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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 intercommunication 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 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 actors. Now we are 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-telephone and television of real entertainment value, and earlier in the evening than the present transmissions (from 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 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. Cummings, 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 range 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.

With radio we can hear but cannot see the announcer or artiste.

Your Suggestions are Welcomed

It is our advice to readers to consider their own contributions in the form of, say, an essay, article, note, or poem, which expresses their thoughts and theories on various aspects of wireless. It is our wish to publish these contributions, and also to encourage others to do so. In this way, we can all contribute to the growth of the science.

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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 derivative 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.

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...
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!

Apparatus Employed

At various times during the past year or so a number of Robota 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.

**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

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

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 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.

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, if 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.

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

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

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

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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 consequently 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 220F, Mullard P.M.2A, or any similar type in other makes.

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 instructions are given in Figs. 3 and 4.

As many 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. 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 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 here 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 wise 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 circuits, there are not quite so many spectacular experiments that can be tried, 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 filament is just 2. The resistances must be large enough, because they have to handle a fair amount of power; consequently the figures given for the wattage ratings 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, 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.

WATER YOU CANNOT CUT

The Remarkable Fountain at Geneva.

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.!

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 splash with a keen sword blade will be resisted, and more than likely if the blow is hard enough the word 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-driven 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.

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-0 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, 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 elevating 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 0-2P-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 5-86 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 section shows that whereas at 2.5 degrees K1 equals .279, at 5.5 degrees the value of K1 is .386. 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.

Smaller Wing Span and Area

The net result of all these facts, therefore, is that this 1-2P-0 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 7.36 superficial ft. to do the same work as did the 7.8 sq. ft. in the 0-2P-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.)
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 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 sandglass, 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

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 thou-

sands 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.

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 1/8 in., a No. 1 size is 1 3/8 in., and No. 2 size 1 1/4th, and so on. The ligne is a Swiss unit of measurement, 11

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 94ths 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 4 7/8 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 3/8 in. in diameter, into which a steel main spring,
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 2\times\text{width} of the area.

The spot is made to move over its predetermined path very rapidly—there are 120 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 screen, 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 televised 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., a name which has long been associated with television. It is therefore 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 periscope 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
This illustration shows the mainspring (22 ins. long) and the parts of the mainspring barrel.

Reference can also be made to the high definition cathode ray tube tele-cine 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 brilliance of the spot light on the screen of the cathode ray tube. At the same time the scanning 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 processes were synchronized by making 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 that 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 being given (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 and washed. It then passes through an intermittent film projector or so that the received image 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 the film.

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.
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 on 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 plasticsurface 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 3s. for the 10-in. size with a cutting needle. This disc possesses none of the disadvantages of OUTPUT 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 perma-

or for that matter, little equipment.

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 1 watt is the minimum output necessary for making records at home, while an amplifier with an output of the order of a bout 1 to 1 1/2 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.

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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 the grooves when recording. The first works by means of a growing 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.

A very ingenious toy which is now obtainable will assist in explaining this little 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.

Fig. 7.-Method of using the control wheel arrangement.

**MARVELS OF THE MECHANICAL MAN**

(Continued from page 209.)

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 arrange that anyone passing in front of it will bring some piece of mechanism into action and either make the Robot call out "Three years" or any other pre-arranged period, but this same reply would be given if you asked, "How old 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 layout-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 saw-toothed 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 seconds 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 "Three years" or any other pre-arranged period, but this same reply would be given if you asked, "How old 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 layout-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 saw-toothed 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 seconds and so on.

**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.

Musiker 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 reel, permanent record which also reproduces a number of remarkable properties and advantages.
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Name

Address

PM1/34
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 \( \frac{1}{4} \)-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 \( \frac{1}{4} \)-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 other 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 \( \frac{3}{4} \)-inch wood, and measuring, each way, about 1 inch more than the length of the slate strip. The contact arm is cut from \( \frac{1}{4} \)-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 \( \frac{1}{4} \)th of an ampere when a 10-ohm resistance is used in conjunction with a 2-volt battery. 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 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.
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.

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. x 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 wave change 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.
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 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-

A rear view of the receiver.

