means that the high-frequency currents are able to leak away through the material from which the coil former is made, and obviously these losses must be kept at a minimum. A reduction in the high-frequency resistance may be obtained by using very thick wire. This leads to a rather clumsy coil, and when a coil is large the surrounding electrical field is also large (I am speaking, of course, of the plain solenoid, or cylindrical coil). The H.F. resistance may be lowered by using stranded wire, but this is expensive, and, owing to the size of the electrical field, leakage losses occur, and there is also the risk of stray couplings with other components in the receiver. The spacing of the turns will reduce the self-capacity, but here, again, the size of the coil will be increased with the same troubles as previously mentioned. Dielectric losses may be reduced (or even completely eliminated) by making the coil self-supporting.

For those readers who are desirous of making up a series of coils for experimental purposes, with the advantage of stripping down one coil and building another of a different type, the coil former illustrated on this page will be found extremely useful. This is the article known as "Ewebec" former, and, as can be seen, it consists of two hexagonal discs of bakelised material, with six strips of similar material having one edge smooth and being cut on the opposite edge into a number of slots—very similar to the ordinary comb.

The illustrations show six different types of coil built up on these formers, and the following data will enable readers to make up some of these coils, and variations may, of course, be carried out to suit any particular ideas or requirements. These coil formers are very cheap.

Simple Coils

The simplest coil is shown in the centre of the group in Fig. 1, and this consists of a solenoid, or single-layer coil, having a total of fifty turns of No. 24 D.C.C., which just fills the straight side of the former. The D.C. resistance of a coil of this description would be roughly 5 ohms, and the inductance approximately 150 microhenries. This will tune, with a ·0005 mfd. condenser in parallel, to just about 500 metres. Obviously, such a type of coil would not be of very much use on the average valve receiver owing to lack of selectivity, but it is a suitable illustration of how the coil is made up. A coil suitable for covering both the medium and the long-wave bands, and which is efficient enough to be included in a modern receiver, is shown on the right, in Fig. 3. This is a dual-range coil wound with 28-gauge double-silk-covered wire. Six terminals are fitted into the top of the coil, and two or more small feet, *constructed from aluminium or brass*, should be attached to the lower end to enable the coil to be mounted in the receiver. It should be particularly noted that iron brackets must not be used for this purpose. The beginning of the wire is attached to terminal No. 1, and fourteen turns are wound into the first slot, after which the wire passes into the second slot, in which a further fourteen turns are wound. The wire then passes into the third slot, in which a further fourteen turns are wound, and the wire is then taken up to terminal No. 2, a space of about ½ inch scraped clear of the silk covering and the bare wire attached to that terminal. The wire is then taken back to slot No. 4, into which ten further turns are wound. The wire is then carried up to terminal No. 3 and a connection made as for No. 2, after which the wire is led back into slot No. 4, into which four more turns are wound. The wire is then taken up to terminal No. 4, connection made, and the wire led down to the third slot from the opposite end. Into this, and the remaining two slots at the lower end, fifty-five turns are wound (in each slot), and the end of the wire taken up to terminal No. 5. A length of wire is then cut off and joined to this terminal and taken down to the fourth slot from the lower end, into which thirty-five turns are wound. The end of this small winding is joined to the remaining terminal, No. 6. All the turns are, of course, wound in exactly the same direction. The connections for this coil are 5 and 4 to earth, 1 to the tuning condenser, and 6 to the reaction condenser. An on-off switch is joined between terminals 1 and 5, whilst the aerial is fed through a small pre-set condenser (·0003 mfd.) to either terminal 2 or 3, according to the degree of selectivity required.

Fig. 2.—A simple wave-trap.

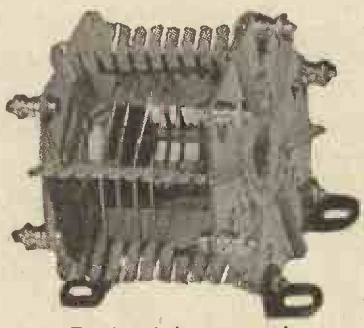


Fig. 4.—A short-wave coil.

Short-Wave Coils

This type of former is ideal for the construction of short-wave coils, a specimen of which is shown below, at Fig. 4. For this particular coil three turns of No. 28 D.S.C. wire are wound in the first slot, the commencement being joined to terminal 1 and the finish to terminal 2. Two slots away, the grid coil is commenced and this consists of 18-gauge enamel wire, wound one turn per slot for five slots. The commencement of this winding is joined to terminal 5 and the end to terminal 6. Into the next, and final slot, is wound five turns of the 28-gauge D.S.C. wire, joined to terminals 3 and 4. The latter winding is for reaction purposes, whilst the first fine wire winding is used as an aperiodic aerial coil. The remaining coil, at Fig. 2, is a simple type of wave-trap for use on the 200-500 metres wave band, and a series aerial condenser is mounted upon one end by using two of the holes as fixing holes. The spacing will be found just right for this purpose.

For an experimental receiver, built with the idea of achieving results from a one-valve set which are comparable with a five-valver, by all means study the points above set out—but remember, if the coil is to be 100 per cent. efficient, every other part of the receiver must also be of the same order or you will be wasting the efforts spent on the coil construction.

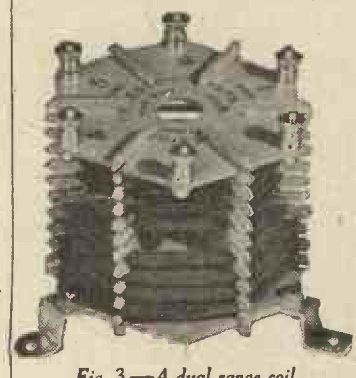
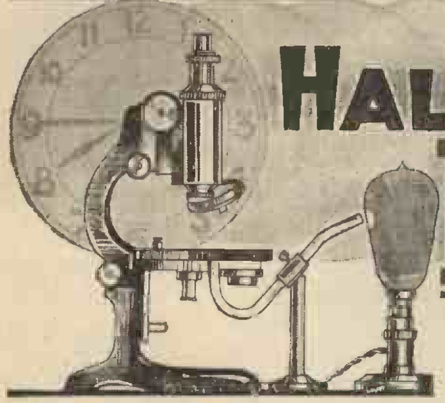


Fig. 3.—A dual range coil.



HALF HOURS *with the* MICROSCOPE

Killing and Dissecting form one of the most interesting branches of Microscopy, and some instructions for beginners are here given by W. J. DELANEY

IN order to obtain certain insect or animal portions for microscopic examination it is obviously necessary to perform some type of dissection, although those to whom this may seem objectionable may purchase, ready mounted, most of the organs, etc., which form such admirable subjects for examination under the lens. Popular items, which always form objects of wonder to the average person, are the following: Fly's or similar insect's proboscis; moths' and butterflies' antennæ; insect feet; butterfly or moth wing scales; and various eyes. All of these are extremely simple to obtain, although the acquisition, for instance, of a fly's eye in perfect condition will not be a simple task for the beginner. However, to proceed to the actual task of dissection. The first point is, of course, to kill the object which is being chosen for the first experiment, and even if this is such an objectionable creature as a human flea, it is worthy of a painless death. The simplest form of killer will be cyanide of potassium, and this is best prepared by placing the crystals in the bottom of a moderately sized glass vessel and covering them over with a thin layer of plaster of Paris. Fig. 1 gives some idea of the arrangement, which will, of course, require a tight fitting cork to prevent the escape of the dangerous fumes. Before going any further it must be stressed that this poison is extremely powerful, and unused portions must be placed in some perfectly safe place in the home where they are not accessible by unknowing members of the household, and also where any fumes are not capable of being inhaled. Chloroform and ether are also very suitable if they are kept in their place, but the first mentioned will prove most suitable for beginners, and is easier to handle.

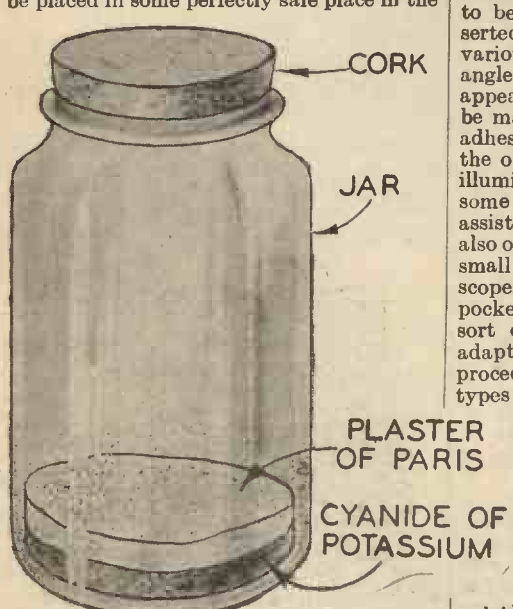


Fig. 1.—A simple killing bottle.

Apparatus Required

Although it is possible to purchase some elaborate knives, needles and other accessories, the beginner will undoubtedly prefer to make his own, and a razor blade (of the stiff-backed variety) will be found very useful, whilst a sharp-pointed pen-knife will also be of assistance. A few lengths of thin dowel rod, or, alternatively, some penholders, and a few ordinary sewing needles of varying thickness will enable a number of various forms of dissecting needle quickly to be made. The needles are simply inserted into one end of the rod (eye first), to various distances, and also at various angles. Fig. 2 gives an idea of the complete appearance, and, if desired, the needles may be made fast by using a small quantity of adhesive such as Seccotine. In order that the object being dissected may be suitably illuminated a bull's-eye lens, mounted on some form of stand, will be required, and to assist in locating small parts a magnifier, also on a stand, will be found useful. Special small magnifiers, known as dissecting microscopes, may be purchased, or, if desired, a pocket magnifying glass, mounted in some sort of universal mount, may be adapted for use. The method of procedure will vary with different types of object, but in every case it will be found preferable to have a liquid in which to place the object during the process. Ordinary water will suffice for some things, whilst alcohol, methylated spirit, etc., will be required with various types of vegetable matter which is undergoing dissection for veins, etc. As a liquid is required, it is obvious that some suitable vessel must be employed, and whilst special glass receptacles may be purchased the ordinary household saucer will fulfil the purpose.

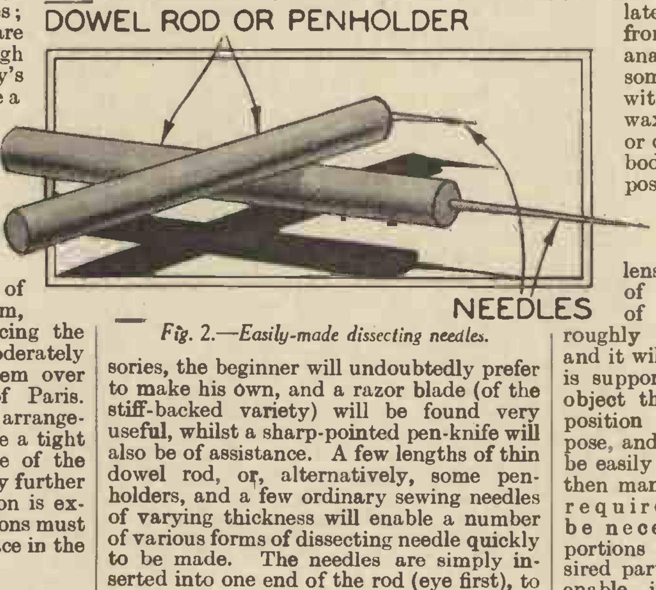


Fig. 2.—Easily-made dissecting needles.

Simple Dissection

As a simple subject we will take a fly's proboscis. As we shall require to manipulate two needles to get this part away from the remainder of the fly's anatomy it follows that we require something to hold the fly still, and with most objects a small quantity of wax, dropped on to a piece of leather or cork, will hold the insect or other body quite firm enough for our purpose. To keep the hands steady two wooden blocks, or a small pile of books, should be arranged on either side of the vessel, and the lens arranged to focus a brilliant spot of light upon the desired portion of the object. Fig. 3 illustrates roughly the complete arrangement, and and it will be seen that the small magnifier is supported at such a height above the object that the eye may be placed into position without assuming an awkward pose, and at the same time the object may be easily picked out. The two needles are then manipulated in order to separate the required portion, although it may be necessary to remove several portions of the body before the desired part is exposed sufficiently to enable its removal without fracture or distortion. In the majority of cases it will be found that the portions of the body have to be "teased" out

(Continued on page 245)

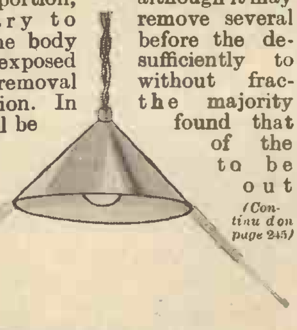
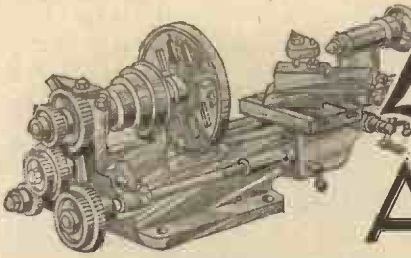



Fig. 3.—The complete assembly of apparatus required for dissection. Note the condenser lens and the small microscope or magnifier

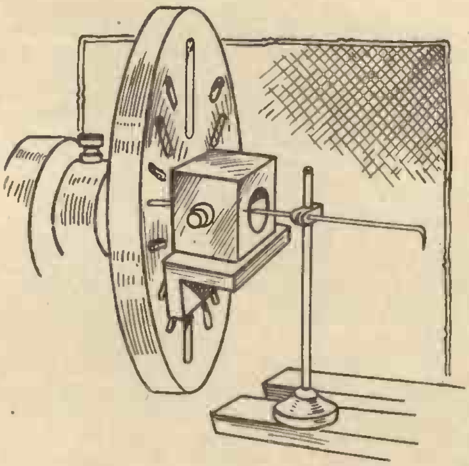


Lathe Work FOR AMATEURS

USING THE FACE-PLATE

By F. J. CAMM

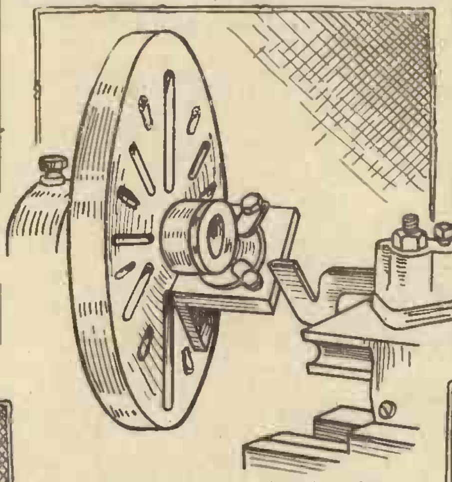
BEGINNERS in lathe work tend to ignore the varied uses of the face-plate, and often laboriously perform by hand work which could be more conveniently and accurately effected by clamping it either to the face-plate or to an angle-plate attached to the face-plate. This month, therefore, I show a number of face-plate operations representative of the many uses of this useful piece of lathe equipment. The face-plate has a number of narrow slots of varying lengths cast in it, and the angle-plate base also has holes cast in it. It is thus possible to clamp the angle-plate to the face-plate in any desired position to accommodate castings or pieces of work having irregular contours. The face-plate is not only useful for certain boring operations (as was described last month) but also for certain facing operations—that is to say, the turning of flat surfaces, as distinct from truly cylindrical surfaces. It is a fact that there are many other irregular forms which can be turned in a lathe by means of simple rig-ups. These will form the subject of a later contribution.



Use of face-plate and angle plate.

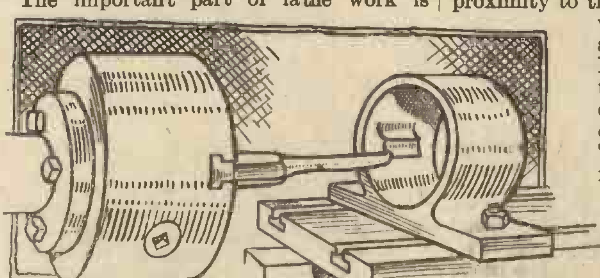
Setting Up

The important part of lathe work is always the setting-up process, and it is necessary, having marked out the casting, to use various bench tools in conjunction with the surface of the lathe saddle or bed, or the surface of the face-plate itself, to ensure that the machining operation will not cut into metal that it is not desired to remove. The lathe bed is parallel to the lathe spindle and the face-plate is at right angles to it. The steel square and the scribing block can hence be used to good advantage in checking the position of the casting and the result of a preliminary cut. If a test after the first cut reveals that the first setting was faulty, or that the casting has moved, there is time to reset before taking the finishing cut.



Further application of the face-plate.

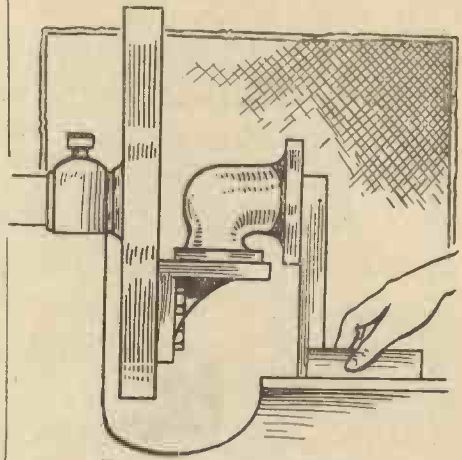
A good example of face-plate work occurs in the case of a square block or a split crank-case casting, in which case the two halves would first be faced, then screwed together, and finally the mouth bored to receive the cylinder spigot. In the case of a casting of this nature which already has a rough cored hole, the position of the casting should be adjusted so that the scribing point of a scribing block held in proximity to the cored hole scribes a circle which fairly covers it, leaving an even margin for boring. If it is necessary to chamfer the corners this may also be done by suitably turning the casting on the angle-plate. The illustrations show other face-plate applications. One example shown, that of a right-angle elbow or pipe coupling, is a good example, for, unless this is carefully mounted, it is possible that the facing operation on the second surface will turn away the entire flange before it could be brought into right-angles with the first It is possible, also, to undertake drilling with work mounted in this way. The drill should be mounted in the tail stock, the hole centres, of course, first being centre punched in the casting and the position of the latter adjusted accordingly.



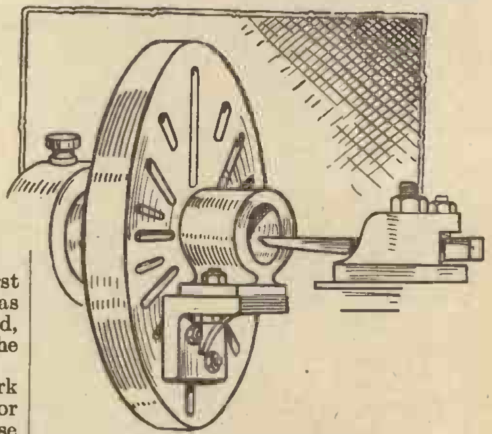
Boring, with work mounted on rest.

Alternative Methods

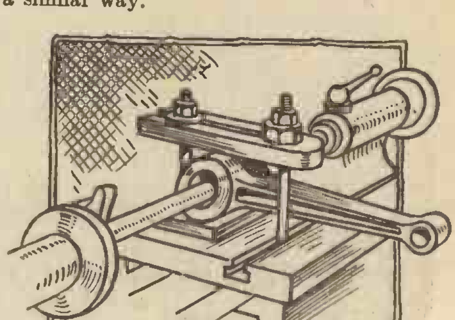
Some readers may not possess face-plates, and whilst I would always advise them to purchase this useful accessory (an angle-plate is not an absolute necessity in every case) it is possible sometimes to adopt alternative methods. Two examples are shown at the foot of this page. In one the casting is bolted to the slide of the saddle, and the boring tool is mounted in the chuck. The feed is effected by racking the saddle along. A connecting rod may be bored in a similar way.



Testing a pipe elbow after facing.



F; *Boring a bearing housing.*



Method of boring a connecting rod.

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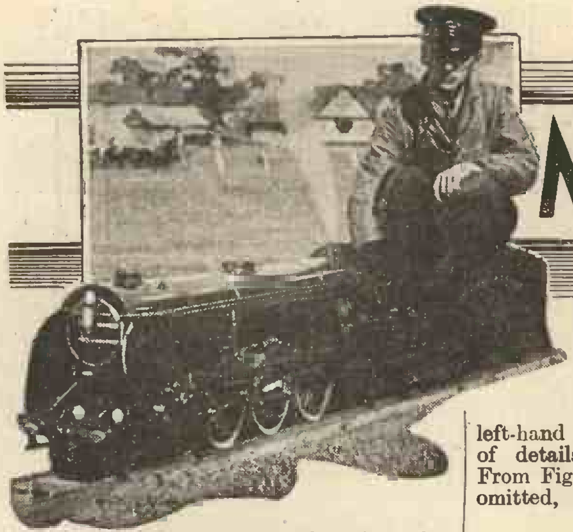

MODEL RAILWAYS

A 4¾ IN. GAUGE GARDEN RAILWAY LOCOMOTIVE. Part II

By E. W. TWINING

In my last article I said that the valve gear constitutes one of the most important parts of the locomotive, and it may be added that the successful steaming and haulage power of the engine largely depends upon it, and the accuracy of its design and construction, since, even with a big-bore cylinder and a good steaming boiler, if the steam distribution, as controlled by the valve gear, is not correct, the best performance cannot be expected, either in pulling capacity or economy of fuel and water; indeed, the engine could be an almost complete failure. With these facts in view, therefore, it behoves the builder of the model to be careful in the making of each of the parts, and particularly the distance between centres of pins in every one of the links.