List of Components for the 1934 Straight Three

One Metaplex Chassis, 12 in. x 10 in., with 1/4-in. runners.
One British Radiogram Tuning Control Unit, Type 66.
One Goltone Q.G.R. Matched Screened Coil.
One 3 × 1 L.F. Transformer (B.R.G.).
One Transcoupler (Belgium).
One 5000 mfd. Fixed Condenser, Type 970 (Dubilier).
One 5000 mfd. Pre-set Condenser (B.R.G.).
One 2 mfd. Fixed Condenser, Type B.R. (Dubilier).
One 1 watt 1 meg. Grid Leak (Dubilier).
One 25,000 Ohm Metallised Resistance (Dubilier).
One Baseboard Fuseholder and Fuse (Belgium).
One Binocular H.F. Choke (Burns-Jones).
One 0.0003 mfd. Fixed Condenser, Type 670 (Dubilier).
One 0.0003 mfd. Pre-set Condenser (B.R.G.).
One 2 mfd. Fixed Condenser, Type B.B.
One 1 watt 1 meg. Grid Leak (Dubilier).
One 25,000 Ohm Metallised Resistance (Dubilier).
One Baseboard Fuseholder and Fuse (Belgium).
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One Baseboard Fuseholder and Fuse (Belgium).
One Binocular H.F. Choke (Burns-Jones).
One 0.0003 mfd. Fixed Condenser, Type 670 (Dubilier).
One 0.0003 mfd. Pre-set Condenser (B.R.G.).
One 2 mfd. Fixed Condenser, Type B.B.
One 1 watt 1 meg. Grid Leak (Dubilier).
One 25,000 Ohm Metallised Resistance (Dubilier).
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1 BULGIN transcooler 10 6
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1 BRITISH RADIOGRAM 6000 pre-set condenser 3 0
1 DUBLER-1 watt, 2-section grid leak 1 10
1 BULGIN B.W.M. fuse holder and fuse 6 6
1 DUBLER-10,000 ohms mut. resistance 1 6
1 BURNE-JONES biacode, H.F. choke 2 3
1 BRITISH RADIOGRAM G.B. battery clip 2 6
1 BRITISH RADIOGRAM 4-pin chassis strip, valve holders 1 6
1 BRITISH RADIOGRAM on-off switch 2 10
1 BRITISH RADIOGRAM wavechannel switch, 2-pint on-off 2 0
2 BRITISH RADIOGRAM coil connecting wire 1 0
1 B.L.E. 4-way battery cord 1 0
2 GLK terminal strips (A1, A2, E, Pick-up) 1 3
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employed 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 bare end of the connecting wire and loop it through the appropriate hole, after which a spot of solder can easily be applied.

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 50,000 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 44-volt socket and G.B. — 1 in the 14-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 tuned sharpened—by slackening 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 knob 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.

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The Efficiency of Tuning Coils

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 a "Ewebec" former, and, as can be seen, it consists of two hexagonal discs of bakelite 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 simple type of wave-trap, using stranded wire, joined 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 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 connection for this coil are 6 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 (0.003 mfd.) to either terminal 2 or 3, according to the degree of selectivity required.

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. 2. 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 terminal to 2. Two slots away, the grid coil is commenced and this consists of 18-gauge enamelled wire, wound one turn per slot for five slots. The commencement of this winding is made 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. 3, is a simple type of wave-trap, using stranded wire, 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-valve set, all means study the points above set out—but remember, if the coil is to be used (100 per cent. efficient), every part of the receiver must also be of the same order or you will be wasting the efforts spent on the coil construction.
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' antennae; 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 unknown 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.

**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 Secotine. 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 fulfill the purpose.

**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 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, be necessary to portions of the body sired part is exposed, enable its removal without fracture or distortion. In cases it will be the portions body have "teased" off wholly or in part, and 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 Secotine. 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 fulfill the purpose.

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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.

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 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.

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.

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.
We have pleasure in announcing that Prof. A. M. Low, the eminent Engineering Scientist, has accepted the post of Principal to the B.I.E.T. It is impossible to over-emphasise the importance of this event and the tremendous advantages all connected with the Institute will enjoy as a result of the Professor’s appointment. We urge you, this New Year, to let us show you how we can help you, how we can alter your entire outlook and earning power, whatever your age or experience. Send to-day for “ENGINEERING OPPORTUNITIES”


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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. 6.—Details of parts of the valve gear.
the connecting and coupling rods and the crossheads with the slide bars. A sectional plan of one of the main crossheads is shown beneath 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 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 L and R 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-hand 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.

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 fire-box stays
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<td>Rd. or Sq. Iron (warm)</td>
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- 5 lb.
- 11 lb.
- 15 lb.
- 20 lb.
- 25 lb.

ESTABLISHED 1822.
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 the connecting wire already attached.

It is advisable to cut a groove around the upper edge of the glass, as shown in Fig. 1; and the jar should be placed between two pieces of wood and held with screws. Care must be taken, however, that the screws used for clamping do not touch each other.

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 one long one, as shown in Fig. 3. The short pieces of carbon are fixed around one long one, as shown in Fig. 3.

The carbon and zinc may be suspended, as shown in Fig. 4. The wood 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.

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.

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 wood 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.

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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. 8 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, mix it occasionally until dissolved; then place it in a bottle and label it: Bi-Chromate Battery Solution POISON.

(Continued on page 234.)
A HOME-MADE MICRO-AM - AND SENSITIVE METER

By G. R. SANDERSON

THE little meter described below has many uses for the radio enthusiast, and can be made for approximately ½s. 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 hack-saw 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), ½ in. outside diameter, 3 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 13 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 ⅛ 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 which is threaded at one end (this may be obtained from some old transformer stampings)

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 be less than 2 mm. Obtain a strip of copper foil, the dimensions for which are given in Fig. 5. Next shape a piece of wood as shown in Fig. 6 to the exact measurements of the coil, i.e., 12.5 mm. across, giving a clearance of ½ mm. on each side when in position. The top and bottom distances may be more than this, say, ⅛ to ⅛ 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 and on some flat surface, gently lift the "flaps," and run a long 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.

The Top and Bottom Contact Wires

Carefully bear 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.

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 ¼ 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 ¼ 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.

WINDING OF 50 TURNS 44 D.S.C.

PART SECTION SHOWING EDGES OF FOIL LAPPED OVER WINDING

SUSPENSION LOOP

START OF WINDING SOLDERED TO TOP CONTACT WIRE.

END OF WINDING SOLDERED TO BOTTOM CONTACT WIRE.

Fig. 5.—The former cut from wood.

Fig. 1.—Details of the pole piece.

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ascertain that the terminal when in position is in the centre of the tube. Take a 3-in. length of phosphor bronze wire and tightly 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 cell should now swing freely.

The Scale

The scale may be made from a 4-in.

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.

Before immersing the zincks in the bi-chromate solution they should be well amalgamated to prevent the acid from eating them too rapidly.

The amalgamating is done by immersing the zincks 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 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

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

PRACTICAL ELECTRICITY FOR BEGINNERS

(Continued from page 223)

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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 not 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.

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The binocular magnifiers shown will be found useful for work of a minute nature. They are made in three powers: x1.75, x2.5, and x3.5 diameters. The focal lengths being 10 in, 7 in, and 5 in. It costs 2s, 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 2s. 6d. Extra blades, if desired, are also obtainable at 1s. each. [32]

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 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 3s. [33]

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]

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 2s. 9d. [35]

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HINTS AND TIPS ON SHOWING FILMS

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

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—17½ mm. With the exception of the 8 mm. projector, the hobbyist 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. With means, in effect, the 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, 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 less 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 lower price at which projectors are sold one cannot expect too much.

The 8 mm. size is a new-comer, 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 of these 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 15s. 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.

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 45s., and from this price you can go on to 50s. 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. If 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 16 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 15s. 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 7s. 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.
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).

Making Vee Blocks

Obtain a piece of 2 x 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).

A Continuous Ranging 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 alarm, 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).

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 the flow of a liquid that is required in small quantities.—F. G. (Sidcup).

Permanent Way for Model Railways

The device shown in the sketch is useful for making 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.

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. cork, will do, with 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 through which is fixed a copper rod ¼ 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).

That Hint of Yours

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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 the bell of a radio, 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 El and E2 are drilled in the case F, and into El 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 (press upon 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 3 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.

How to Draw a Scroll

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 \( \frac{3}{4} \) 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—\( \frac{3}{4} \) in. diameter giving approximately \( \frac{1}{8} \) in. spacing and \( \frac{1}{4} \) in. diameter about \( \frac{1}{8} \) 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 bursts instantly 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 Illuminating or Flash Paper. A large sheet will burn with a bright flash if ignited.

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 bands which are riveted to the ring \( z \) at one end, and at the other end to another ring \( y \), the same outside measurements as \( z \), but with a 4 BA clearance hole in the centre and a 4 BA nut secured to one side of the other ring \( y \). 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\( \frac{1}{2} \) 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 beating 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**

**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 minimum, 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 facula 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 be at greatest eastern elongation, 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.

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 luminaries. Among the brighter stars of Orion above the " Belt" are Betelgeuse, radiating 3,000 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).
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 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 ratios of the several units 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 electromagnets.

As the wheel rotates, these magnets 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 escapement, 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 4 ton. Despite this figures change 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.
A SMALL PRECISION LATHE FOR MODEL MAKING—PART II

The simple 14-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 1 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 1 in. With this diameter it would be quite practicable to pass a 1-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

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 pre-

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of the pattern shall not be made to exceed that of the finished part by more than \( \frac{1}{8} \) in. By taking

Due care in this respect and considerable amount of labor is saved in the process of 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.