The Valve Gear and Motion

To enable him to thus work accurately, the elevation drawings given in Figs. 1 and 2 are not sufficient, and two other detail drawings are now appended. The first (Fig. 5) is a complete general arrangement of the left-hand gear, whilst Fig. 6 is a group of details showing each of the parts. From Fig. 6 one or two of the details are omitted, but for convenience these are included in Fig. 5; for instance, the return, or eccentric, crank, which is really part of the valve gear. The two drawings, of course, include the motion; that is to say,

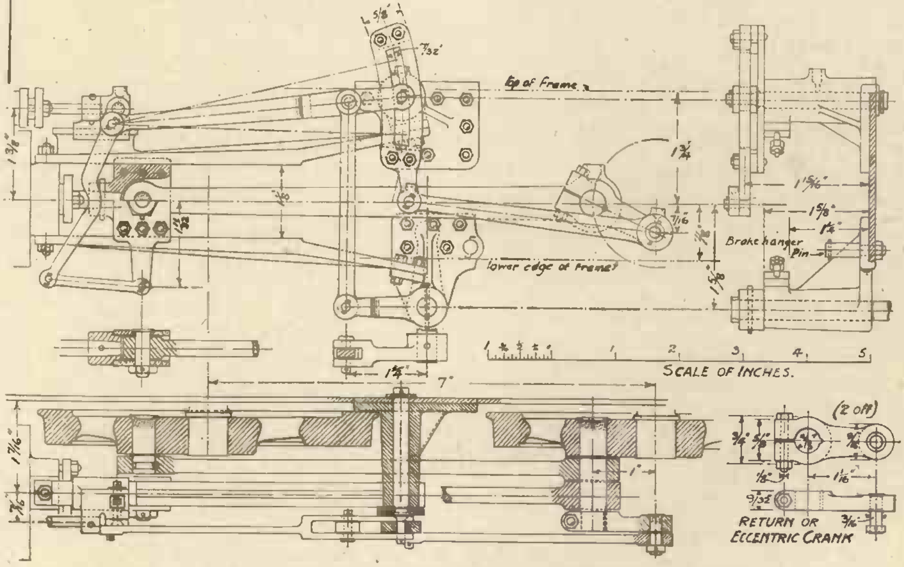

Fig. 5.—General arrangement of motor and valve gear.

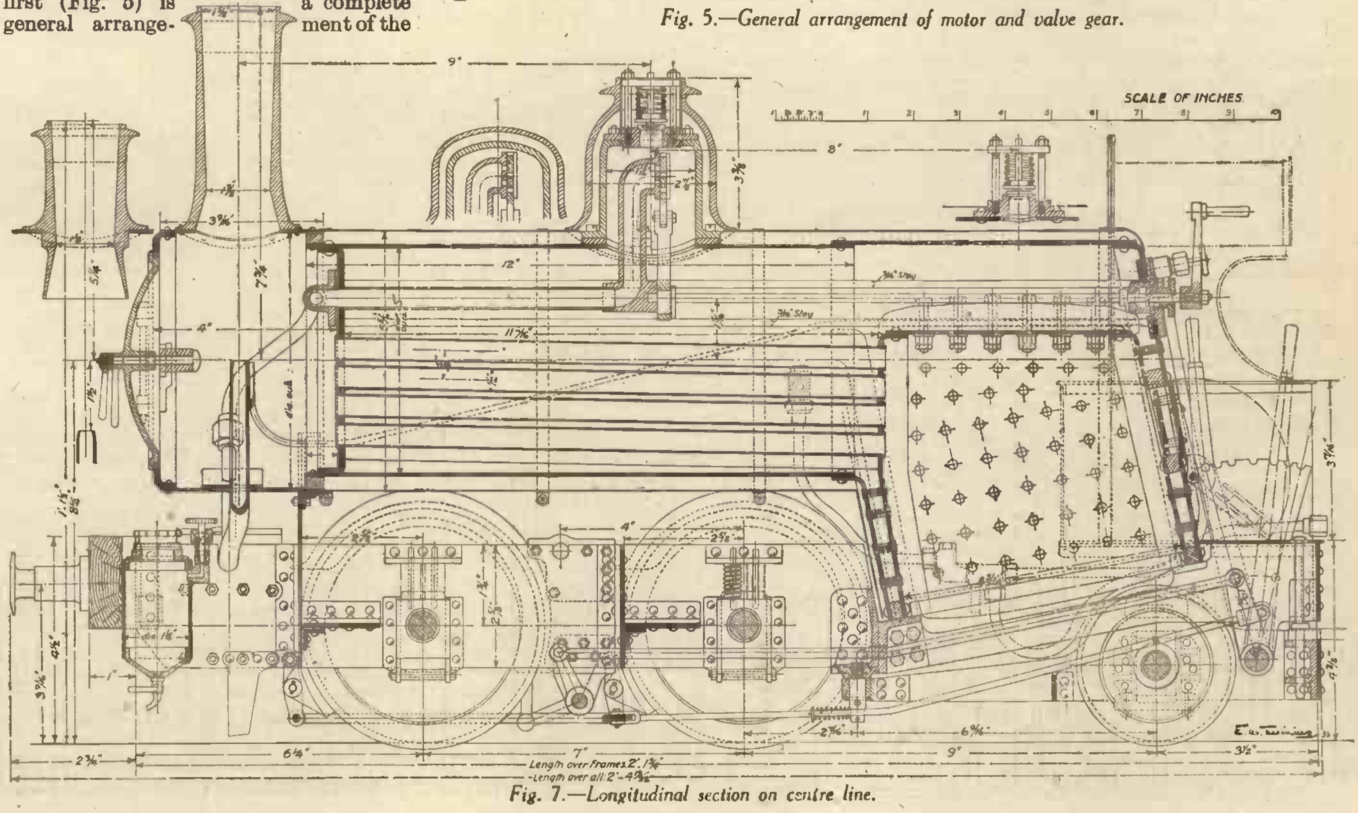

Fig. 7.—Longitudinal section on centre line.

the connecting and coupling rods and the crossheads with the slide bars. A sectional plan of one of the main crossheads is shown underneath the elevation in Fig. 5. It will be noticed that these main crossheads each consist of three parts. The centre, which receives the piston rod end, is of gunmetal, and to this is bolted on each side a plate of steel, through which the gudgeon pin passes. The outer plate is cut with a long lug, to which the union link of the valve gear is attached, the inner one being, of course, without this extension.

Cast Metal Rods

For the connecting rods, and, as a matter of fact, this applies to the whole of the rods constituting the motion and the valve gear, the choice of three metals is available. It may sound, perhaps, somewhat drastic and unengineering to suggest gunmetal for these parts, but, nevertheless, I do suggest it for the sake of ease of making. For an engine of this class, which makes no pretence to follow either scale or prototype, the various parts could be made of any metal which is most convenient, provided it has sufficient strength and stiffness, and provided, of course, that it does not present an eyesore to correct appearance, but if gunmetal were used for all moving parts, it could, of course, quite well be plated in dull nickel or chromium, and would still involve less labour in making than would the use of steel forgings. If castings were obtained from wooden patterns there would be no need whatever to bush the ends of the rods, not even the connecting and coupling rods, since, when they become worn, it is an easy matter to either then bush them or scrap them and fit new rods. Of course, the fastidious model locomotive enthusiast would prefer, and perhaps rightly, to use steel throughout for the motion and gear, and gunmetal is only suggested as a simple means of avoiding time and hard work. There is a middle course which one can take: that is, to use malleable cast iron for all the largest rods, cast, of course, from the same patterns as might be used for gunmetal, and cut all the smaller links out of steel plate. The only difficulty is that such malleable castings are not easy to obtain. Only a few foundries specialise in their making, and they are, if anything, rather dearer than gunmetal.

Numbers Off

It will be noticed in the two drawings that I have written against each of the parts "two off" or "one off," as the case may be. This means, of course, that two or one are required of each of the parts. The letters R and L are added in some cases, the information which this conveys being that if two are required, they are to be right- and left-handed respectively. In some cases this right and left-handing will involve, if castings are to be used, two distinct foundry patterns, in others the same pattern can be used, but provision made for cutting or filing away a portion of the casting. For instance, in the connecting rod the big ends on the inside and outside are not alike, since the centre line of the rod does not pass through the centre of the big end. The pattern could, therefore, be made so that the thickness is equal on each side of the centre line, in which case one face of the big end will have to be filed away or a lubricator can be cast on both above and below, the bottom one being cut away for the left-hand rod, and the opposite one removed for the right-hand rod. In the case of the expansion links, the slotted links themselves can be both cast alike and mounted differently for the right and left hand. The curved piece, which is at the back of the slotted link, is, of course, of steel plate. In this the rocking shaft is riveted.

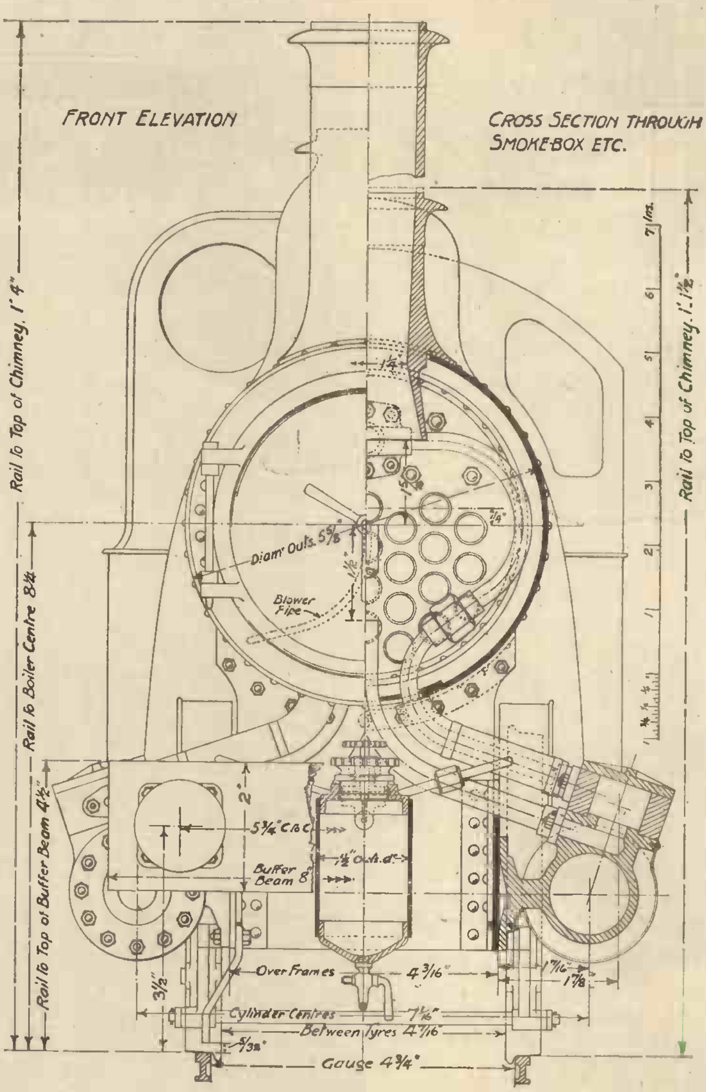

Fig. 8.—Front elevation and section through smoke box.

The idea of cutting away unwanted parts in order to save making two patterns applies to the slide bars. The top bar carries the slide for the valve crosshead. Now the same pattern can be used for the lower bar, and it is only necessary, in order to adapt the top bar casting to the bottom bar, to saw away the web which carries the valve crosshead slide.

Crank Pins

Fig. 5 includes a sectional plan taken through the centre line of the wheels and showing the crank pins. These, of course, are in steel, shouldered as shown, and knocked into the wheels. The riveting over of the pins at the back of the wheels generally calls for some heavy hammering, which may be liable to cause injury to the other end of the pins on which the rods have to work. To reduce the need for such hard blows with a hammer, it is recommended that the ends of the pins which have to be closed over be made somewhat cup-shaped, leaving a lip only projecting around the edge of the pins. This lip closes down very readily into the slightly countersunk hole in the wheel.

The foregoing suggestions regarding facilitated riveting over apply equally to the pin for the eccentric rod in the return crank, and, although we have not yet come to deal with the boiler, the firebox stays

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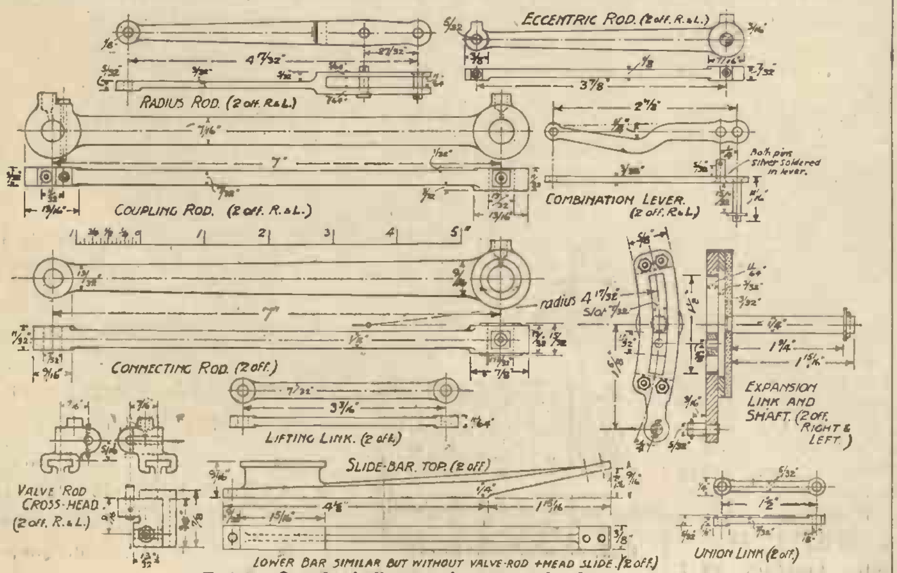


Fig. 6.—Details of all parts of motion and valve gear.

PRACTICAL ELECTRICITY FOR BEGINNERS—I

PRIMARY CELLS AND BATTERIES

By "ELECTRON"

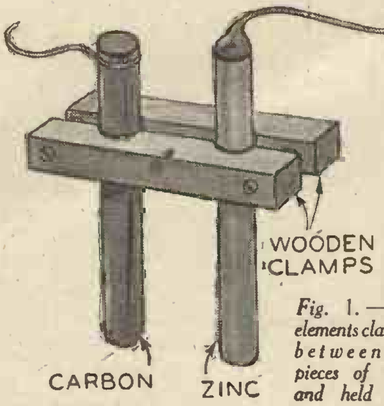


Fig. 1.—The elements clamped between two pieces of wood and held with screws.

In order to generate electricity it is necessary to employ cells, batteries or dynamos. Since the construction and operation of a dynamo is somewhat intricate, it will be better to start with the simpler methods whereby electricity is generated, and so work up to the more complicated forms. For small apparatus, such as electric bells and small magnets and motors, the zinc-carbon-sal-ammoniac cell will answer very well; but for larger machinery, where more current is required, the copper sulphate and the bi-chromate batteries will be found necessary.

A simple and inexpensive cell may be made from old arc-lamp carbons and zinc rods similar to those used in Leclanche cells. Copper wire is to be bound around the top of each carbon rod and firmly fastened with pliers, so that it will not pull off or become detached. The zinc rods are usually sold with a connecting wire already attached. It is advisable to cut a groove around the top of the carbon rods with a file so that the connecting wire will fit into it. The elements should then be clamped between two pieces of wood and held with screws, as shown in Fig. 1.

A more efficient carbon pole is made by strapping six or more short carbon rods around one long one, as shown in Fig. 3. The short pieces of carbon are fixed around the long carbon rod with heavy elastic bands or cotton thread dipped in molten wax to make the cotton impervious to water and the sal-ammoniac solution.

Another arrangement of elements is shown in Fig. 2, where a zinc rod is suspended between two carbons, the carbons being connected by a wire which must be kept clear of the zinc rod.

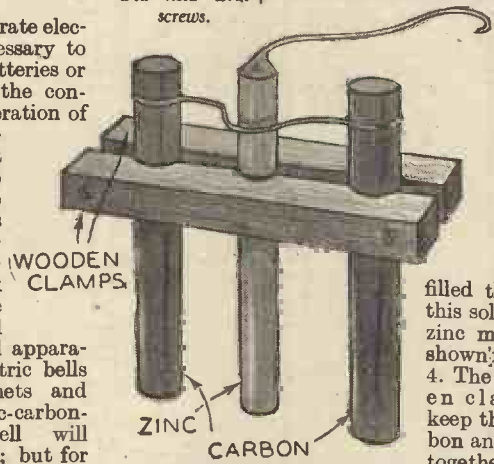


Fig. 2.—Another arrangement of the elements.

A Container for the Cell

A fruit jar, or a wide-necked pickle bottle, may be employed as a container for a cell, but before the solution is poured in, the upper edge of the glass should be coated with paraffin wax. This should be melted and applied with a brush or the edge of the glass dipped into the paraffin wax.

The solution is made by dissolving 4 oz. of sal-ammoniac in 1 pint of water, and the jar should be filled three-fourths full. In this solution the carbons and zinc may be suspended, as shown in Fig. 4. The wooden clamps keep the carbon and zinc together, and the extending ends rest on the top of the jar and hold the poles in suspension. Another method is to clamp plates of zinc and carbon on either side of a strip of wood and suspend in the sal-ammoniac solution, as shown in Fig. 5.

Care must be taken, however, that the screws used for clamping do not touch each other.

If one cell is not sufficiently powerful, several of them may be made and coupled up in series—that is, by carrying the wire from the zinc of one to the carbon of the next cell, and so on to the end, taking care that the wire from the carbon in the first cell and that from the zinc in the last cell will be the ones in hand, as shown in Fig. 6. This constitutes a battery. Be sure to keep the ends of the wire apart to prevent galvanic action and to save the power of the batteries.

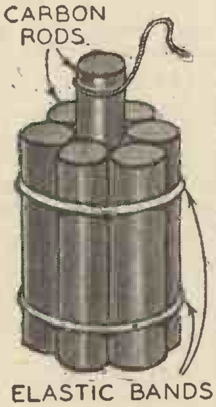


Fig. 3.—An efficient carbon rod made by strapping a number of short carbon rods round a long one.

For Bells and Light Experimental Work

This battery is an excellent one for bells and light experimental work, and when inactive the zincs are not eaten away (as they would be if suspended in a bi-chromate solution), for corrosion takes place only as the electricity is required or when the circuit is closed. A series of batteries of this description will last about twelve months if used for bells or light experiments, and at the end of that time will only require a new zinc and fresh solution.

The cell in which the plates shown in Fig. 5 are used may contain a bi-chromate solution, and for experimental work, where electricity is required for a short time only, this cell will produce a stronger current. But remember that the solution eats the zinc rapidly, and the plates must be removed as soon as you have finished using them.

The bi-chromate solution is made by slowly pouring 4 oz. of sulphuric acid into 1 quart of cold water. This should be done in an earthen jar, since the heat generated by adding acid to water is sufficient to crack a glass bottle. Never pour the water into the acid. When the solution is about cold, add 4 oz. of bi-chromate of potash, and shake or mix it occasionally until dissolved; then place it in a bottle and label it:

BI-CHROMATE
BATTERY
SOLUTION
POISON.

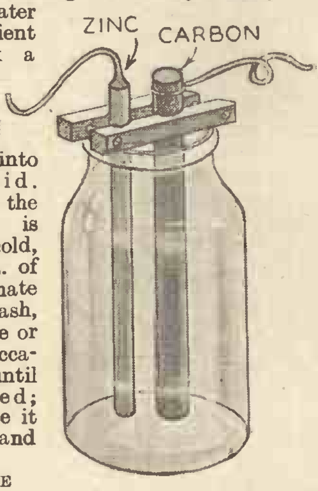


Fig. 4.—The carbon and zinc suspended in the solution of sal-ammoniac.

(Continued on page 234.)

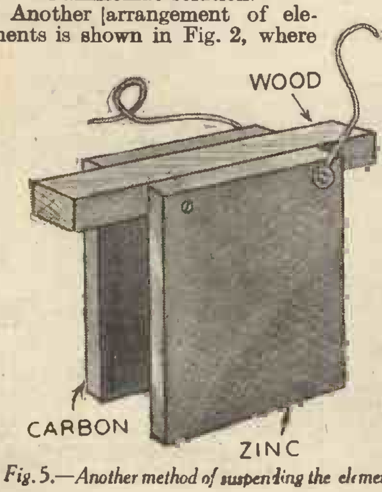


Fig. 5.—Another method of suspending the elements.

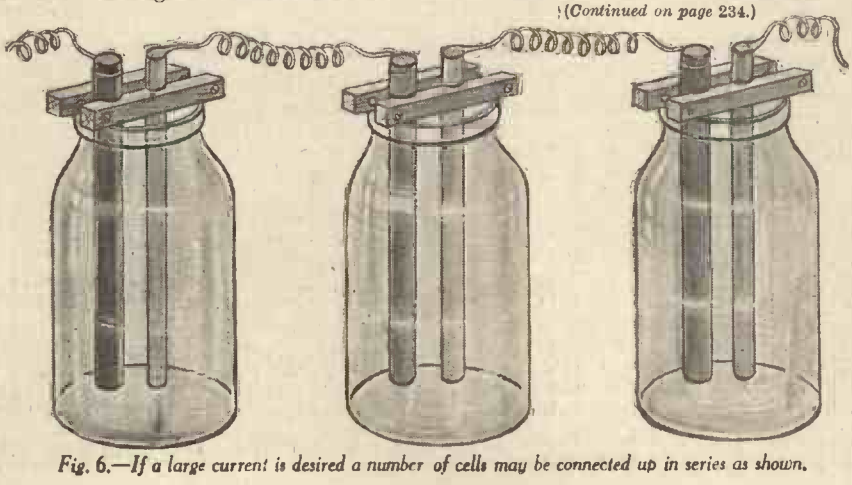
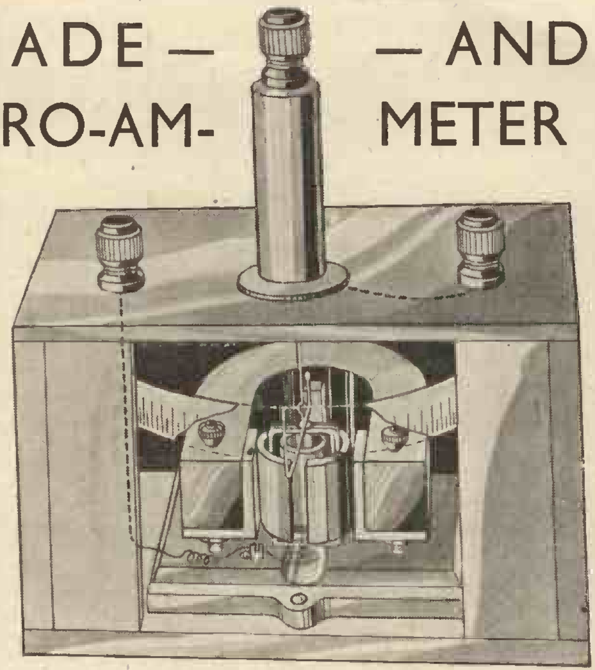


Fig. 6.—If a large current is desired a number of cells may be connected up in series as shown.

A HOME-MADE— —AND SENSITIVE MICRO-AMMETER

By G. R. SANDERSON



A simple instrument used for taking the accurate measurement of small currents.

THE little meter described below has many uses for the radio enthusiast, and can be made for approximately 5s. Most readers will, no doubt, have in their "Junk" box, an old speaker unit. First dismantle the unit, leaving the magnet bare, and with the aid of a hacksaw and a file, shape the pole pieces as shown in Fig. 1. Drill a hole in the centre of the inside face, and then tap the hole to take an 8 B.A. screw. The shoes (Fig. 2) may be made from some old transformer stampings. Another way is to obtain a soft iron cylinder (or piece of pipe), ¾ in. outside diameter, ⅝ in. inside diameter, *i.e.*, the wall of the tube is ⅛ in. thick, the length of the tube is equal to the "height" of the magnet, or pole pieces. Cut the cylinder down the centre and trim the edges with a file; drill a hole in the centre of each piece and tap to take the same thread as the pole pieces. It is advisable to flatten the shoes to ensure a good magnetic contact with the pole pieces. Now obtain another length of soft iron tube, the outside diameter being 12 mm. The inside dimensions are of no consequence, and may, if desired, be cut from a solid piece of soft iron. Drill and tap a hole in the cylinder to take a threaded brass rod, which need not exceed ¾ in. in length. The other end of the screwed rod is let into a piece of square section brass rod which is threaded at one end (this may be obtained from an old condenser); a washer and terminal head will complete the job (Fig. 3).

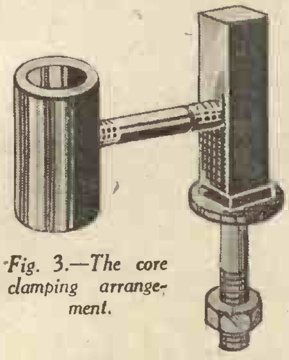


Fig. 3.—The core clamping arrangement.

Fitting the Cylinder

Place the cylinder in position and secure the terminal head on the underside; gently move the cylinder to the centre of the field, making certain that the core (cylinder) and shoe pieces are parallel. Secure rigidly in this position. The clearance between the cylinder and shoes on either side should not be less than 2 mm. Obtain a strip of copper foil, the dimensions for which are given in Fig. 4. Next shape a piece of wood as shown in Fig. 5 to the exact measurements of the coil, *i.e.*, 12·5 mm. across, giving a clearance of ·5 mm. on each side when in position. The top and bottom distances may be more than this, say, 1·0 to 1·5 mm. Carefully wrap the foil round the former, and solder the two ends of the foil, using as little solder as possible, bearing in mind that the coil must be as light as possible. Holding the wood in a vertical position with the foil end on some flat surface, gently lift the "flaps," and run along each one with the blunt edge of a knife, so that they stand out at right angles to the former, and appear as forming the three sides of a box. Now obtain a small reel of fine wire, that used in the original instrument was 44 gauge D.S.C. Carefully wind on 50 turns, leaving 2 or 3 in. spare at the start, and finish. Give the whole coil a light coating of shellac and put aside to dry. Cut two 1-in. lengths of wire, say 36 gauge D.S.C., leaving the insulation intact until later. Take hold of the coil, and tap the flaps over the wire, being very careful not to damage the winding. Now take the two lengths of 36 gauge wire and wrap one round the top centre of the coil, and the other at the bottom centre, giving each wire one twist to secure.

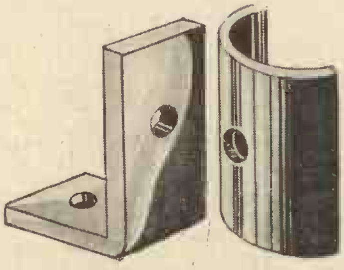


Fig. 1.—Details of the pole piece.

The Top and Bottom Contact Wires

Carefully bare the contact and coil wires, now wind the coil wire round one leg of the contact wire, that is to say, the start of the coil will go to the top contact wire and the finish to the bottom one, four turns will be sufficient. Give the contact wires one more twist each. The spare ends of the *bottom* wire may now be clipped off; the top wire needs a little more consideration. First make a small loop, and again twist the wire. These ends may now be clipped off. With a moderately hot iron, touch the contact wires, allowing the solder to run round the wire and so ensure a sound electrical contact.

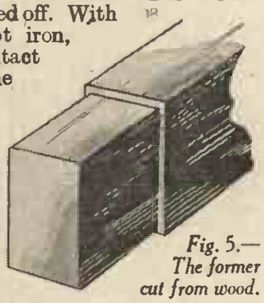
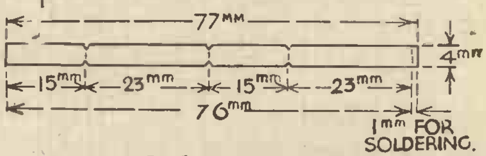


Fig. 5.—The former cut from wood.

I will presume that the case has been constructed and has an ebonite top. Obtain a brass plate or disc, and secure it on the underside of the ebonite; three or four screws will suffice. Drill a hole through the centre of the ebonite and brass plate to take a ½-in. diameter brass tube (the length of the tube need not exceed 3 in.). Take a brass washer and file the centre out until it will fit comfortably over the tube; place the tube through the hole in the ebonite and allow it to protrude not more than ⅛ in. on the underside. Now solder the washer in position, as in Fig. 6. Make four contact pieces and solder them on the edge of the tube. Obtain a large terminal and nut; remove the nut and solder it into the top of the tube;



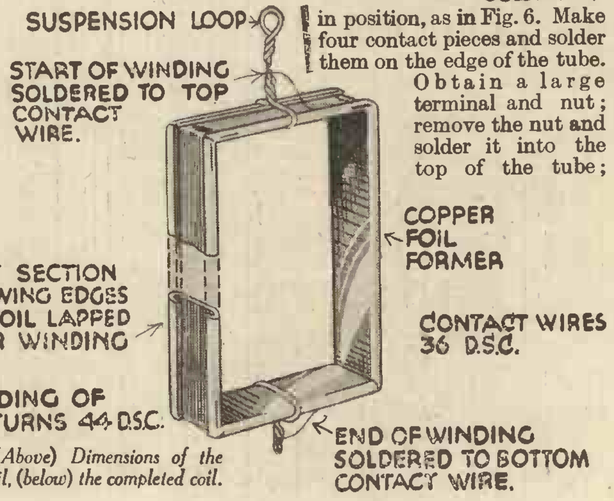


Fig. 4 (Above) Dimensions of the copper foil, (below) the completed coil.

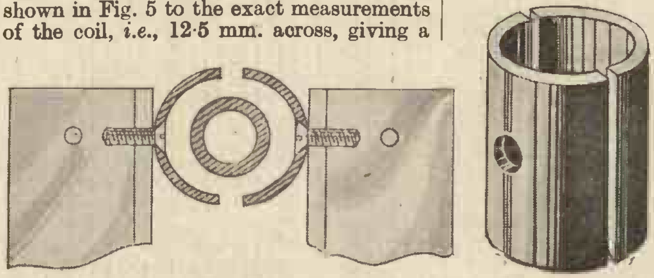


Fig. 2.—(Above) the shoes and core assembled, and (right) a piece of tube cut down the centre and drilled.

ascertain that the terminal when in position is in the centre of the tube. Take a 3-in. length of phosphor bronze wire and lightly draw it between the finger and thumb of the left hand. Do not exert too much pressure; this may be increased if the desired result is not obtained at the first attempt. The wire should take the form of a hair spring of a watch. Solder the inside end to the bottom contact wire, the other end to the spade terminal which is placed in front of the left-hand limb of the magnet (see Fig. 7). A wire is also taken from this point to the left-hand terminal on the case. The suspension wire may now be soldered in position. The coil should now swing freely.

The Scale

The scale may be made from a ½-in.

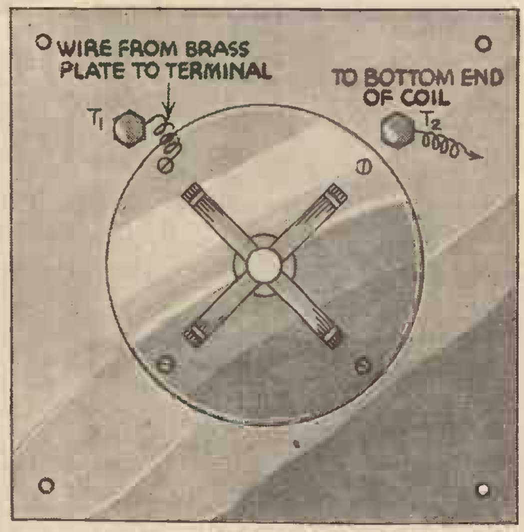


Fig. 6.—Details of the top showing the four contact strips.

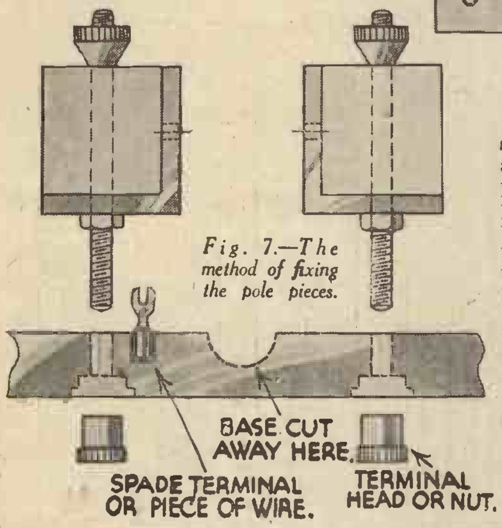
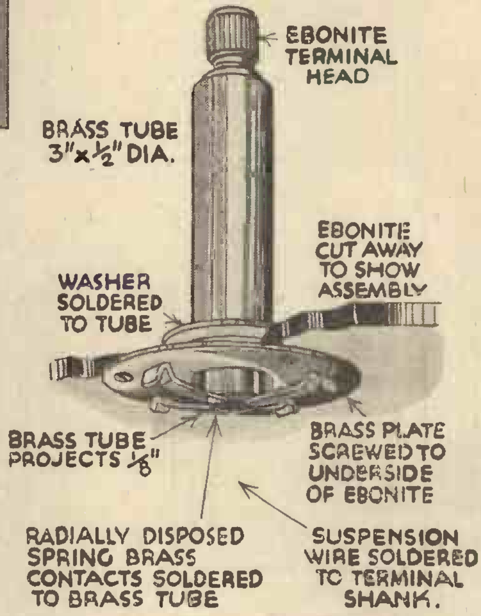


Fig. 7.—The method of fixing the pole pieces.

strip of ivorine (stiff glossy paper will serve admirably); a dab of Chatterton's compound will secure the scale in position. The pointer should be made from aluminium wire. Measure the distance from the suspension wire to the scale; add ¾ in. for turning up. You will also require a further ¾ in. beyond the "loop" for adjusting. Balance the pointer by means of a small piece of tin-foil. The point of balance should be ¾ in. from the *inside* end. Secure the pointer by means of a little shellac warmed on the blade of a penknife, the shellac may also be applied to the contact wires to make them more secure. The instrument may now be calibrated. Connect a 2-volt accumulator in series with a one-megohm resistance; the deflection registered will be equal to 2 micro-amps.: 500,000 watts equals 4 micro-amps., and so on. The instrument may be used to measure the insulation resistance of a condenser, using the formula $R = \frac{E}{I}$. "E" will be known, "I" will be the deflection on the instrument, and "R" should be in megohms. It may also be used in the grid circuit of the detector valve, and will measure the grid current in micro-amps.

As is always the case when using a sensitive instrument of this nature, the greatest care should be taken not to connect it to any circuit where it can be overloaded and its rating must therefore be borne in mind.



PRACTICAL ELECTRICITY FOR BEGINNERS (*Continued from page 232*)

Before immersing the zincs in the bichromate solution they should be well amalgamated to prevent the acid from eating them too rapidly.

The amalgamating is done by immersing the zincs in a diluted solution of sulphuric acid for a few seconds and then rubbing mercury (quicksilver) on the surfaces. The mercury will adhere to the chemically-cleaned surfaces of any metal except iron and steel, and so prevent the corroding action of the acid. Do not get on too much mercury, but only enough to give the zinc a thin coat, so that it will present a silvery or shiny surface.

A Two-Fluid Cell

Another type of cell, a two-fluid cell, is made with an outer glass jar and an inner porous cup, through which the current can pass when the cup is wet (see Fig. 7).

A porous cup is an unglazed earthen receptacle, similar to a flower pot, through which moisture will pass slowly. The porous cup contains an amalgamated plate of zinc immersed in a solution of diluted sulphuric acid—1 oz. to 1 pint of water. The outer cell contains a saturated solution of sulphate of copper in which a cylindrical piece of thin sheet copper is held by a thin copper strap, bent over the edge of the outer cell. A few crystals of copper sulphate should be dropped to the bottom of the jar to keep the copper solution saturated at all times. When not in use, the zinc should be removed from the inner cell and washed, pour the solutions back into bottles and wash the several parts of the battery, so that it may be fresh and strong when next required. When in action, the solutions in both cups should be at the same level, and be careful never to allow the solutions to get mixed or the copper solution to touch the zinc. Coat the top of the porous cell with paraffin wax to prevent crystallisation and also to keep it clean.

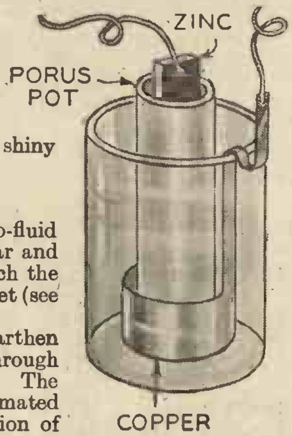


Fig. 7.—How to make a two-fluid cell.

For Buzzers

For buzzers, large electric bells, etc., the gravity cell will give very satisfactory results. The one shown in Fig. 8 consists of a deep glass jar, three strips of thin copper riveted together, and a zinc crow-foot that is fixed on the upper edge of the glas jar.

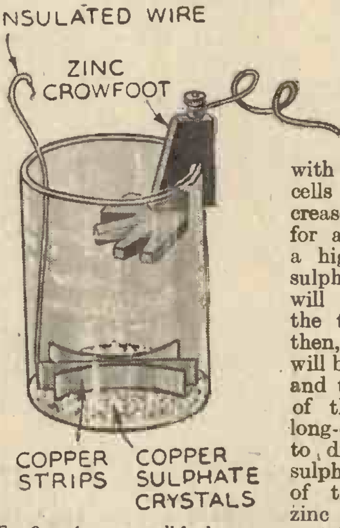


Fig. 8.—A gravity cell for buzzers, large electric cells, etc.

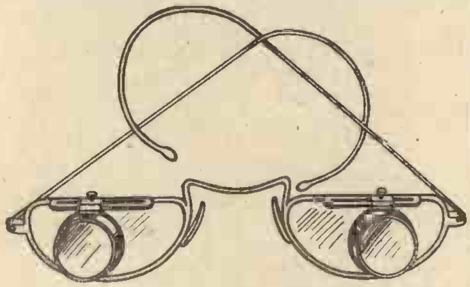
To set up the cell, place the copper at the bottom and drop in enough copper sulphate crystals to generously cover the bottom, but do not try to embed the metallic copper in the crystals; then fill the jar half full of clear water. In another jar dissolve 2 oz. of sulphate of zinc in enough water to complete the filling of the jar to within 2 in. of the top; then hang the zinc crow-foot on the edge of the jar so that it is immersed in the liquid and is suspended about 3 in. above the top of the copper strip. The wire that leads up from the copper should be insulated with rubber and well covered with paraffin wax. A number of these cells may be connected in series to increase the power of the current, and for a working battery this will show a high efficiency. At first the copper sulphate and zinc sulphate solutions will mingle. To separate them, join the two wires and start the action; then, in a few hours, a dividing line will be seen between the white, or clear, and the blue solutions, and the action of the cell will be stronger. After long-continued use it may be necessary to draw off some of the clear zinc sulphate, or top solution. The action of the acids reduces the metallic zinc to zinc sulphate and deposits metallic copper on the thin copper strips.

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.

"Speera" Binocular Magnifiers

THE illustration at the top of this column shows a fine pair of achromatic lenses with a prismatic element mounted in specially designed spectacle frame adjustable for interocular distance. They will be found useful in a number of ways, especially

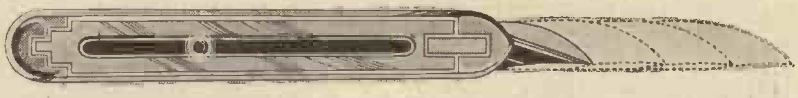


The binocular magnifiers shown will be found useful for work of a minute nature.

for work of minute and delicate character. They are made in three powers: $x1{\cdot}75$, $x2{\cdot}5$ and 3·5 diameters. The focal lengths being 10 in., 7 in., and 5 in. It costs £2, complete in case. [31]

A Sliding Blade Knife

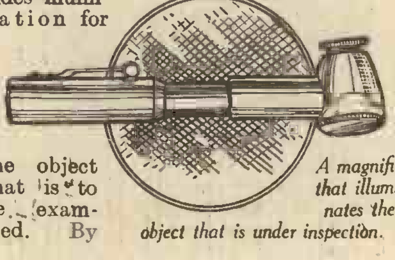
INGENIOUS pen-knives with special gadgets attached, etc., appear from time to time on the market. Here is a splendid new knife with a replaceable sliding blade, as can be seen from the illustration. The blade can be made to protrude to any desired length by simply sliding a small knob along a groove in the handle. There is no danger of cutting fingers or breaking your nails. The blade is of the finest quality stainless steel scientifically hardened and sharpened. It is obtainable at the reasonably low cost of 2*s.* 6*d.* Extra blades, if desired, are also obtainable at 1*s.* each. [32]



By sliding along the knob fitted to the slot in the handle the blade may be made to protrude to any desired length.

An Illuminated Magnifier

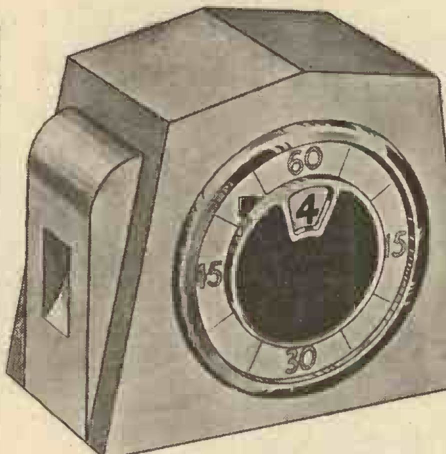
MOST readers know that there is hardly any novelty in a pocket magnifier, as there are quite a number of these on the market. That shown on this page, however, is both ingenious and novel, as it provides illumination for the object that is to be examined. By placing it to the eye and pressing on the clip, light is thrown on to the object so that it may be examined when the light is rather dim. It costs 21*s.* [33]



A magnifier that illuminates the object that is under inspection.

A New Design in Clocks

A GLANCE at the clock shown on this page will show that it has a number of ingenious features. It will be seen that a small pointer travels round the dial completing one revolution for every hour. When the pointer reaches sixty, the number of the hours which is shown in a small window on the dial, alters. For example, the time shown by the illustration would be roughly ten to five. It is supplied in a special case which transforms it into a travelling clock when closed, and by opening and closing the case the clock is wound up The price is 10 guineas. [34]



A novel clock that is both ingenious and neat in appearance.

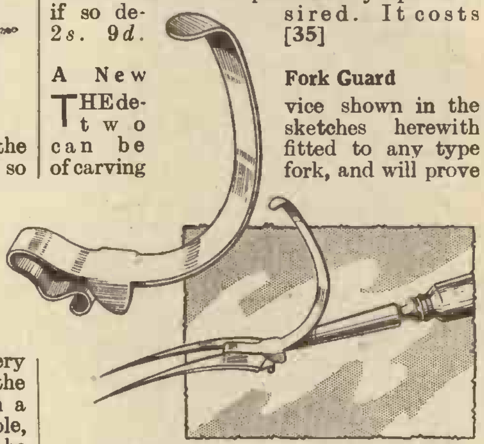
An Ingenious Inspection Lamp

CYCLISTS and motorists will find the inspection lamp shown herewith very useful to them when repairing punctures, overhauling the engine, etc., in the dark. The lamp can be attached to the forehead as shown, or round the waist, so leaving both hands free to perform any operation if so desired. It costs 2*s.* 9*d.* [35]

An inspection lamp that may be attached to the forehead or waist, so leaving the hands free to do the job required.

A New Fork Guard

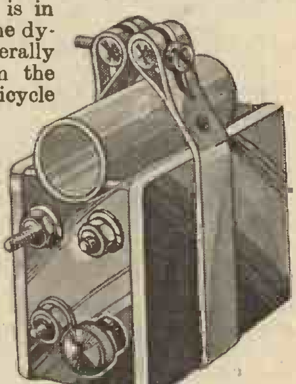
THE device shown in the two sketches herewith can be fitted to any type of carving fork, and will prove an efficient guard for the hand. It can be fitted to the fork in an instant, and is just as easily removed for cleaning purposes. It is obtainable at the very low cost of 6*d.* [36]



A detachable guard that may be fitted to a carving fork.

A Useful Stand-by Battery for the Cyclist

AS most cyclists who use a dynamo for the front and rear lamp of their bicycles know, light is only obtainable whilst the bicycle is in motion. The dynamo is generally driven from the side of the bicycle tyre by means of a knurled friction wheel, but as soon as the bicycle stops the lights go out. The stand-by battery shown on this page will overcome this difficulty when the cycle is at a standstill, as it can be fitted in a few seconds to the top the cycle frame. It consists of a neat case about 3 × 2½ in. × 1¾ in. containing one or two standard pocket lamp refills. In order to use these emergency sets, the connecting cord with plug connector to generator is taken from the generator and plugged into the projecting pin on the battery con-



A stand-by battery for cyclists that is easily fitted to the rear frame.

Binoculars that may be worn like ordinary glasses, so preventing the arms becoming tired.

Continued on page 245.

CHOOSING YOUR PROJECTOR

HINTS AND TIPS ON SHOWING FILMS

By PERCY W. HARRIS, F.A.C.I.

An excellent example of an inexpensive hand-driven 9½ mm. projector, The Coronet, which sells for forty-five shillings.

PROJECTORS for home movies are of four kinds, 35 mm., 16 mm., 9½ mm. and 8 mm. And if you go to France you will find still one more size—a 17½ mm. With all these sizes available a newcomer to the hobby may well wonder why they all exist and which he should choose.

The 35 mm. is the professional size. Good projectors of this kind for home use can be bought at prices similar to those charged for the higher grades of 16 mm. apparatus, which means, in effect, that satisfactory apparatus of this kind is expensive. It is, however, not the first cost which is the main drawback, but the size of the film used. No less than 1,000 ft. of full-size 35-mm. film is required to give the same screen time as 400 ft. of 16- or 9½-mm. film, while the large film is expensive, bulky, and highly inflammable. It is impossible to hire modern films for home projection, and by no means easy to obtain old ones which are satisfactory and not scratched.

Educational and Instructional Work

The 17½ mm. size, which is largely used in France, particularly for educational and instructional work, is not generally sold in this country. It is exactly half the width of the 35 mm. film and was originated by the Pathé firm as a sub-standard size about the time Kodak in America brought out the 16 mm. film. It has the advantage over the 16 mm. of a slightly larger picture area and the disadvantage of requiring a slightly greater footage for the same screen time as well as slightly bigger machines. It failed to "catch on" in other countries, and the 16 mm. soon proved the vastly more popular.

The 16 mm. size, originated in the States, has now become one of the two popular standard sizes. Whereas in the case of the 17½ mm. size there is only one make of projector available for it, in the 16 mm. size there are many, ranging in price from £6 or £7, up to well over £100. Excellent libraries for hiring films are available; the prices for hire being in some cases as low as a shilling a night for a reel, each reel taking about sixteen minutes on the screen. There is also a wide range of cameras available if you wish to take your own.

A Popular Size

The 9½ mm. size originated in Europe about the same time as the 16 mm. size originated in the United States. So far as Europe is concerned it is probably the most popular of all sizes, the popularity being largely due to the neatness, high efficiency and low cost of the projecting apparatus designed for use with it. Another reason for its popularity is the fact that the films for showing with it are marketed in short lengths of about 30 ft. at very popular prices, while an ingenious notching system makes it possible in some of the projectors to stop the film automatically on titles or other pictures one wishes to remain stationary upon the screen for a short time, thus economising film. A fairly wide range of projectors is now available for this size, some of the more recent and expensive types giving large screen pictures of considerable brilliancy although, in the main, projectors sold for this size have very low-power lamps and give quite small pictures compared with those obtainable with the 16 mm. size. Naturally, at the low price at which projectors are sold one cannot expect too much.

A popular 9½ mm. motor driven projector—The Pathé Home Movie.

The 8 mm. size is a newcomer, and it is too early to say whether it will settle down to any considerable popularity. It is exactly half the width of the 16 mm. size, has only one row of perforations, and the pictures are a quarter of the size of 16 mm. There are already one or two firms marketing apparatus of this size and the results on the screen are excellent. So far as projectors are concerned the disadvantage at the moment is the relatively limited number of films available in the one library supplying them, but probably most people who buy this size also buy the camera and take their own.

Hand and Power-driven Machines

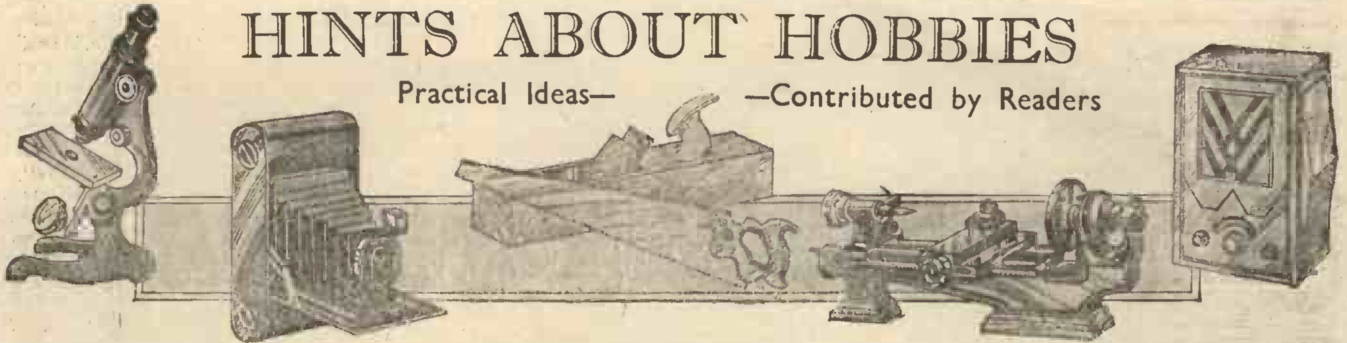
If you have a limited amount of money to spend there is no question that the 9½ mm. size is the size for you. Assuming you are going to start with the projector only, then an excellent little machine can be purchased for as low as 45*s*., and from this price you can go on to 55*s*. and higher prices until at £36 you can buy a machine which will show both 9½ or 16 mm. size at will and give a screen picture big enough for lecture purposes. Your machine can be either hand-driven in the lower prices, or motor-driven at a slightly higher figure. The size of the picture on the screen is really dependent on the illumination available for, as with the magic lantern, the farther you go away from the screen the bigger the picture will be. Even the cheapest projector will give a big picture of sorts if you take the projector far away enough from the screen, but the light available in the inexpensive projectors is so small that any picture above about 2 ft. in width becomes feeble and indistinct. To get a really bright and big picture you must pay £15 or more, and, as a matter of fact, for this figure you can buy a 9½ mm. projector, motor-driven, fan-cooled and with all kinds of refinements, which will give a bigger and brighter picture than any 16 mm. projector at anywhere near this price. The lower-priced 9½ mm. projectors are all made to take the 30-ft. reels which last about a minute and a quarter only on the screen. If you want to show long films on these projectors you must buy what is called a super-attachment. If you have this, the so-called super-reels can be fitted and used. These take about a quarter of an hour to show, and the super-reels from the libraries include many very interesting professionally-taken films. It is, however, rather a nuisance turning such a machine continuously and steadily for such long periods and one of the motor-driven machines is much preferable. The very cheapest projectors of this size cannot be satisfactorily adapted to motor drive and if at a later date you want to go over to this form of drive then you will have to scrap your existing machine and buy another. The slightly higher-priced machines however (there is a popular one at £6 15*s*. which is hand driven) can be adapted to motor drive simply by buying a motor attachment at a later date. The more expensive 9½ mm. projectors are all motor driven.

In the 9½ mm. size there has recently been introduced a very interesting machine combining both camera and projector, and selling for £7 7*s*. This machine is primarily designed to project the films taken with it although 9½ mm. film in 30-ft. lengths made on other projectors can also be shown with it if they are re-wound on to special reels.

The Midas—a very ingenious instrument combining both camera and projector in one. It sells for £7 7s. 0d.

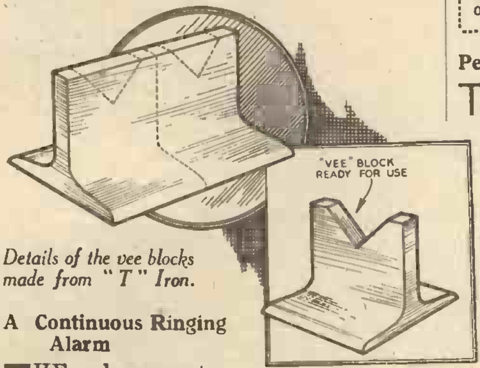
HINTS ABOUT HOBBIES

Practical Ideas— —Contributed by Readers



Making Vee Blocks

OBTAIN a piece of 2 × 2-in. "T" iron about 4 in. long. The bottom is then filed up flat and the ends squared. Mark off the centre line and vee's to ensure accuracy, and cut through the lines with a hack-saw and finish with a fine file.—W. H. (Clapham).



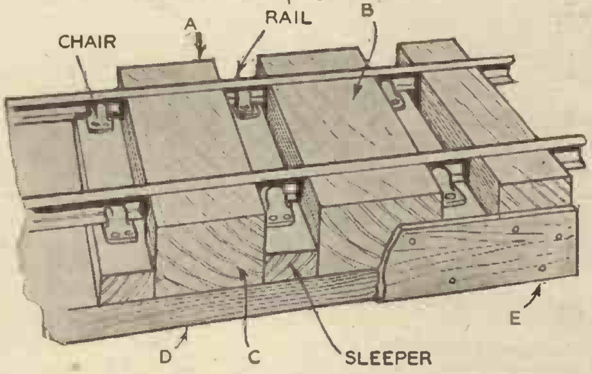
Details of the vee blocks made from "T" Iron.

A Continuous Ringing Alarm

THE only apparatus required is an ordinary alarm clock, a switch (optional) and an electric bell and button. Wire up as shown in the diagram and set the alarm at the required time. When the alarm is set in motion the alarm clock spring winder begins to revolve anti-clockwise and comes into contact with terminal "A," which completes the circuit through the clock, thus setting the electric bell in motion. If a switch is not available, the alarm may be switched off by rewinding the alarm by a half turn of the winding handle.—W. M. (Swindon).

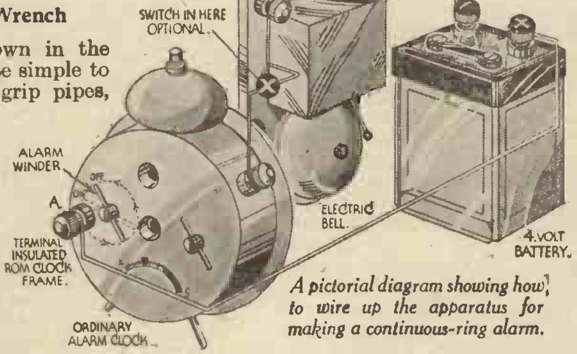
Permanent Way for Model Railways

THE device shown in the sketch is used for making accurately and neatly small permanent way for model railways. Cut blocks of wood A, B and C as shown, and screw or glue them to a large block D, whose width and length is equal to the length of the sleeper and rail used. The width of block B is equal to the gauge of the track being made. Strips of wood E are secured to the sides as shown, in order that the sleepers may be set correctly, although this is not absolutely necessary.



This device is used for making permanent way for model railways.

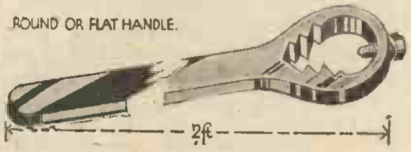
The sleepers are inserted as shown. The rails on which the chairs have been evenly spaced are then laid in the long narrow gaps; it is now only necessary to drive in the keys to secure the chairs to the sleepers. — G. W. (Leamington Spa).



A pictorial diagram showing how to wire up the apparatus for making a continuous-ring alarm.

A Useful Pipe Wrench

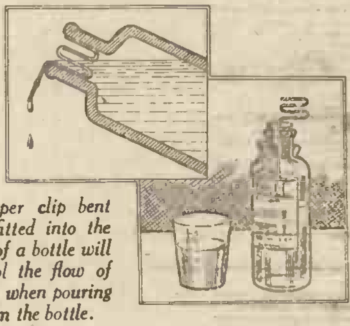
THE tool shown in the sketch is quite simple to make, and will grip pipes, rods, etc., without slipping. When it is placed on a pipe or rod and drawn on one side the teeth grip the object, thus making it a simple matter to turn the pipe, etc., by pulling backwards and forwards. The screw in the top can also be adjusted to obtain a firmer grip.—F. B. (Sheffield).



An ingenious pipe wrench.

Pouring Liquid from a Bottle

WHEN pouring liquid from a bottle it is apt to flow rather more quickly than is required, with the result that too much is poured out. By bending an ordinary paper clip to the shape shown and inserting it into the neck of the bottle it is possible to control an easy flow of a liquid that is required in small quantities.—F. G. (Sidcup).



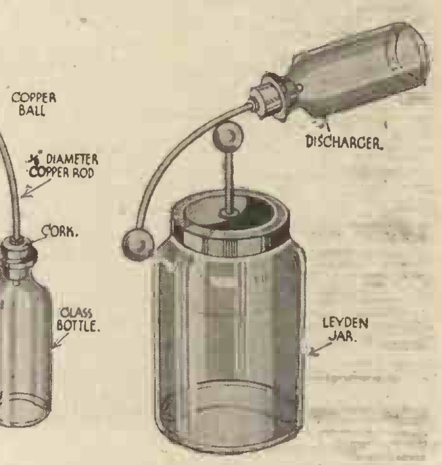
A paper clip bent and fitted into the neck of a bottle will control the flow of liquid when pouring from the bottle.

Discharging Leyden Jars

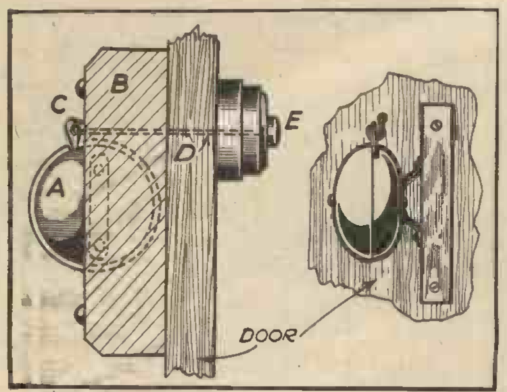
THE device shown in the sketch is useful for discharging leyden jars, and also for testing points where there is a chance of shocks. It consists of a glass bottle, about a 3 oz. will do, with a cork, through which is fixed a copper rod ⅛ in. diameter. To the end of this fix a copper ball, soldered or threaded. Thus two points can be connected or earthed.—E. A. (Hants).

A Simple but Effective Door Bell

THE sketch shows how an ordinary cycle bell may be utilised to make an effective door bell. A is a cycle bell screwed



This piece of apparatus is useful for discharging leyden jars, etc.



Showing how to fit up an effective door bell.

to a shaped piece of wood that fits inside of the door B. The thumb piece of the bell C is connected to a bell push button outside the door by means of a wire rod D. When the button is depressed D moves C and the bell rings. This little gadget can be put up in thirty-five minutes and is quite suitable for small houses.

A Guard for an Inspection Lamp

WHEN using an inspection lamp it often happens that the lamp is broken by being knocked against a protruding corner.

An easy guard is made by means of some strong iron wire, a block of wood about 1 inch thick, and a lamp-holder.

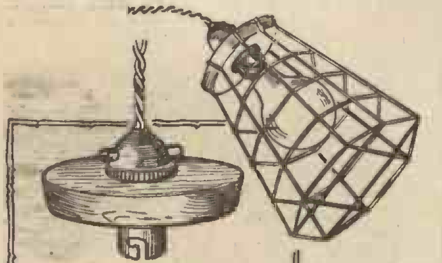
The sketch shows the completed holder, and the way in which the wire is bent to accommodate the block of wood.

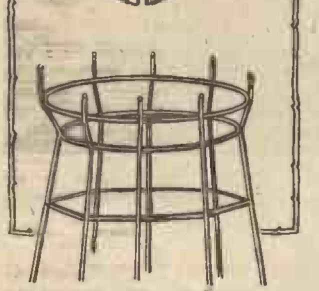
It also shows the block fitted into the wire guard, showing the wire bent over the block to keep it in position.

It is also easy to replace the lamp when it is worn out.

An Alarm Clock Time Switch

THE time switch described in the following paragraphs is made from a cheap alarm clock primarily for ringing a time bell, but it can be put to many other uses. It has two great advantages. It is cheap and it is compact. It is cheap because the material required, *i.e.*, two pillar type terminals, an inch or so of brass and two insulating bushes, can be found in the average tool box, and it is compact because there are no separate external fittings.



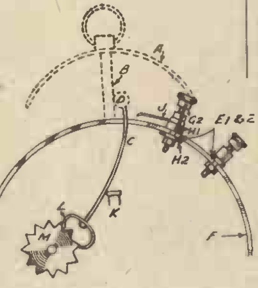


A wire guard used for protecting the bulb of an inspection lamp.

The bell A and its supporting pillar B are unscrewed from the clock base, leaving exposed the hammer C from which is removed the head D. Two holes E1 and E2 are drilled in the case F, and into E1 is fitted a pillar type terminal in direct contact with the case. In the hole E2 is fitted another pillar-type terminal G2, but this is insulated from the case by an ebonite bush and washer (presspahn will also do) (in the original model the ebonite base of a Belling-Lee terminal was used for H1). Beneath this terminal is clamped a small tongue of brass, bent over at the free end, and about $\frac{3}{8}$ in. wide. The hammer arm should be adjusted so that the catch K, which will be seen at the back of the clock, holds it as far away from the tongue as possible.

When the alarm "goes off" the catch releases the arm, which is thrown against the tongue by the pressure of the tooth M against the pawl L, thus closing the open circuit between the two terminals. The arm is prevented from oscillating, as usually, by the length of the brass tongue being made sufficient to prevent the pawl lifting entirely clear of the tooth.

The switch is set by setting the small alarm dial as usual, and then pulling the arm away from the tongue until it clicks over the catch K.



These two sketches show the finished alarm clock time switch and also the connections for same.

How to Draw a Scroll

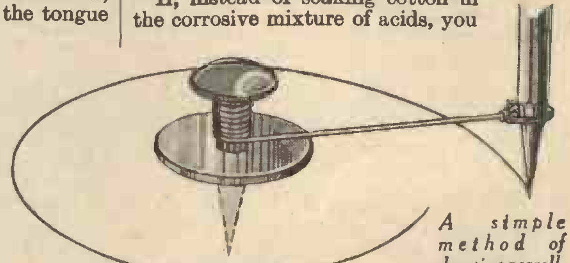
I HAVE often found it advantageous to describe graphically the sequence of operations of a machine or engine requiring more than one revolution of the main shaft to complete the cycle of operations. I have done this by showing the "setting" points on a scroll drawn out on paper, and in the absence of curves or other suitable instruments have used the following method.

Solder a copper rivet with shank about $\frac{1}{4}$ in. diameter to the brass head of a drawing pin, as shown in the sketch—attach about 6 in. of linen sewing thread by tying round the shank near the head of the rivet, the opposite end of the thread being secured to a small wire ring. The drawing pin is placed securely in position on the paper in the centre around which the scroll is required and the thread carefully coiled around the rivet from top to bottom, forming a right- or left-handed spiral as required. A pencil with a good long sharp point is then inserted in the ring and with a tangential pressure the thread uncoils, the pencil tracing a scroll. It will be observed that the diameter of the rivet shank determines the space between the lines—$\frac{1}{8}$ in. diameter giving approximately $\frac{3}{8}$ in. spacing and $\frac{1}{4}$ in. diameter about $\frac{13}{16}$ in. spacing.—M. B. (Bradford).

Making Gun Cotton

THIS substance, a high explosive, is easily prepared. Add very cautiously 1 part of concentrated sulphuric acid to 3 parts of strong nitric acid. Cotton wool is soaked in this mixture for twenty-four hours and at the end of this time is removed on a glass rod, thoroughly washed and allowed to dry. Its appearance remains almost unaltered, but it is now highly inflammable, and when ignited burns instantaneously and completely with a bright flash. When used as an explosive, it is compressed and fired with a detonator.

If, instead of soaking cotton in the corrosive mixture of acids, you use thin paper, a product remains which is often marketed under the name of Parlour Lightning, or Flash Paper. A large sheet will burn with a bright flash if ignited.

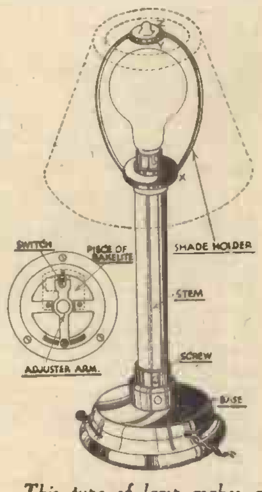


A simple method of drawing a scroll.

A Handy Reading or Bench Lamp

THE accompanying sketch shows a handy reading or bench lamp which can be made up from parts to be found in many radio fans' junk box, and consists of the following:

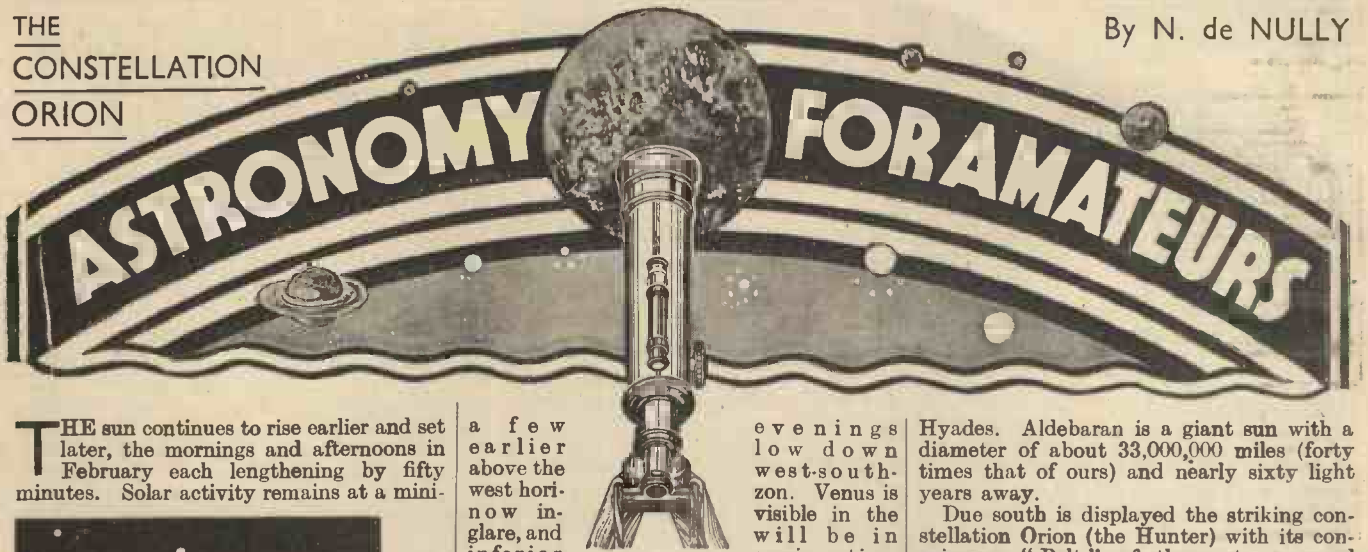
An old horn-type loud speaker base with magnet, bobbins, etc., removed, a piece of metal tubing about 4 in. or 5 in. long to fit the socket for the horn; this can be secured by the screw which is to be found in most of these bases. In my own case the stem was actually cut from an old bicycle saddle pillar. An old brass lamp holder should be obtained and after connecting a length of fairly heavy flex which is passed down the stem, the lamp holder is then soldered into the top of the stem, the shade holder being made from an old headphone band. Cut this in two, leaving two hinged bows which are riveted to the ring *x* at one end, and at the other end to another ring *y*, the same outside measurements as *x*, but with a 4 BA clearance hole in the centre and a 4 BA nut soldered to one side over the hole. Cut the piece *x* out of a small piece of 16-gauge aluminium, although a piece of strong tin would do as well. *Z* is a washer cut from the same piece of aluminium, and is $1\frac{3}{8}$ in. diameter with a 4 BA clearance hole in centre, and is used to secure the shade by screwing a 4 BA screw into the nut on *y* of the shade holder. A sixpenny shade from the local store and a 25-watt lamp complete a really handy lamp, and one which will take a lot of knocking over, a weakness which is found in many commercial lamps.—F. J. (Stafford.)



This type of lamp makes a handy reading or bench lamp.

THE CONSTELLATION ORION

By N. de NULLY



THE sun continues to rise earlier and set later, the mornings and afternoons in February each lengthening by fifty minutes. Solar activity remains at a mini-

Fig. 1.—The constellation Orion. The two larger star discs above the "belt" are Betelgeuse (left) and Bellatrix (right), while the largest disc in the centre near the bottom is Rigel. The position of the Great Nebula is indicated by parallel lines on each side of the string of small stars.

mum, but sunspots should be looked for whenever atmospheric conditions permit, care being taken to protect the eyes by one of the methods described last month. A single spot or group, if they survive the journey, will take from twelve to fourteen days to cross the disc and, after disappearance, take a similar period to reappear at the opposite side. It is very interesting to watch the changes of form and size almost from hour to hour. An isolated spot will often break up into smaller ones, or a scattered group coalesce into a single one ; while, with sufficient optical assistance, gleaming faculæ may be seen floating round their margins, especially when near the edge of the disc.

The Moon

Except for the first two or three nights of this month, the moon will be absent from the evening sky until about the 16th, when it may be found as a thin crescent in the early twilight over the west-south-west horizon. The slowly moving broken line of the terminator will then once more (weather permitting) provide the amateur astronomer, though equipped with the smallest telescope, an ever-changing panorama of rugged moon scenery until the full phase is reached.

Mercury is an "Evening Star," and will be at greatest eastern elongation, *i.e.*, at the limit of its swing to the east (or left) of the sun, on the 18th. It may possibly be seen a few evenings earlier low down above the west-south-west horizon. Venus is now invisible in the glare, and will be in inferior conjunction, *i.e.*, between the earth and the sun, on the 5th. On that date it will be a little way above the solar disc, and its lower illuminated edge may perhaps be perceived through a telescope immediately after sunset. Later on Venus will emerge as a "Morning Star." Jupiter rises before midnight, but not quite early enough yet for convenient observation. Mars and Saturn are practically out of view.

The Stars

The constellations Pegasus and Andromeda are now sinking in the north-west, while Cassiopeia and Draco (the Dragon) with Ursa Major (the Great Bear) swing eternally round Polaris the Pole Star without ever setting in these latitudes. High up, slightly west of south, glitters the well-known Pleiades group in the constellation Taurus (the Bull). Six stars can be seen with ordinary vision, but good sight is able to discern seven, and a binocular will show many more. A small telescope will reveal several scores. The entire cluster is imperceptibly moving towards the south, and its distance is placed at over 300 light years. In long exposed photographs the brighter stars seem to be shining through a faint haze, like street lamps in a fog. A short way to the left of the Pleiades glows Aldebaran, the "Eye of the bull," ruddy in tint and situated on the margin of a much more scattered naked-eye cluster, the Hyades. Aldebaran is a giant sun with a diameter of about 33,000,000 miles (forty times that of ours) and nearly sixty light years away.

Fig. 2.—The Great Nebula in Orion. From a photograph taken at the Yerkes Observatory, U.S.A., with a Reflecting telescope of 24 inches aperture and exposure of one hour.

Due south is displayed the striking constellation Orion (the Hunter) with its conspicuous "Belt" of three stars spaced equally apart in a row. Though seemingly small, these twinkling points of bluish-white light are actually enormous spheres enveloped in incandescent helium gas. Each radiates four times the heat and 4,000 times the light of our luminary. Among the brighter stars of Orion above the "Belt" are Bellatrix, radiating 8,000 times more energy than our Sun and Betelgeuse, the biggest known star. The latter is a colossal ball of pulsating red-hot gas, which expands and contracts its huge diameter from 260,000,000 miles to 180,000,000 miles, within a period of five to six years. Beneath the "Belt" scintillates Rigel, another giant white-hot sun emitting 15,000 times the light and more than twice the heat of ours. They are all some 500 light years from us. The most interesting feature of this constellation is of course the famous Great Nebula, the largest of its kind in the heavens. Unlike the so-called nebula in Andromeda, this one consists not of countless stars but of clouds of fiery vapour apparently swept hither and thither and doubled over in twisting folds by some terrific cyclonic force. The remarkable photograph here reproduced shows the extraordinary structure of this amazing object. Its dimensions are prodigious and its surface temperature is estimated at 50,000 degrees Fahrenheit. Still nearer the horizon flashes Sirius the Dog Star, in the constellation Canis Major (the Greater Dog).

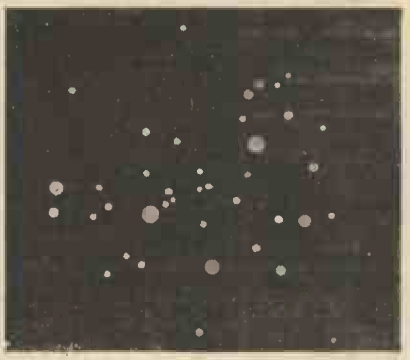
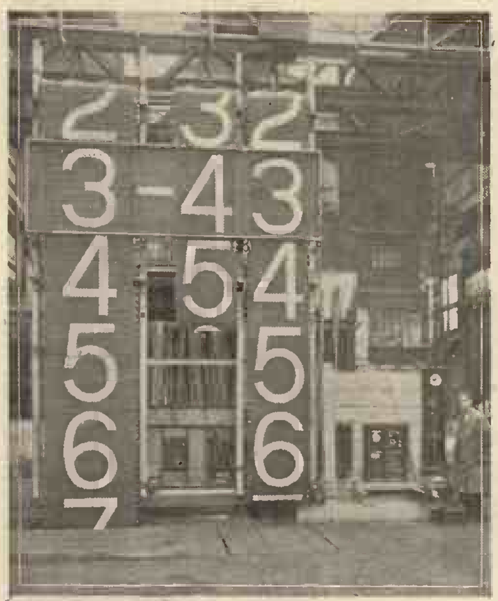


Fig. 3.—The Pleiades Star Cluster in the constellation Taurus (the Bull), as seen through a binocular.

THE PADDINGTON STATION CHRONOSCOPE CLOCK

A Remarkable Electrical Timekeeper

By T. R. ROBINSON



A general view of the assembly of the chronoscope clock.

THE latest, and perhaps the most novel, of the many public clocks in London is the electrical Chronoscope, now in operation at the Paddington Station of the Great Western Railway.

This timepiece is the largest of its kind in existence, and its mechanism is unique. It has no dial of the usual form, this being replaced by an oblong frame, in which appear a group of three Arabic numerals, giving together the hours, tens of minutes and single minutes.

These figures are changed minute by minute and hour by hour under the control of an electrical master clock of the impulse type, which is itself synchronised from Greenwich.

The figures appearing in the frame are actually painted on three endless bands, somewhat resembling roller shutters, and each figure-band is built up of many steel strips, flexibly jointed at their corners by special links. The left-hand band carries the hour numerals, while the other two give the tens of minutes and single minutes respectively.

The links of the bands not only unite adjoining strips, but also engage with slots in their respective driving sprockets, which are fitted at the topmost points of the bands. The action is, therefore, very similar to that of a cinematograph film, and it is by this means that the bands are moved forward at the change of figures.

The Motive Power

The motive power for the figure-changes is provided by a continuously rotating electric motor, driving through a worm reduction gear to a main shaft. A whittle belt drive from this shaft transmits power to a second shaft extending the full width of the three-figure bands and mounted on bearing brackets fixed slightly behind and below the figure-band sprockets.

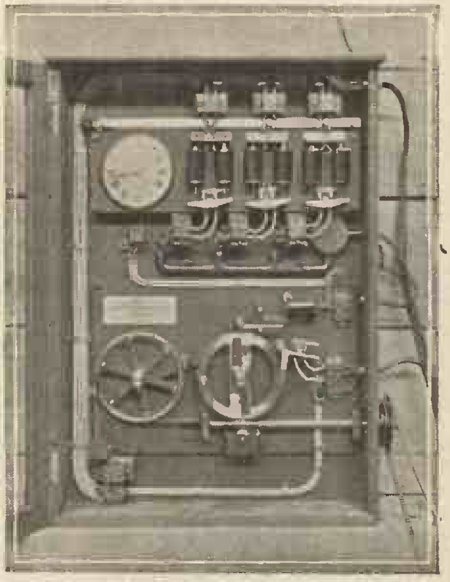
On this second shaft are fitted three epicyclic gear units, one for each figure band, and it is by the control of these that the bands are moved forward at the appropriate moments.

These gear units are completely independent of each other, and each is made up of a central " sun " pinion, keyed to the belt-driven shaft, with three " planet " pinions spaced around it. These planet pinions are fitted to studs on a disc, the bearings of which run freely on the shaft.

Meshing with the planet pinions is an annular gear-ring, and this is also mounted on bearings running freely on the central shaft. Both the component carrying the planet pinions and that attached to the annular gear are provided with brake drums, and a pair of powerful brake shoes acts upon each drum.

Springs are fitted to these brake-shoes, those of the planet pinion component causing them to grip their drum and hold it stationary, while those acting upon the brakes of the annular gear hold the shoes free of their drum.

In addition to the springs, the pairs of shoes are fitted with electromagnets which, when energised, can reverse the



Details of the motive power.

braking effect. These magnets are series-connected and act simultaneously.

While the magnets are out of action the rotation of the central shaft will only result in the idle turning of the annular gear, but with the completion of the magnet circuit the reversal of the braking grip will cause the planet pinion disc to revolve instead.

As this last component is coupled by a chain drive to the sprocket spindle of its corresponding figure band, its movement will at once shift the band forward and bring the next figure into position.

The Control of the Circuits

The control of the circuits of the electro-magnets on the three gear units is centralised on a contactor panel, the main portion of which is a master contact-maker. This consists of a worm and worm-wheel, driven by a chain from the main motor-driven spindle. The ratios of the mechanism cause the worm-wheel to revolve in about fifty seconds, and fitted at two opposite points on the rim are two spring catches.

As the wheel rotates, these catches will engage in turn with a trigger lever, which is unlocked at each half-minute by the master clock. Since the worm-wheel is timed to revolve slightly faster than once per minute, the catches will lock on the trigger some seconds before each half-minute and will be held until the thirtieth second.

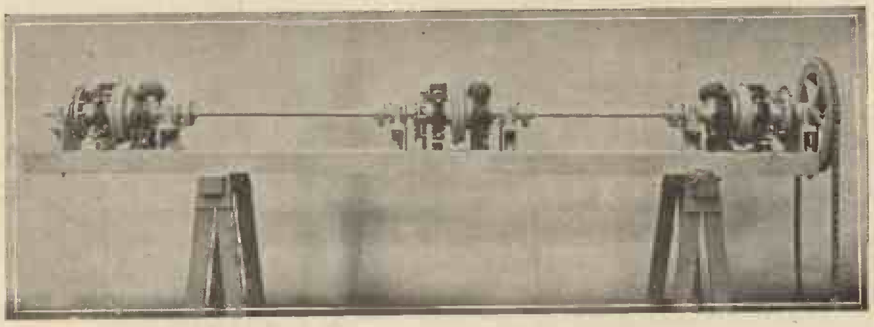
In addition to the catches the worm-wheel is provided with a trip-pin which at each complete turn of the wheel rocks over a mercury-tube switch and closes a local circuit through a relay controlling the switching of the minute band-brake magnets.

Once tripped, the relay will keep the brake circuit closed until the next figure is in position, when a cam mounted on the sprocket spindle will make a still further contact and return the relay to its original position, thus stopping the band.

The other two bands are also controlled by relays in an exactly similar manner, but additional contacts are included in the " make " circuits of these and a count wheel only closes these additional contacts at each tenth and sixtieth minute.

As the worm spindle of the contact-maker is driven from a continuously rotating shaft, the driven chain wheel is held to it by a spring clutch, which allows of slip during locked periods and gives efficient action both for synchronising and contact making.

The figures appearing on the bands are 3 ft. high and, in addition to being painted, are fitted with silvered reflectors to make them more prominent. The Chronoscope is the largest in the world, and its three bands weigh together ¾ ton. Despite this, figure changes only occupy eight seconds. Electric power for its operation is drawn from the station supply and is suitably transformed and rectified, the Chronoscope having its own equipment for the purpose.



Further details of the motive power for driving the clock.

A SMALL PRECISION LATHE FOR MODEL MAKING—PART II

The simple 1⅝-in. centre lathe described in this article is not, of course, intended for large work, but it will be found extremely useful for making small parts within its capacity. All of the work may be undertaken on a Drummond or any similar lathe, and when completed will be found a most useful accessory to it.

IN the drawing of the mandrel (Fig. 5) given in the last article, the diameter of the bore was figured ¼ in. This will probably be found quite correct, but it is possible that the shanks of all collets, or split chucks, of different makes are not uniform, and it would be advisable for the maker of the lathe to purchase at least some of his collets and two draw-in spindles before he bores the mandrel or the tailstock poppet. The writer has one of these collets, or split chucks, before him, and the diametrical measurement of its shank is a full $\frac{7}{32}$ in. With this diameter it would be quite practicable to pass a ¼-in. drill through the steel for the shafts. It should be mentioned that the mandrel and back poppet are of different lengths, and as neither of these lengths are standard for the Lorch and other watchmakers' lathes, it will be found necessary to alter the draw-in spindles to make them fit our own lathe; this alteration will be in respect to length only. One end of the spindle has an inside thread which screws on to the shank of the split chuck. This end must not be touched, and what the reader will have to do will be to cut off the milled wheel and lengthen the spindle by inserting a piece of steel rod of the same diameter as the spindle. The best way to do this will be to drill the end of the new steel, turn down a shoulder on the spindle to fit the drilled hole and braze the two together; then re-mount the milled wheel on the new end, the two spindles, one for the headstock and the other for the tailstock, being made the exact length to correctly operate and draw in the collets, or chucks.

The Slide Rest

Fig. 6 shows the complete compound slide rest in longitudinal and cross section. As the drawings will probably make the design and construction all clear, there is little that need be said. With regard to the materials in which the parts will be cast, it is, of course, usual on larger lathes to employ cast iron, but in this small tool gunmetal will be found much more suitable and less liable to fracture. The lowest member of all, the saddle, which slides upon the lathe bed, may perhaps be cast in iron if preferred, but there is really no advantage to be gained, even in the matter of cost, and gunmetal will be found much more convenient to work up by hand and get all the surfaces and lines true. In making the foundry patterns for the parts of this slide rest, and indeed for all the castings in the lathe, very little allowance for machining or working up need be made, and only in the pattern for the bed is there any need to allow for contraction. It is suggested that for all the gunmetal parts the measurement

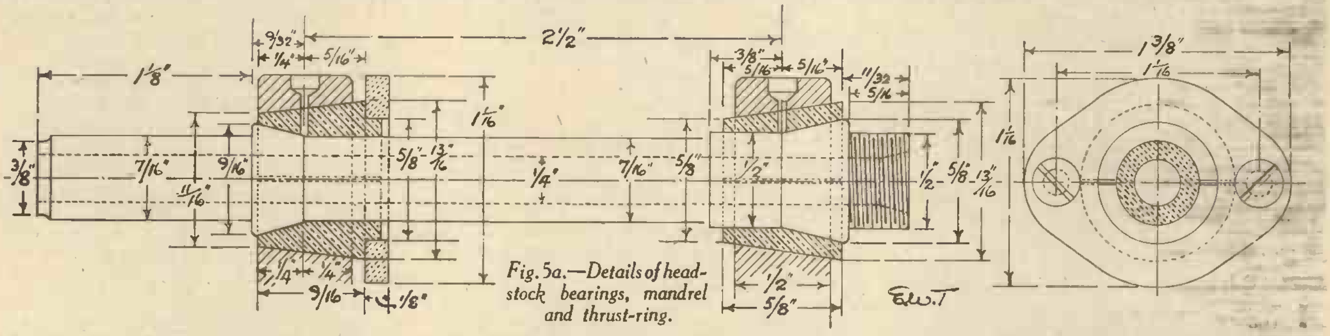


Fig. 5a.—Details of head-stock bearings, mandrel and thrust-ring.

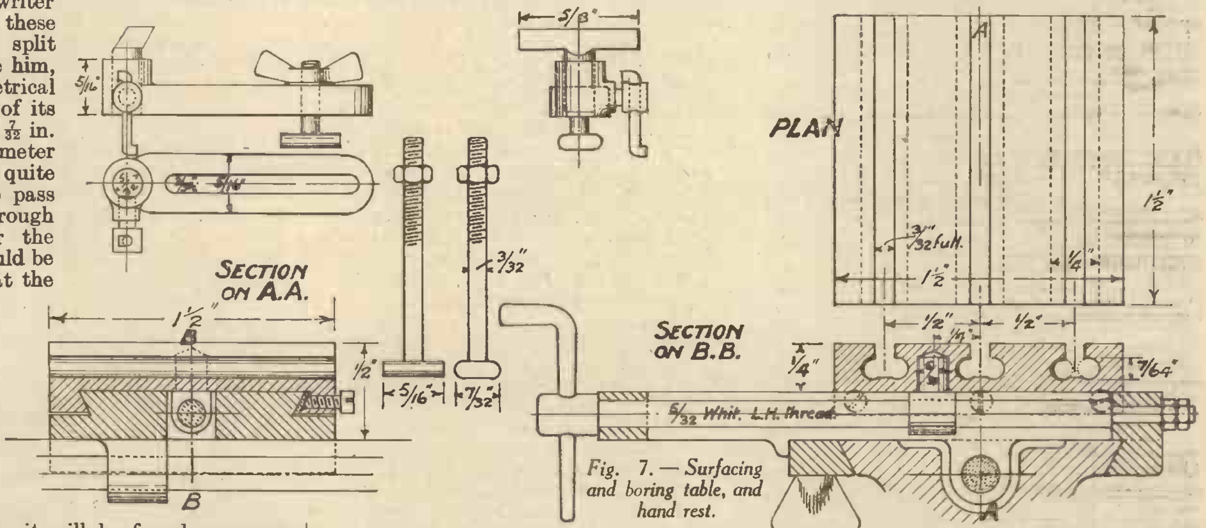


Fig. 7.—Surfacing and boring table, and hand rest.

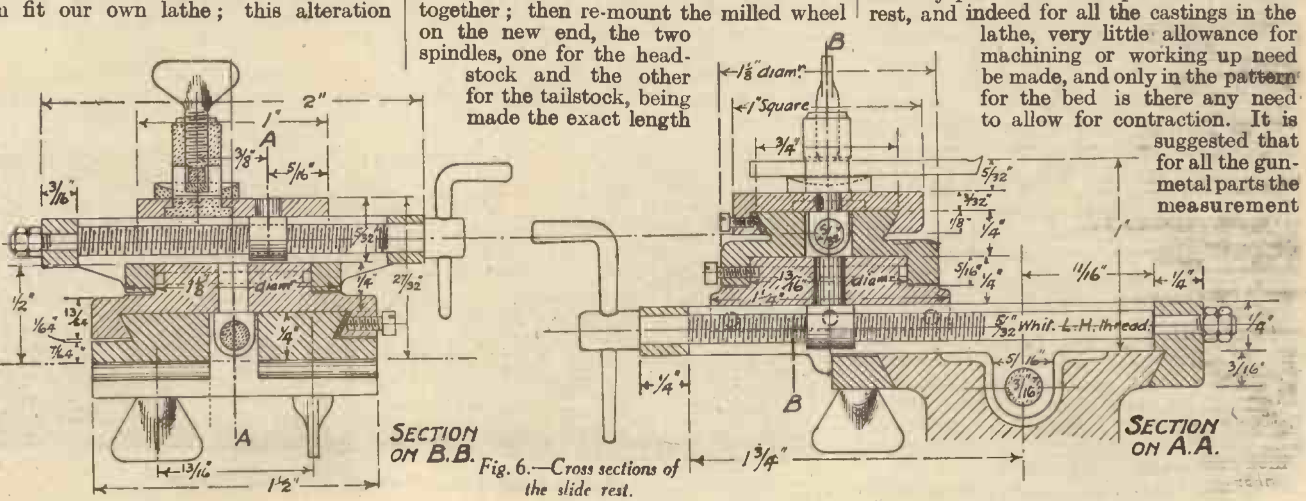


Fig. 6.—Cross sections of the slide rest.

of the pattern shall not be made to exceed that of the finished part by more than $\frac{1}{32}$ in. By taking great care in this respect a considerable amount of labour is saved in file pushing. It is assumed, of course, that the castings are not going to be dealt with on a shaping or milling machine; if they were, the case would be altogether different.

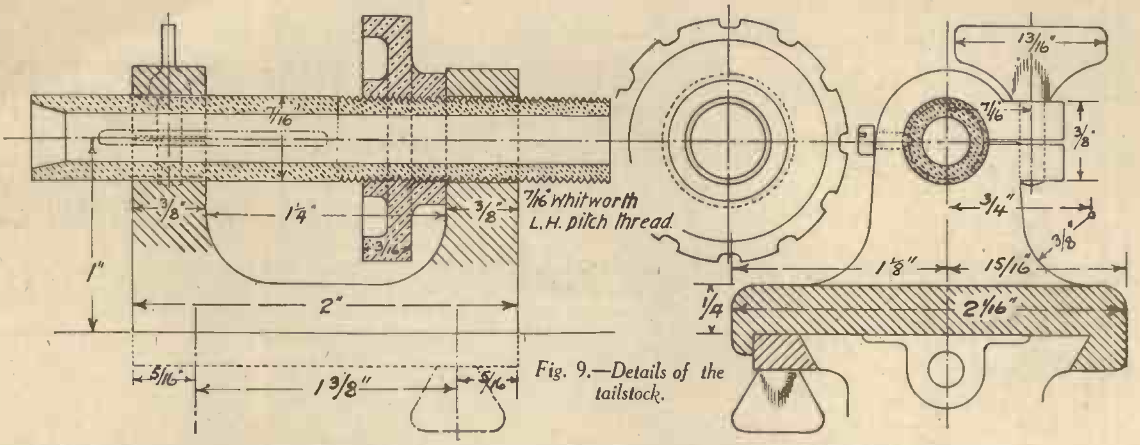


Fig. 9.—Details of the tailstock.

In our slide rest it will be noted that all the threads of the operating screws are of left-hand pitch; this is the case also with the long lead screw in the bed. In most lathes left-hand screws are employed, because the use of them enables one to get movements to the tool which are much more natural and instinctive than would result from the use of right-hand threads. Of course, it may be to some extent a matter of use, and if the reader who makes this lathe prefers for convenience to use right-hand pitch Whitworth dies and taps, he can quite well do so, and will become accustomed to the direction in which he must turn the handles to give the tool a certain movement, but if one has other and larger lathes, or is used to the handling of them, it would be found very awkward, and may quite possibly result in damaged work. Left-hand dies and taps are obtainable quite easily, though they may not be stocked at small local tool shops. Throughout the lathe, and, of course, as shown in Fig. 6, on the slide rest, the clamping screws are of the fly-headed pattern. There is no need to make the head and the screwed shank from one solid piece of metal. The easiest way will be to use cheese-head steel screws having heads as large as possible. File the head to approximately the shape indicated, open out the slot with a wide saw, and braze in flat steel plates cut to the shape shown. The operating handles are formed from tapered steel rods driven into holes in the ends of the screws and bent.

The Surfacing and Boring Table

Fig. 7 shows this complete. The lower portion, or saddle, with its clamp and screw, is exactly like that of the slide rest. The boring table is exactly square, made of hard gunmetal, and having three slots in its upper surface. The most convenient way to form these slots will be to drill two holes parallel and close together for each, the size of drill required being $\frac{7}{64}$ in. Dotted lines in one of the slots of the right-hand section indicate the circles of the two drill holes. After drilling, a wide hack-saw, having a width across the teeth of $\frac{3}{32}$ in., is used to form the slot and cut the two drilled holes into one. The drawing shows two views of one of the holding-down bolts. These will be made of different lengths, according to the nature of the work which is to be bolted down on to the table. They can be made as and when required. Their construction is quite simple, the easiest way to form them being to cut square plates to fit in the slots of the table, drill and tap them, and screw the bolt shanks in, and make all secure by brazing. It will be noticed that on the bolts hexagon nuts are shown. These may very well be replaced with butterfly nuts. One of the holding-down bolts, a very short one, will be required for the hand rest, which is also included in Fig. 7. This hand rest is intended to be carried by and clamped to the surfacing table, not perhaps an always convenient method, but it will save making a complicated adjustable carrier specially for it to fit on the bed.

The Gear-cutting Attachment

In connection with the surfacing and boring table, a gear-cutting attachment, referred to in the last article, may very well be dealt with next. This is shown complete in Fig. 8. The frame bolts down on to the table as shown in the side view of the attachment, short holding-down bolts being used. This frame is of gunmetal, and carries in upper and lower coned bearings the vertical spindle, which spindle is, of course, of steel. The upper cone is formed by a boss on the pulley, and it will be advisable, therefore, for this pulley to be cast in iron. Adjustment of the bearings is arranged by means of a nut and cupped washer on the top of the spindle. At its lower end the spindle carries the gear cutter; such a cutter is shown in the little detail drawing at the bottom right-hand corner of Fig. 8. One of these cutters, exactly as shown, is before the writer as the drawing is made, but he is not very sure whether all such tiny cutters are provided with holes of the same diameter. They are probably made for particular lathes and gear-cutting machines, and so may vary in diameter, according to the particular make. It is recommended, therefore, that the turning of the spindle for the attachment be not

(Continued on page 244.)

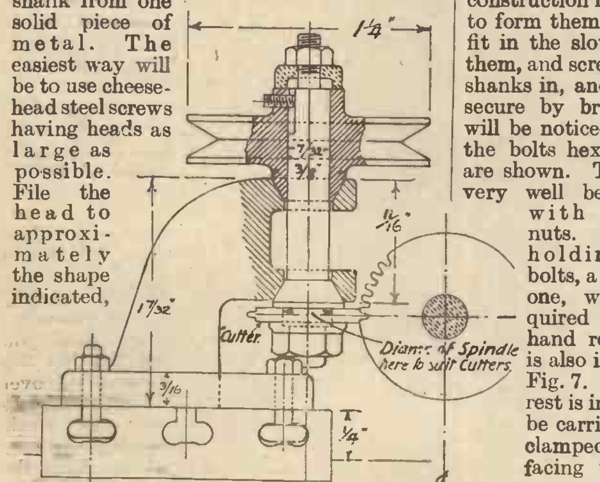


Fig. 8.—Side elevation and plan of gear-cutting attachment.

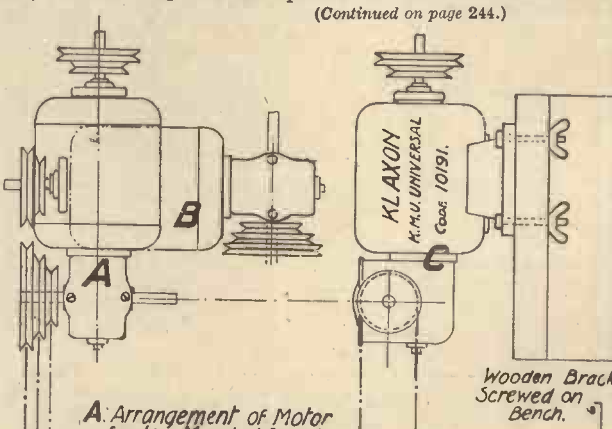
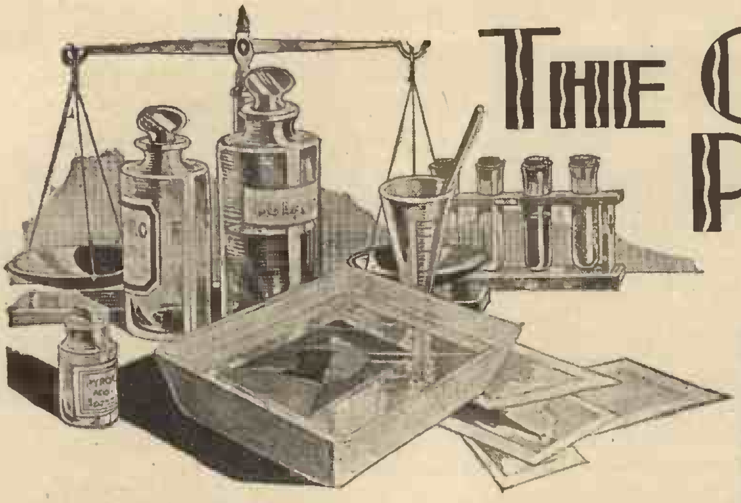


Fig. 10.—Plan of motor drives for lathe.



THE CHEMISTRY of PHOTOGRAPHY

With Instructions on Making Your Own Plates

By W. B. RICHARDSON

THE process of photography may be divided into two principal sections. There is the *optical* part, represented by the camera, and the *chemical*, which embraces the plates, films, developer, etc., and all the processes associated with their use. It is the latter phase of the subject that is dealt with here.

The vast majority of photographers interest themselves only in the artistic and mechanical side of the pastime. Anything connected with the production of the sensitive film, the action of the light on the film, its development and so on is a sealed book to them. They go to the chemist for a film and take it back there for developing and printing, and that often represents the whole of their knowledge of that side of the subject. Of course many are content to let it rest at that, but those who are at all interested in chemistry and physics, and more especially those who do their own developing and printing, will find a knowledge of the chemical processes involved will add greatly to their enjoyment of the work and, moreover, help them in obtaining the best results.

The Sensitive Film

The chemical side of photography starts with the production of the sensitised plate or film. As it is essential to have perfect cleanliness in all the work the glass plates or the celluloid film are first made *chemically* clean by treatment with an acid or other solution and then washed and dried.

The dried plate or film is then coated in the dark with an emulsion of gelatine containing certain salts of silver such as silver bromide and silver iodide. The gelatine forms the body or substance of the emulsion while the silver salts are the active principle. The emulsion is allowed to dry, or rather set, for it is applied hot, and the plate or film is ready for use.

On exposure to light in a camera the silver salts undergo a subtle change. There is no difference in appearance, the gelatine coating being the same creamy colour as before, but those parts on which the light has fallen, that is to say, the bright parts of the picture formed by the lens on the plate, appear to receive minute charges of electricity. It is as though the rays of light act like an electric current and charge up each little sensitive particle on the film just like a miniature accumulator; in other words, the action is of an electro-chemical nature. It is hardly in the scope of this article to discuss the actual chemical composition of the latent image, as it is called. Suffice it to say it is of a very complicated nature. There is, however, one clearly defined difference between the pure emulsion which has been unexposed to the light and those parts on which the light has fallen. If the plate or film be brought in contact with a reducing agent called a "developer," the unexposed parts will remain virtually unchanged while the exposed parts will be *reduced* and metallic silver will be deposited. This deposit is in the form of an extremely fine-grained film varying from grey to black, according to the amount of light which has fallen on the plate.

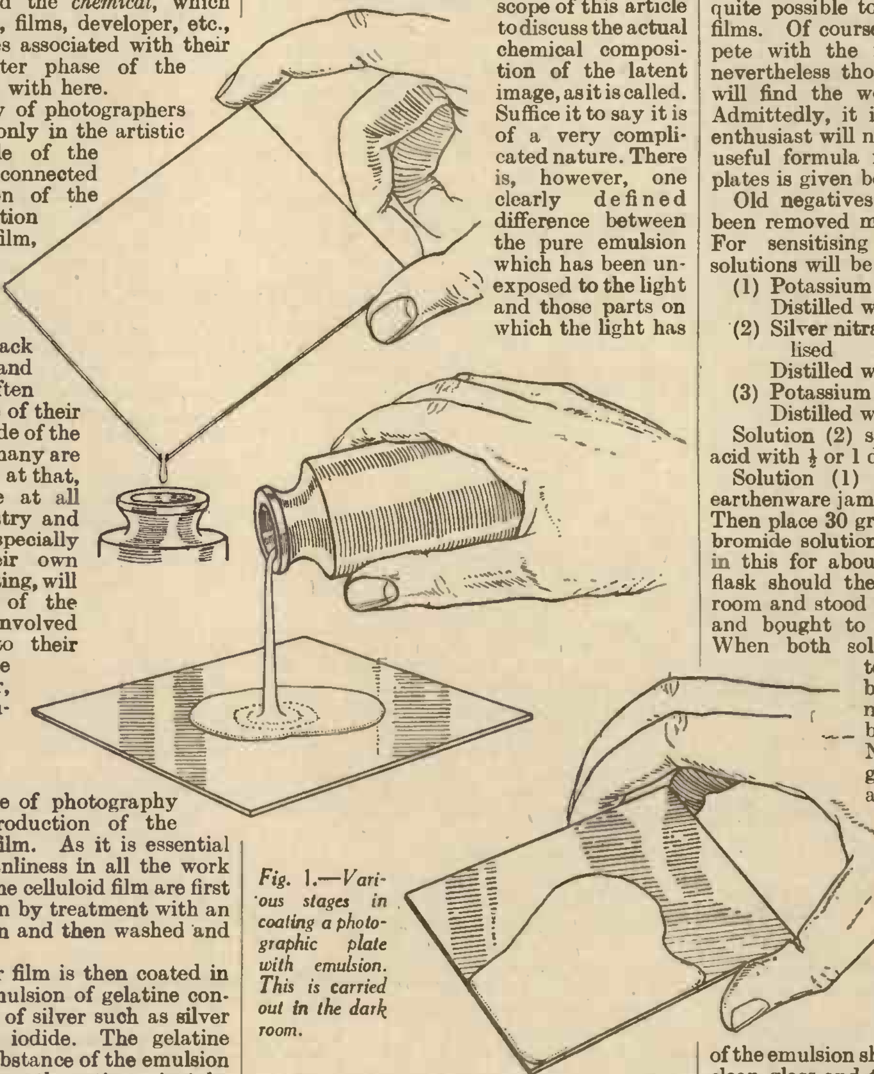


Fig. 1.—Various stages in coating a photographic plate with emulsion. This is carried out in the dark room.

It is the "charging" due to the light which enables the reducing action to take place. In the presence of the developer the tiny charged electric cells are set working, and the silver is deposited in much the same way as a metal is deposited in electroplating.

How to Make a Photographic Plate

Before proceeding further with the subject of development and printing it may be of interest to the amateur to know that it is quite possible to make his own plates and films. Of course it is not possible to compete with the manufactured article, but nevertheless those who like experimenting will find the work extremely interesting. Admittedly, it is a little tedious, but the enthusiast will not be daunted by that. A useful formula for the production of dry plates is given below.

Old negatives from which the film has been removed may be used for the plates. For sensitising purposes the following solutions will be needed:—

(1)	Potassium bromide	170 grains.
	Distilled water up to	2⅝ oz.
(2)	Silver nitrate, recrystallised	200 grains.
	Distilled water up to	3⅞ oz.
(3)	Potassium iodide	6 grains.
	Distilled water up to	4 drachms.

Solution (2) should be rendered faintly acid with ½ or 1 drop of acetic or nitric acid.

Solution (1) should be placed in an earthenware jam jar and (2) in a small flask. Then place 30 grains of hard gelatine in the bromide solution in the jar and let it soak in this for about an hour. Both jar and flask should then be taken into the dark room and stood in a saucepan of hot water and bought to a temperature of 160° F. When both solutions have reached this temperature as determined by a thermometer, the silver nitrate solution (2) should be very slowly added to the No. (1) solution, stirring gently with a clean glass rod all the while. Now add solution No. (3), place a lid over the jar, and gently stew the whole thing for an hour or so. Keep the water in the saucepan boiling gently for this length of time. When the stewing process is nearly complete a drop of the emulsion should be placed on a piece of clean glass and taken out of the dark room and examined by looking at a candle flame through it. It should appear bluish in colour. After stewing, the solution should be allowed to cool and a further 150 grains of gelatine added. This gelatine should have been previously softened by soaking in water for about an hour. The whole is stirred well until the gelatine is dissolved, and then left to get quite cold, when it will set.

The cold emulsion must be washed by squeezing it many times through muslin or net under water. The water is then drained off and the emulsion heated to 120° F., when the following is added a few drops at a time.

Chrome alum (1 per cent. solution)	3 drachms
Alcohol	$1\frac{1}{2}$ oz.

The emulsion should finally be filtered through calico or chamois leather.

The Plates to be Coated

These are thoroughly washed with strong soda, rinsed, and dried. For the coating process the emulsion is warmed up to about 105° F., and poured on to the centre of the glass as in Fig. 1. The plate is then tilted until the emulsion runs over the entire surface. Any surplus may be drained off from one corner. The plate should be placed on a perfectly level surface for the emulsion to set. Keep it as free from dust as possible.

In connection with the making of the emulsion there is one point which may not be quite clear to those whose knowledge of chemistry is not very advanced. It is the fact that although we mentioned that such salts as silver bromide and iodide are employed in the manufacture of plates and films, yet neither of these appears in the formula for the emulsion just described. Of course, the reason is that the silver bromide and the silver iodide are produced by the combination of two other chemicals during the process of manufacture. You will notice that three solutions are made, and these are mixed together only in the dark. Two of the solutions contain potassium bromide and potassium iodide respectively, while the third contains silver nitrate. When they are mixed the silver nitrate interacts with the other two. The silver combines with the bromine and iodine to form silver bromide and silver iodide, while the "nitrate" constituent combines with the rejected potassium and produces potassium nitrate. The equation may be expressed thus:—

$$\underset{\text{Silver nitrate}}{AgNo_3} + \underset{\text{potassium bromide}}{KBr} = \underset{\text{silver bromide}}{AgBr} + \underset{\text{potassium nitrate}}{KNO_3}$$

Also:

$$\underset{\text{Silver nitrate}}{AgNO_3} + \underset{\text{potassium iodide}}{KI} = \underset{\text{silver iodide}}{AgI} + \underset{\text{potassium nitrate}}{KNO_3}$$

You will see that the necessary silver bromide and iodide are freshly produced while the emulsion is being made. Incidentally, as these salts are sensitive to light, mixing of the three solutions could not take place other than in a dark room, otherwise they would be acted upon by the light at the moment they were produced. In other words, the emulsion would be "fogged" during the course of preparation.

Developing and Fixing

There are quite a number of reducing agents which may be used as developers. A *reducing* agent, by the way, is one that has a great affinity for oxygen. It has the opposite properties of an *oxidising* agent. When metallic salts are oxidised it takes them further from the metallic state; a reducing agent, on the other hand, brings them back, or tends to bring them back to metals.

One of the best-known developers is *pyrogallic acid* or, strictly speaking, *pyrogallol*. Its formula is $C_6H_3(OH)_3$. It is in the form of white, snow-like powder which gradually turns dark on exposure to light and air. When discoloured right through it is useless. In combination with an alkali such as sodium carbonate (washing soda), it forms a very powerful reducing agent. A suitable developer for plates or films using "pyro" may be made as follows:—

Pyro	48 grains
Sodium carbonate	384 „
Sodium sulphite	1 oz.
Citric acid	4 grains
Water	17 oz.

The sodium sulphite and the citric acid are included chiefly as preservatives and to prevent staining of the negatives. One of the drawbacks of this otherwise excellent developer is that it oxidises rapidly on exposure to the air, and while development is being carried out it changes from an almost colourless liquid to a dark brown. This stains the gelatine in the emulsion of the plates or films, resulting in a brownish-coloured negative. However, the staining will not be excessive, and will have no ill-effects if sufficient sulphite is employed and fresh developer is used for each batch of plates.

After development it is necessary to remove the remaining silver bromide and silver iodide which has been unaffected by the light. This is, of course, the "fixing" process for which the familiar *hypo* is employed. The plate or film is removed from the developer and rinsed in water, and then placed in a dish containing a solution of hypo crystals in water. Hypo is really *sodium thiosulphate* ($Na_2S_2O_3$), although it is generally misnamed *hyposulphite of soda*, hence the abbreviation "hypo."

(To be continued.)

A SMALL PRECISION LATHE FOR MODEL MAKING—PART II.

(Continued from page 242.)

completed until it is definitely known what range of cutters the maker of the lathe will purchase. The reader is advised to go to a reputable firm who stocks all classes of machines and tools for the use of watch and clock makers. The method of using the attachment will doubtless be obvious from the drawing. The blank which is to be cut and made into a gear wheel is held on a mandrel carried by the headstock of the lathe and supported by the back centre. By operating the cross-feed screw of the surfacing table the cutter is brought up to one side of the blank. The spindle is set running and the index pin dropped into the first hole on the division plate. With the lathe mandrel locked in position, the cutter is then made to traverse the edge of the blank by moving the table with the lead screw handle. If the cut so made does not produce the full depth of the teeth, the cross-feed is adjusted until it does so. On completion of the first cut, the division plate is turned one hole, and the second cut is made. It must, of course, be the subject for previous calculation whether the diameter of the blank, the pitch of the teeth, and the number of teeth required is going to work out correctly.

The Tailstock

A detail drawing of this is given in Fig. 9, and does not call for much descriptive matter. The reader will note one measurement figured which differs from that figured in Fig. 1, and will understand that the dimension $\frac{3}{4}$ in. takes the place of the $\frac{13}{32}$ in. previously given. A further difference will be noted in the position of the poppet clamping screw.

The Layout and Motor

By way of conclusion, the arrangement of the layout, together with a dimensioned sketch of the Klaxon K.M.U. motor, is given in Fig. 10. The pulleys which are shown are not, of course, supplied with the machine, and will have to be made by the constructor of the lathe.

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 14th of each month for inclusion in the subsequent month's issue.

STREATHAM COMMON MODEL RAILWAY CLUB

OUR Clubroom at 201 Gleneldon Mews, Streatham High Road, is open every day of the week for members' use. Each night has been allotted to a definite object, and every Tuesday and Saturday evenings the workshop is in use. On every Wednesday, Thursday, Friday and Monday (with the exception of February 5th) the track is in operation. On February 5th we had a Lantern Lecture: "Liverpool Overhead Railway," by I. Macnab, Esq. Important Announcement: Our Third Annual Exhibition will be again held at 70 Conyers Road, Streatham, S.W.16, on Friday, April 20th (6.30 p.m. till 8 p.m.), and Saturday, April 21st (3 p.m. till 8 p.m.). Tickets may be obtained from the Secretary, or any member now, price 3*d.* each (inc. Tax). The Exhibition includes examples of members' work, a passenger-carrying railway in operation on both days, a workshop in operation at certain times, and the Club track. Various sideshows and amusements. Please book the dates now, and come along.

The Club magazine, "The Rocket," is now ready, and can be obtained price 5*d.* post free.

Secretary: L. J. Ling, Brooke House, Rotherhill Avenue, Streatham, S.W.16, will gladly send particulars to anyone interested.

THE PARK MODEL AIRCRAFT LEAGUE

TOOTING. MITCHAM

A WELL-ATTENDED evening meeting was held at the Streatham Hall on Friday, January 5th last, when Mr. G. S. Broadway read a paper entitled "Some Points in Construction," which was followed by a very instructive discussion.

The Annual General Meeting and Election of Officers was held on Friday, February 2nd at 7 o'clock. On Friday, March 2nd, Mr. D. J. Jordan has kindly consented to read a paper on "Flying Scale Model Aircraft." In spite of the foggy weather and short afternoons, the flying meetings are still very well attended, and visitors may be sure of a hearty welcome. Full details of the League may be obtained from the Hon. Secretary, 112 Rodenhurst Road, Clapham Park, S.W.4.

THE MALDEN SOCIETY OF MODEL AND EXPERIMENTAL ENGINEERS

THE progress has been very satisfactory. Among the present members there are two experienced engineers who are a great assistance to the Club.

We have been engaged during the past few weeks in erecting our own lighting plant, which is now in full working order, we are also fitting up shafting to drive a lathe and drilling machine and a small circular saw.

We shall be organising an Exhibition during the coming Spring, when we hope to have a good show of members' models and work on view, and also some large working models, including an automatic coaling plant.

We are also considering the building of a locomotive testing track, which should appeal to new members that are interested in model locos.

The subscription is 3*s.* a month, which will be reduced as membership increases. If there are any readers residing in Malden and the surrounding districts who are interested in model engineering or engineering generally, we shall be very pleased to hear from them.

I should like to point out that there are no members under eighteen.

Communications should be addressed to the Secretary, R. W. Blake, 31 Idmiston Road, Worcester Park, Surrey.

THE MODEL RAILWAY CLUB

A FEATURE of the track nights on November 23rd and December 7th was the large number of new models shown as competition entries. One member was responsible for five L.M.S. models in 7 mm. scale, including two locomotives, two goods' wagons, and a bogie passenger coach. The large track was in great demand, and good running by 7 mm. and 3½ mm. scale models was demonstrated. A member had four locos. on the track, with one of which he hauled tremendous loads.

The Club Social on December 14th was a great success, and our many visitors were treated to a comprehensive display of members' work. Outstanding items were Southern Railway goods' rolling stock (7 mm. scale) in great variety, and L.N.E.R. stock (also 7 mm. scale), including several Great Central locos. and three fine single-wheelers of N.E.R., G.N.R. and G.E.R. designs, respectively. An interesting film on American railway practice was shown, while the social character of the evening was emphasised by the exhibition of other films in lighter vein. These films were made available through the kindness of Mr. W. J. Bassett-Lowke.

An unusual method of construction was demonstrated at a recent meeting, when four locos. constructed from Bristol board were shown. Special treatment of this material gave a finish to the painting that was remarkably good.

Full information concerning the Club may be had from the Hon. Secretary, Mr. J. C. Watts, 85 Wood Vale, N.10.

THE BRITISH INTERPLANETARY SOCIETY

SUCCESSFUL meetings were held on December 15th, 1933, and on January 5th, 1934. The former meeting was primarily concerned with the composition of the Journal of the Society, which has since been published. A competition was held to provide a suitable design for the cover. This was won by the Hon. President, Mr. P. E. Cleator, A.M.I.R.E., A.M.I.E.T., F.R.S.A., who came forward with the futuristic design now adorning the front page of the Journal. On January 5th, 1934, the Hon. Vice-President, Mr. Colin H. L. Askham (G6TT) took the Chair in the absence of the Hon. President, who is at the moment in Berlin on a visit to the German Society, the Verein fur Raumschiffahrt, the Secretary of which is Herr Otto Willy Ley. A talk was given at this meeting by the Hon. Vice-President, in collaboration with Mr. J. Davies (G20A), on "High Frequency Radiation and Interplanetary Communication," which proved most interesting, and led to much discussion on the possibilities. Meetings continue to be held at 81 Dale Street, Liverpool, 2, Room 15, Second Floor, at 6.30 p.m. Meetings are held fortnightly from January 5th, 1934, on Fridays, at the above time. Communications should be addressed to L. J. Johnson, 46 Mill Hill, Liverpool, 13.

LATEST NOVELTIES

(*Continued from page* 235)

tainer. When the emergency light is no longer required the connecting cord can be again plugged on to the generator. It costs 4*s.* 6*d.* complete. [37]

The "Sportocular" Binocular Glasses

THE "Sportocular" is a pair of small binocular glasses mounted in a comfortably fitting imitation shell frame arranged to fit the eyes like a pair of spectacles. They are so devised that no undue pressure or discomfort arises from use even after a long period. A neat focussing device is fitted to the object glasses, and when once they are set no further adjustment is necessary. They are an ideal companion for the spectator at cricket, football or rugby matches, at theatres or races. They are worn with comfort, and leave both hands entirely free. The weight is 2½ oz., and the magnifying power is that of ordinary full-size field glasses, namely, three diameters. They cost £3 10*s.* complete in leather case. [38]

HALF HOURS WITH THE MICROSCOPE

(*Continued from page* 226)

and floated off on the liquid to one side until the final part is obtained. It should then be removed to a fresh quantity of liquid and prepared for mounting as described last month. Remember that alcohol hardens animal tissue, and therefore will prove most desirable when removing the nervous systems of small animals or insects. Vegetable matter will have to be thoroughly softened in order to avoid tearing, and dilute caustic soda solution will be most useful, although it must not be used for too long a period (or in too strong a solution) owing to its bleaching properties. When the required part has been obtained, mount it as previously described, and attach a label to the slide upon which the date of mounting should be entered. This will prove extremely interesting to look back upon in years to come, and it would also be very useful to try and obtain a commercial slide of a similar subject for comparative purposes.

POWER DRIVEN MODEL AIRCRAFT

(*Continued from page* 213.)

pletely independent centre section; independent inasmuch as it is made as a separate unit and then attached to the fuselage. The engine has its centre-line vertically under the entering edge of the upper wing. In order to give directional stability to the model, two vertical fins or vanes will be provided behind the main wings, one on either side of the propeller.

It is perhaps a little unfortunate that three wheels are necessitated by this form of machine. The German Focke-Wulf "Ente" (Canard) has three wheels, and I see no way in which the number can be reduced. At the rear I have shown the axle carried on two skids. These skids may perhaps be not altogether indispensable, but it would be as well to fit them to protect the propeller in the event of a momentary elevator stall near the ground. My experience with this type of machine has always been that it seldom nosedives at the finish of a glide, and never makes a landing with its elevator in the air.

The battery and coil will be carried well in front of the engine, and the perfect adjustment of the elevator and main wing loading can be arrived at by the movement of these items fore and aft, as may be required. In the present machine we have, of course, a greater space in front of and behind the position marked for the coil and battery. The fuselage of the machine shown in Fig. 2 is of oval cross-section and can be made entirely of paper on a former as previously described, the parting line being on the horizontal centre of the engine.

We shall have to adopt a cardan shaft between the engine and the propeller. In this case, however, it will be somewhat longer.

A 4½-IN. GAUGE GARDEN RAILWAY LOCOMOTIVE—PART II.

(*Continued from page* 230.)

can be rendered steam-tight in the same way.

It is time that I gave to the reader some general arrangement drawings so that he can see what the internal construction and disposition of the parts of the engine is going to be like. Fig. 7, therefore, shows a longitudinal vertical section, and Fig. 8 a half cross-section. The left-hand of Fig. 8 is, of course, an outside front elevation. In both of these drawings I have shown the alternative boiler mountings, to which reference has already been made. Touching the matter of the chimney first, it must be noted that the height of this above the top of the smokebox affects the question as to whether a petticoat pipe is needed or not. The shorter chimney will need such a petticoat, and this forms part of the chimney casting itself. Obviously it cannot equal in effect the tall chimney wholly outside of the smokebox in respect to natural draught, but the ejector, or air-exhausting effect, in the smokebox when the engine is running, is practically the same. The differences in the chimney arrangement will affect the height of the exhaust pipe. With the tall chimney the blast nozzle should be on the centre line of the smokebox, whereas if the shorter chimney is adopted, the pipe will terminate as at 1½ in. below the centre line. The most convenient way to make it will be to let two pipes, leading from the exhaust ports of the cylinders, unite at the point where they enter the smokebox. They are bent to the curvature shown in Fig. 8, and each is cut away so that they mitre and form one pipe, the joint being brazed together.

Money Making IDEAS

By FREDK. JACE

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.

Making Carbon Paper

THE following solution, all of the ingredients of which are obtainable from the chemist, should be brushed very thinly on to thin paper to convert it to carbon paper. Melt together 5 parts of castor oil and 1 part of cerasin, stir in 5 parts of drop black (lampblack), remove from the fire and add 10 parts of petroleum ether.

Tooth Pastes

THESE consist of powders thickened to the necessary consistency with either glycerine or honey. The ingredients of the powder are thoroughly intermixed by the aid of pestle and mortar. The liquids (if any) are then added, and finally the syrupy base (gradually) until the desired consistency is attained. This procedure is invariable. The following are good recipes:

Antiseptic Tooth Paste.—Precipitated chalk, 5 drachms; powdered white soap, 1 drachm; sodium salicylate, 20 grains; oil of rose geranium, 4 minims; oil of wintergreen, 3 minims; solution of carmine, 2 minims; glycerine (4 parts); water (1 part), a sufficiency.

Carbolic Tooth Paste.—Precipitated chalk, 6 oz.; powdered orris root, 1 oz.; carbolic acid, ½ drachm; oil of wintergreen, 8 minims; oil of peppermint, 5 minims; saccharin, 3 grains; glycerine, 6 drachms; rosewater, a sufficiency.

Caponaceous Tooth Paste.—Pulverised soap, 1 oz.; heavy carbonate of magnesia, 2 oz.; precipitated chalk, 6 oz.; oil of neroli, 20 minims; glycerine, 2 oz.; orange-flower water, a sufficiency.

Remaking Guttapercha Golf Balls

FOR this the guttapercha should be in the form of sheets. A piece sufficiently large should be cut off and softened on an iron plate heated to about the temperature of boiling water; the rubber core should be rolled in the guttapercha, and the ball placed in a mould in which it can be submitted to great pressure in a screw press. The ball should be made warm enough to soften the guttapercha before it is pressed, otherwise the cover will be loose. Old uncured guttapercha could be used again by kneading it in boiling water to remove the dirt and sand, rolling it out thin, and allowing it to dry.

Asbestos Paint

MIX powdered asbestos with distemper vehicle or with a crystal varnish. In the former case it is advisable to use about 10 per cent. of Paris white to secure purity of tone, and in the latter case from 5 to 10 per cent. of zinc white.

Chemical Soap

THIS is used for removing grease and other spots. Take ½ oz. of powdered Fullers earth, moisten with pure turpentine and add ½ oz. of salts of tartar and ¼ oz. of best potash. A paste is made of these ingredients with a little soap.

Etcher's Wax

THE following wax can easily be moulded and is suitable for use as a bank round a plate that is to be etched. Melt together in a pan, 3 oz. of yellow resin and 2 oz. of beeswax stir well together, then add ½ oz. to 1 oz. of olive oil mix, and pour out on to a stone to cool.

Making Celluloid Map Cases

IN making these cases the celluloid should be cut in the form of an ordinary envelope, that is to say a rectangle 8 in. by 4 in., a ¼-in. full being allowed all round in addition for the thickness of the map, and four triangular pieces proceeding from the four sides. By opening out an ordinary envelope it will be seen what is meant. When this piece is cut out the celluloid should be put in a warm place—not too hot, or it will take fire—and the folds should be made over a straight edge of a piece of plate glass. When the celluloid is cold it will remain as folded. A cement should be used that does not act on the celluloid. Try a solution made by covering gelatine with acetic acid and melting down by a gentle heat.

White Paste for Canvas Shoes

SCRAPE pipeclay into a saucer, add a few pieces of oxalic acid and a very small portion of washing blue, and then pour on warm water till the paste is of the required thickness. If a paste of not quite such a dead white is desired, scrape in a little buff-ball after the oxalic acid has dissolved. In using the paste well rub it into the shoes, allow to dry, rub out, and lightly brush.

Composition of Shoemaker's Heelballs

SHOEMAKER'S heelballs are made from carnauba wax, which is softened by the addition of tallow or beeswax; the exact composition can easily be found by trial. Gum-arabic is not used in heelballs because it will not melt with the wax. The black is obtainable by the addition of a small quantity of drop black.

Making Sticking Plaster

FOR the base of ordinary sticking plaster a fine cotton material should be used. The lead plaster is worked in hot water and made into a thick roll, then a portion is cut off with a hot flexible steel spatula, and spread smooth and thin with the same instrument; the spatula is kept warm for the purpose.

Silvering Electric Light Bulbs

THERE are several methods of depositing a fine layer of silver on glass, but they will depend upon the same chemical reaction, that is, the reduction of ammoniacal silver nitrate solution to finely divided metallic silver. Success depends upon the cleanliness of the glass to be silvered, the use of clean vessels and distilled water. The glass is best cleaned with soapy water, ammonia and distilled water in turn. It can be immersed direct in the silvering solution, which is made by adding a reducing agent in the shape of formaldehyde tartaric acid, sodium, and potassium tartrate (Rochelle salt), or glycerine. It is immaterial which is used, to a solution of silver nitrate made alkaline with ammonia. You need not worry yourself about the strength of solu ions which you use; any reasonable strength will give a good result, say about 30 grains of silver nitrate and the same of Rochelle salt to the ounce of distilled water.

Curing Rabbit Skins

THE skin must be fresh flayed and cleaned of all fat and particles of flesh by scraping it with a blunt knife while stretched, fur inwards, upon a rounded surface, such as a baluster. It should then be steeped in a solution made by thoroughly mixing together when dry, 4 parts of alum and 1 part of common salt, and then adding as much warm water as will dissolve the mixture, the quantity depending on the size of the skin. To ascertain when it is soaked long enough squeeze the liquid from it and double it with the skin side upwards so as to make a crease. When the line shows white the soaking can be stopped. This usually takes about forty-eight hours. Make a paste of flour and water, and having rinsed the skin dip it for a minute in the warm gruel. Now wash it clean with cold water and dry it. When about half dry stretch again on a board and rub with pumice. Small skins when freshly flayed can be cured by being soaked for a few days in a solution of tan. This can be made by boiling oak bark or oak galls in rain or distilled water or by dissolving tannin in soft water. Fill a pot with oak bark and boil it in twice as much water for three hours. Use the solution cold and take out and rub the skin as often as possible during process.

Chemical Weather Glasses

THE materials used in preparing the familiar chemical weather glasses are stated to be 1 part of potash, 2 parts of camphor, and 1 part of ammonium chloride, with a mixture of alcohol and water. The proportions of the latter are so adjusted that there is no deposit at a temperature of 80° F., but a very large deposit at 32° F. These glasses are not affected by changes of the weather unless the temperature rises or falls. They cannot possibly be affected by changes in barometric pressure because the tubes are closed, but if the change is accompanied by a rise or fall in temperature, then the glasses give an indication.

Colourless Varnish

COLOURLESS varnish for use on fine labels or other prints, as well as for white wood and other spotless articles, is made as follows: Dissolve 2½ oz. of bleached shellac in 1 pint of rectified alcohol; to this add 5 oz. of animal boneblack, which should first be heated, and then boil the mixture for about five minutes; filter a small quantity of this through filtering paper, and if not fully colourless, add more boneblack and boil again. When this has been done, run the mixture through silk and through filtering paper. When cool, it is ready for use. It should be applied uniformly and with care.

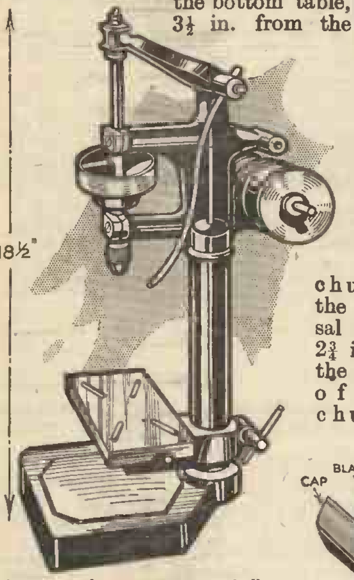
Cream-Soap

BEAT small portions of soft white lard potash soap in a mortar until it has formed a white homogeneous mass. To perfume it, add, whilst pounding, enough essential oil of almonds, with a small quantity of oil of bergamot or cassia oil.

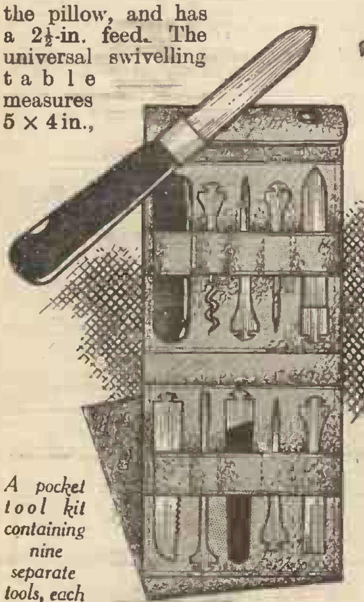
A Review of the Latest Devices for The Amateur Mechanic. *The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

Sensitive Drilling Machine

A SMALL power-driven drill is a very useful acquisition for any workshop where source of power is available. The chief features of this type of machine are as follows: It has a ⅜-in. three-jaw chuck, measures 5½ in. from the chuck to the bottom table, 3½ in. from the chuck to the universal table, 2¾ in. from the centre of the chuck to the pillow, and has a 2½-in. feed. The universal swivelling table measures 5 × 4 in., the bottom table 5 × 5 in., the machine is 18½ in. in height and weighs only 19 lbs. It is not workable by hand or foot, and costs 35*s.* [30]



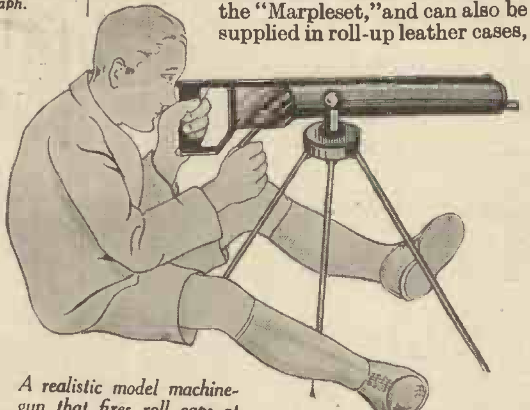
A power-driven sensitive drilling machine which will prove a useful acquisition to a workshop.



A pocket tool kit containing nine separate tools, each of which may be fitted to a specia handle which is provided.

A Serviceable Pocket Tool Kit

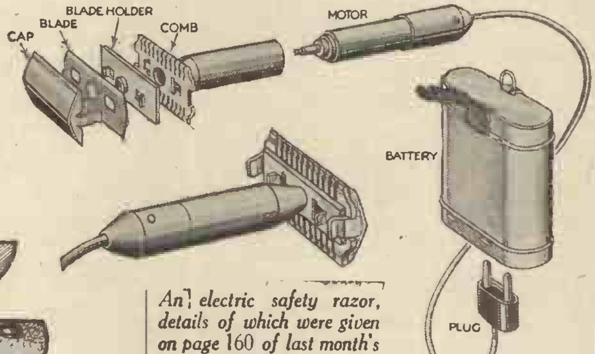
THE pocket tool kit shown in the illustration on this page will prove a boon to engineers, wireless constructors, etc. The tools consists of a chisel, file, rimer, saw, screwdriver, twist gimlet, shell gimlet, pocket knife and corkscrew, all of which are fitted into a string lined bound leather case. It measures when closed 5 × 4 × ¾ in., and when opened 12 × 4 in. It is marketed under the name of the "Marpleset," and can also be supplied in roll-up leather cases, both types costing 21*s.* [31]



A realistic model machine-gun that fires roll caps at a rapid rate by simply turning the handle at the side.

Model Machine Gun

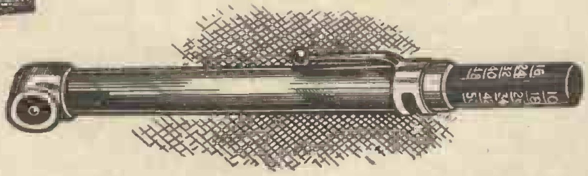
MOST boys enjoy playing with realistic model guns of any type, and the model shown in the sketch will certainly not prove an exception. The machine-gun is fitted on a collapsible metal tripod, can be turned in any direction and elevated to an angle of 45 degrees. It fires roll caps at a very rapid rate, and these are easily fixed into the rear portion of the gun. It emits a very loud report and smoke pours from the barrel giving a realistic effect. It costs 10*s.* 6*d.* [32]



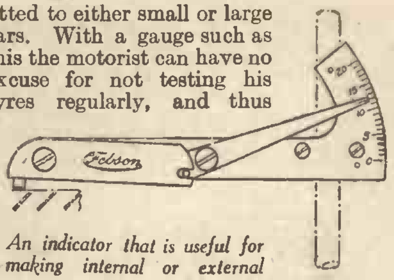
An electric safety razor, details of which were given on page 160 of last month's issue.

A Pocket Tyre Gauge

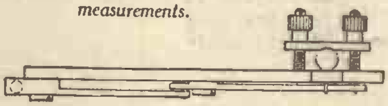
A VERY neat tyre pressure gauge has lately been introduced on the market that will prove very handy to motorists. This gauge is particularly compact, and is fitted with a convenient pocket clip so that it can readily be carried about like a fountain pen. It gives accurate readings of pressures between 10 and 50 lb. per square in., and is therefore suitable for use in conjunction with tyres of any pattern and fitted to either small or large cars. With a gauge such as this the motorist can have no excuse for not testing his tyres regularly, and thus obtaining the best and most reliable service from them. Priced at only 3*s.* 6*d.*, this instrument is sure to prove popular. [33]



An efficient tyre gauge that can be carried about in the waistcoat pocket.

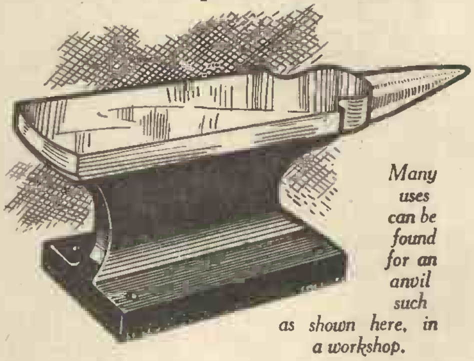


An indicator that is useful for making internal or external measurements.



A Useful Engineer's Indicator

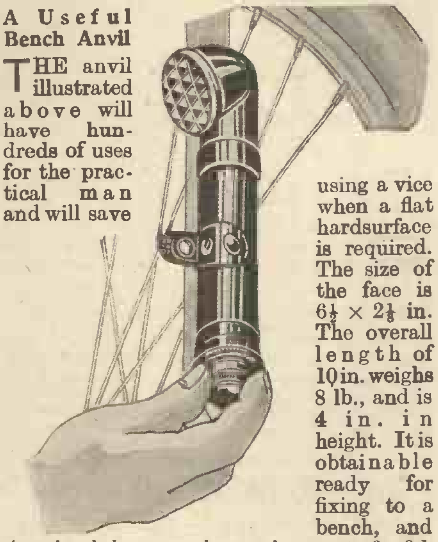
THE indicator shown in plan and side view will register to $\frac{1}{1000}$ part of an inch any variation in the surface level or diameter of an object. It is especially suitable for attachment to the pillar of a surface gauge and may be fitted to any suitable form of vertical pillar for use on machines, etc. The tool is extremely strong in construction, reliable, sensitive and accurate, made throughout in nickel silver with hardened steel studs and pivots. It is marketed under the name of the Febson Indicator. [34]



Many uses can be found for an anvil such as shown here, in a workshop.

A Useful Bench Anvil

THE anvil illustrated above will have hundreds of uses for the practical man and will save using a vice when a flat hardsurface is required. The size of the face is 6½ × 2¼ in. The overall length of 10 in. weighs 8 lb., and is 4 in. in height. It is obtainable ready for fixing to a bench, and costs 6*s.* 9*d.* [35]



A combined electric rear lamp and reflector.

A Rear Lamp and Reflector—Combined

CYCLISTS will appreciate the fact that there is now on the market a combined electric rear lamp and reflector. The "Dualite," as it is called, is easily attached to the back fork by means of a spring clip. It costs 3*s.* 6*d.* complete. [36]

BRIEF ITEMS AND TOPICAL THOUGHTS CONCERNING MANUFACTURERS AND THEIR PRODUCTS.

That Broken Ornament

OWING to the number of so-called repairing preparations that are on the market failing to give the satisfaction that is claimed, the average person is apt to hesitate before paying a shilling for a new preparation. Pix Chemicals Ltd., however, will refund your money if the results obtained from their new mending preparation (which is marketed under the name of Pixo) prove unsatisfactory. Pixo is not a glue, gum or solder, but just a fine powder that you mix with water into a paste, and when set cements the broken pieces, cracks, etc., permanently. Any articles mended with this adhesive will withstand boiling or cold water or naked flame without coming apart. Pixo will also mend holes and cracks in saucepans, kettles, pots and pans of aluminium, tin, iron, copper, etc. It costs 1s. per packet and is well worth a trial.

A Career with a Future

SELECTING a career always necessitates a considerable amount of thought, and as there is so much unemployment at the present time one is apt to be at a loss to know what to take up. If you desire a career with a future let the Wireless College, Colwyn Bay, help you. They train students for all branches of the wireless profession. They state that the demand for their qualified students is much greater than the supply. Many more could have been placed in good appointments recently had these been qualified and available. Write at once for their prospectus, which is obtainable free of charge upon application.

Magnum Cine Accessories

MESSRS. BURNE-JONES, who are well-known as wireless component manufacturers, also manufacture some ingenious home cine devices. Their Cine Pilot is an ingenious device which covers the problem of illumination of the room and control of the projector, light and motor from one source. A two-way switch controls the pilot lamp and projector, whilst a second switch provides illumination for the room and the projector control, which is essential when threading up and re-winding. The lamp supplied is suitable for all-mains voltages from 200 to 250 volts, and consumes 15 watts. Made in walnut bakelite, and supplied complete with pilot lamp and cord, with combined adaptor and two-pin plug. They also place on the market a cine tinter, which can be attached to the lens hood in a few seconds. This ingenious unit is provided with four-colour discs and an open aperture. This component may be left permanently on the projector, and enhances its appearance.

Economic Electric Co.

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

Cine Crafts Supplies

MOST readers are no doubt familiar with the above firm's title maker, and may therefore be interested to know that they have recently marketed a new Cinecraft super model. This model is a title maker of amazing simplicity and precision, and offers limitless scope for perfect titling in endless variety, as good as three titling outfits in one, and ready for instant use by day or artificial light. The Cinecraft super is complete with all accessories for cine and modelled titles, felt lettered titles, and direct traced titles.

A New Principal for the B.I.E.T.

OF special interest is the acceptance to the post of Principal to the B.I.E.T. by Professor A. M. Low, the well-known engineering scientist. This event will prove a tremendous advantage to all connected with the Institute. Write at once for a free copy of "Engineering Opportunities," a 256-page guide, which shows clearly and definitely the way in which you may carve out a successful career.

An Invaluable Handbook

ACCUMULATORS. Up to date, practical, dealing with every type of accumulator, methods of charging them at home, care and maintenance. This little book also explains how to erect a charging station. This is one of Newnes' Home Mechanic Books. Ask your Newsagent to show you other Titles in this Helpful Series. Obtainable at all Booksellers, 1/– each, or by post 1/2 each from George Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

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 252. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8-11 Southampton Street, Strand, London, W.C.2.

"Making Your Own Accumulators"

Sir,—"With regard to the article on 'Making Your Own Accumulators,' what are the plate dimensions, spacing, etc.?" (C.A.R., Brondesbury.)

The voltage of a cell does not depend on the number of the plates or on the distance between the plates, nor does the capacity depend on the distance between the plates. C.A.R. (Brondesbury). For a single cell of 2 volts and capacity of 20 amp. hours you will require three positive plates and four negative, measuring $\frac{1}{8}$ in. × 4 in. × $\frac{1}{4}$ in.

Displacement of Fluid by a Fluid

Sir,—I am rather uncertain about the experiment I am working at, and should be glad if you would kindly confirm the following. A tank, say 12 in. cube, has a tube fixed near the bottom, with a non-return valve at the tube's base, which is vertical. The vertical tube is 1 in. sectional in area. The tank is nearly filled with water, and air is pumped past a non-return valve, and the pressure of 15 lb. above that of the atmosphere. The 15 lb. pressure is sustained for a distance of nearly 12 in. (1) How high will the water rise in the V.P. which opens at its upper end? (2) If the sectional area of the pipe is 1/10 and $\frac{1}{2}$ cubic inch area? (3) And the method you use to find the answers? J.M. (Port Talbot).

(1) About 34 ft., provided that the pressure is maintained in the tank all the time. (2) The cross-sectional area of the pipe makes no difference to the height of the water in the pipe, provided that there is more than enough water in the tank to fill the pipe, as in your example. (3) Height of water column in inches =

$$\frac{\text{Pressure in tank, in lbs. per square inch.}}{\cdot 036}$$

An Illusion of Wheels in Motion

Sir,—Why does any of the wheels of a car in motion appear when viewed obliquely to stop suddenly as if the wheel was instantaneously locked and then resume rotation? The effect is best observed in the case of a wheel with thick spokes. The possibility of skidding can be eliminated, for the effect has often been noticed when the road surface was dry.

Some years ago I read a comment on the danger of operatives in factories of wheels in motion appearing motionless, and it seemed as if this were due to some effect of the artificial lighting. R.T. (County Down).

Cinema exposures are made at the rate of about 16 per second, therefore, if a wheel having sixteen spokes is revolving at one revolution per second, then every exposure will show the spokes in a similar position, and when the film is projected the wheel will appear to be still. As a matter of fact, it will, of course, have rotated the distance between two spokes.

If, however, the wheel turns slightly faster than one revolution per second, each spoke will travel a little further than the position of the previous spoke in the previous exposure, and the wheel will appear to be moving forward slowly. If, on the other hand, the wheel is revolving slightly slower than one revolution per second, each spoke will have moved between exposures slightly less than the distance from its neighbour and the wheel will appear to be going slowly backwards.

The figures mentioned refer to only one case, but there are many combinations of speed and numbers of spokes which will give a similar result. If the wheels appear to revolve slowly forward, then to stop and then to move backwards, that is explained by the fact that the speed of the wheel is changing, *i.e.*, it is slowing down.

Non-Reflecting Glass

Sir,—Can you give me any details regarding non-reflecting transparent glass? I should also like to know how it can be made. J.S. (Stockton).

No transparent glass is non-reflecting. Non-reflecting shop windows have been built and consist of glass so bent and glazed that no reflections are seen by anyone looking into the shop. There is one such window in the show-rooms of the Ford Motor Company, Regent Street, London.

Volatile Oil of Mustard

Sir,—Can you tell me how the chemical compound Volatile of Mustard is made? J.B. (Manchester).

Volatile Oil of Mustard is made by macerating black mustard seeds in water. The seeds are powdered and the period of maceration should be for several hours, after which the oil is gently distilled off. The seeds contain an enzyme, myrosin and a glucoside, sinigrin. In presence of water enzymic catalysis occurs, and the sinigrin is decomposed into allyl isothiocyanate and glucose, thus:—

$$\underset{\text{(sinigrin)}}{C_{10}H_{16}O_9NS_2K} + \underset{\text{(water)}}{H_2O} \rightarrow \underset{\text{(glucose)}}{C_6H_{12}O_6} + \underset{\text{(allyl isothiocyanate)}}{C_3H_5NCS} + \underset{\text{(potass bisulphate)}}{KHSO_4}$$

A Hair Cream Recipé

Sir,—In the October issue of "Practical Mechanics," you gave an excellent hair oil recipé. Upon inquiring at a local chemist for one of the ingredients, namely, Arachis Oil, he informed me that he had never heard of it, but suggested it may be another name for olive oil. This I tried, but the mixture when made up was too liquefied to be of any use. Could you please state why it does not make up to a cream? M.C. (York).

The hair cream recipé given in the October issue does not yield a satisfactory permanent emulsion, and would be much improved by the addition of 30 grains of Gum Tragacanth. As the recipé stands, the lotion must be well shaken before use, as separation is inevitable. The following is highly satisfactory, and is stated to be identical with the much-advertised lotions that are on the market.

White wax	10
Liquid paraffin (pharmaceutical)	130
Borax	1
Distilled water	15

Heat together wax and paraffin. Dissolve the borax in warmed water and mix the solutions. It is important that the liquid paraffin should be of low viscosity, and, if the cream is too thick, the amount may be increased to 150 or even 200 to secure the desired fluidity.

Arachis Oil is official in the *B.P.*, 1932. It was also the subject of a monograph in the *B.P.*, 1914. It was, therefore a curious chemist who had never heard of it. The common name for it is pea-nut or earth-nut oil.

A Semi-Permanent Ink for Posters

Sir,—I would very much appreciate any help you may be able to extend me on the following:—

(a) A semi-permanent solution that can be used for printing posters.

(b) A solution which, when washed over the posters as printed, will cause the printing to disappear. E.S. (Kent.)

We presume that when you speak of printing posters you mean with a brush and special ink. For this we suggest that you use an ink of starch iodide solution. This is dark blue, and is prepared as follows:—

Make a starch paste by mixing to a cream and adding boiling water in the usual way. Add sufficient iodine (tincture) to give the required depth of colour, and thin the paste with water to a convenient consistency for use with the brush.

A sign painted on paper with this "ink" may be wiped off with a solution of photographic "hypo" (about 2 oz. to the gallon of water).

If your intention was to print the posters with lithographic stones, we fear that it would be impracticable to carry out your scheme owing to the protective nature of the special ink which is used in this process, and which could not be modified to suit your purpose.

Ordinary writing ink could be used for a handwritten poster. This could be subsequently bleached out by washing over with a solution of sodium hypochlorite or Milton. The main objection to this method is in the objectionable smell of chlorine.

Detachable Sleeves for Shirts

Sir,—Can you enlighten me as to the validity, novelty and worth of the following idea, namely, detachable sleeves for shirts? Many men have occasion to roll up their shirt sleeves for working purposes, causing an inconvenient bunch of material around their upper arm, besides creasing the cuff badly. My idea is to have shirts supplied with detachable sleeves, so avoiding the above drawbacks. R. B. (Cornwall).

It is very questionable whether the suggested invention for detachable sleeves for shirts is sufficiently novel to support a valid patent. From personal knowledge, slip on sleeves have been used for many years to protect the sleeves and cuffs of shirts, these sleeves it is true are in addition to the existing sleeves, and merely formed protective coverings for same. Detachable cuffs for shirts have also been used. It may be possible to obtain a patent of a kind for the proposed invention which would probably be of some value from an advertising standpoint if the inventor were a manufacturer, but as he is not a shirt-maker and desires to sell his invention to a manufacturer, the commercial value of the patent, if it were possible to obtain one, is extremely small. It is not considered that any invention is required to produce the new article, in view of what has already been done, although the exact arrangement may not have been done before, and possesses a certain amount of merit.

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

MANY readers of this paper are probably inventors and potential patentees, and so will be interested in some early patents for inventions; other readers may consider that such a subject will be for them devoid of interest; but the glamour of romance surrounding the earliest discoveries and inventions which undoubtedly gave to England commercial supremacy cannot be but interesting to the majority of readers. It is quite true that many of these early inventions which, if not so successful as the inventors hoped, opened the door to later inventions which laid the foundation for wealth and commercial supremacy. Early inventors were always sanguine of success, not in this way differing greatly from the modern inventor, and ludicrous as some of these early efforts may appear to our wiser minds to-day, they were responsible for the great changes which happened in the eighteenth century and which created the great manufacturing towns that we know to-day. For instance, the use of coal for smelting iron, inventions for the use of steam, and even such comparatively modern inventions as the motor car were to a certain extent developed by inventors in the sixteenth and seventeenth centuries, though they had not the knowledge to make their own early experiments of any real value to their own generation.

The Sovereign's Power

From a very early time Edward III (1327–1377) until the reign of James I (1578–1625), it was the custom of the Sovereign to grant some particular person a monopoly for some particular article or business, that is, the sole right to make or sell such articles or to have the sole right to carry on some particular business or trade. Such monopolies, covering even the necessaries of life, were so freely granted by Elizabeth (1558–1603) as to become, through enhancing the price of such monopolised articles, serious abuses which were brought to the attention of Parliament, but Elizabeth was sufficiently astute to show that such monopolies were not given at her pleasure, but really for the benefit of her subjects. For instance, Elizabeth granted a monopoly for the manufacture of playing cards, which, by the way, "mad" King Charles VI of France is erroneously credited with inventing; what he actually did was to introduce them into France, probably from Italy, where they had come from Arabia in 1379. The reason given for granting a monopoly for the manufacture of playing cards by Elizabeth was because "divers subjects of able bodies, which might go to plough did employ themselves in the art of making cards." The Sovereign granted monopolies for articles already in common use, and not necessarily for the introduction or establishment of a new manufacture within the Kingdom, because in the above instance it was made clear from the patent that playing cards were already manufactured within the Kingdom. Again, Elizabeth granted a monopoly to William Humfrey and Christopher Schutz for working calamine (zinc ore) and making brass and securing to them the exclusive right of manufacturing brass, which monopoly was extended and taken over by a company which continued until 1710—although the manufacture of brass would seem to have been an established industry in the reign of Henry VIII (1509–1547), inasmuch as during the reign of their Monarch an act was passed prohibiting the export of brass, which prohibition was not withdrawn until 1799.

Granting a Special Privilege

Out of this custom of granting monopolies arose the practice of granting a special privilege to an inventor for a new invention, now commonly known as a "Patent."

Hence we find a number of people coming along during the reign of James I and asking for patents which should protect the new devices which they claimed to have invented.

It is interesting to note that most of these people were very confident of their powers, and asked for their patents to protect a whole number of devices they thought they had invented for improving every kind of thing.

Many of the monopolies that were granted even in these early times undoubtedly did much to foster and create new industries.

One of these early inventors, who, however, reaped little reward for his ingenuity, was William Lee, a native of Woodborough, a village near Nottingham, a graduate of St. John's College, Cambridge, who invented the stocking frame in 1589. The stocking frame, as is known, is a machine which mechanically produces a looped stitch in hosiery. Lee set up a works at Calverton, near Nottingham, but met with little success, and was discouraged by Queen Elizabeth on appealing to her for assistance in carrying on his work. Henry IV, King of Navarre (of St. Bartholomew's Massacre fame), who had heard of Lee's invention, invited him to France and offered him a large reward if he would do so. Accordingly Lee, with nine journeymen and several looms went to Rouen, but unfortunately for Lee, shortly after he arrived at Rouen, King Henry IV was assassinated (by Ravillac on May 14th, 1610), and the venture getting into difficulties, Lee died in poverty in Paris in 1610. A knowledge of the machine was brought back to England by some of the workmen who had gone to France with Lee, and these workmen established themselves in Nottinghamshire, and so was founded the principal centre of the hosiery trade in this country.

(To be continued.)

P.M. Gift Stamp No. 5

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For the Woodworker

EVERYONE—regardless of occupation or position—can turn the long dull winter evenings to profitable account with the G.T.L. Tool Chest and Home Repairing Outfit. With it you can make all kinds of articles of furniture and fixtures both for your own home and to sell. Just as easily you can do all home repairs and save the expense of outside help. Instead of spending money to fill your leisure hours, you will be saving money for a rainy day—you will enjoy your new hobby—and you will be giving added comfort to your family, just as thousands of others in all walks of life are now doing.

A beautiful brochure describing the G.T.L. Tool Chest and how you can make money will be sent free to readers on receipt of the coupon on p. 219. [26]

Grafton Electric Co.

THE above firm, whose offices are at 54 Grafton Street, W.1., have just issued a very comprehensive 104-page catalogue covering a wide range of electrical apparatus, toys, etc. No matter what electrical device you may require, you will find something to suit your requirements in this well-illustrated catalogue. Wireless components, batteries, meters (all types), telephones, bell pushes, cells, charging boards, electric light fittings, electric toys, etc., are all listed at reasonable prices in this booklet. They also give a fine list of books on all technical subjects that will appeal to the practical man. Write at once for this fine catalogue, which is obtainable free of charge upon applicaton. [27]

Radio Components

MESSRS. BURNE-JONES & CO. LTD., 296 Borough High Street, London, S.E.1, the well-known wireless manufacturers, have recently issued a number of comprehensive pamphlets on wireless components, etc., for the home constructor. Their pamphlet on short-wave adaptors, including methods of tuning, a list of short-wave broadcasting stations, and much other useful data is well worth perusing. They also do a fine fifteen-page catalogue on their "Stenode" radiogram, which incorporates many novel features. The home constructor will also welcome their component lists which cover a wide range, spaghetti resistances, volume controls, differential condensers, chokes, etc. Their pick-up is now available as a complete unit, including tone arm and volume control, or pick-up with tone arm, or the pick-up head only, complete with adaptor. Write at once for this fine range of pamphlets that are obtainable free of charge upon application. [28]

Hivac Valves

THE High Vacuum Valve Co. Ltd., 113-7 Farringdon Road, E.C.1, the well-known firm of valve manufacturers, offer to the public a fine range of first quality valves at reasonable prices. These valves embody all the latest and most advanced methods of construction and manufacture. They are fully recommended by a number of wireless journals as cheap and efficient, and a valve that will suit the pocket of every home constructor. This firm have recently introduced a new valve to the market which is a Class "B" and driver valve combined. This valve should go a long way towards still further increasing the popularity of Class "B" amplification, since it makes for economy both in prime cost and running expenses, besides simplifying construction and effecting a saving of space. Write at once for their valve list, which is obtainable free of charge upon application. [29]

Warneford Model Aeroplanes

F. J. MEE, 137A Greenwich Road, Greenwich, have recently issued an interesting pamphlet which includes a complete range of their many fine models. All these models are capable of a duration flight of thirty seconds or over, and any Warneford model aeroplane pilot who can exceed a duration of thirty seconds, duly witnessed, is entitled to a certificate and a pair of blue and gold wings supplied by the firm. They also organise a number of model aeroplane competitions, so why not obtain a model and experience the thrills which every competitor goes through whilst competing. The models sold by this firm are both strong and reliable, and, above all, are so priced that they will suit nearly every enthusiast's pocket. Write at once for a list of Warneford models which will be sent free of charge upon application. [30]

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