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 of the use of them enables one to get the lathe to the direction in which it is 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 butterfly-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 \( \frac{3}{8} \) 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 \( \frac{3}{8} \) 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 done. These are to be bolted down 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.)
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 entrust this 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 the 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.

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 electro-plating.

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 31 oz.

(2) Silver nitrate, recrystallised
Distilled water up to 31 oz.

(3) Potassium iodide 170 grains.
Distilled water up to 4 drachms.

Solution (2) should be rendered faintly acid with 1 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. Now place the flask and jar should then be taken into the dark room and stood in a saucepan of hot water and brought to a temperature of 180° 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 to about 160° F. If the gelatine added. This gelatine should have been previously softened by soaking in water for about an hour. The whole is then placed well until the gelatine is dissolved, and then left to get quite cold, when it will set.
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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 129° F., when the following is added a few drops at a time:

Chrome alum (1 per cent.)

Alcohol 3 drachm.

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 the centre of the glass as in Fig. 1. The plate is then tilted until the emulsion runs over the entire surface. Any water is then 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 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 the formulas 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 chemical during the process of manufacture. You will notice that three solutions are made, and these are mixed together 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 reacts with the bromine and iodine to form silver bromide and silver iodide, while the "silver" constituent combines with the rejected potassium and produces potassium nitrate. The equation may be expressed thus:

\[
AgNO_3 + KBr = AgBr + KNO_3
\]

Also:

\[
AgNO_3 + KI = AgI + KNO_3
\]

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 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 are 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, pyrogallic acid, which is the reaction of silver nitrate with pyrogallic acid or, strictly speaking, pyro xanthine in the emulsion of the form of white, snow-like powder which is being carried out it changes from an emulsion just described. Therefore, 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 is washed 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 (Na2S2O3). In other words, it is generally misnamed hypsulphite 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 desired to know what range of cutters the maker of the lathe will make. The reader is advised to go to a reputable firm who stocks all classes of machines and tools for instrument and clock makers. The method of using the attachment will double as 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 backcentre. By operating the cross-feed screw of the turning 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 turned it is then set to traverse the edge of the blank by moving the table with the lead screw. When this does not produce the full depth of the teeth, the crossfeed 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 illustrated which differs from that Fig. 1, and will understand that the division 1 in. takes the place of the 1 in. given above. A further indication will be noted in the position of the poppet clamping screw.

The Layout and Motor

By way of conclusion, the arrangement of the instrument and the general layout, which 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.
February, 1934

PRACTICAL MECHANICS

HALF HOURS WITH THE MICROSCOPE

(Continued from page 296)

and floated off on the liquid to one side until the final part is obtained. It should then be removed from the container and dried, before being used as suspensions for sponges, etc.

Remember that alcohol hardens animal tissue, and therefore will prove most useful to try and obtain a commercial slide.

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HALF HOURS WITH THE MICROSCOPE

(Continued from page 230)

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

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The "Sportocular" is a pair of small binoculars mounted in a comfortably fitting imitation shell frame arranged to fit the eye 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 focusing device is fitted to the object glasses, and when once they are set no further adjustment is necessary. They are ideal for spectating, 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 glasses, namely, three diameters. They cost £3 10s. complete in leather case. [38]
POWER DRIVEN MODEL AIRCRAFT

(Continued from page 213.)

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The following solution, all of the ingredients of which are obtainable from the chemist, should be boiled very slowly on a bunsen burner, and the mixture finally poured out on to a stone to cool. The paper obtained is perfectly white, and is more durable than ordinary paper. It is not affected by damp weather or by atmospheric influences. The process is a simple one and can be carried out in a very short time.

Toothpaste

1. This is a paste for the treatment of teeth, but it may also be used externally for the treatment of boils, carbuncles, and abscesses. It is also effective in the treatment of boils, carbuncles, and abscesses.

Remaking Gutta-Percha Golf Balls

The following is the composition of gutta-percha used in the manufacture of golf balls:

Chemical Soap

This soap can easily be moulded and is suitable for use as a base for a plate that is to be etched. It is a good substitute for glycerine, and is also suitable for use in the manufacture of other articles, such as toothpastes.

Etcher's Wax

The following is a formula for the preparation of etcher's wax:

Chemical Weather Glasses

The following is a formula for the preparation of chemical weather glasses:

Carbon Paper

The following is a solution for making carbon paper:

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Compositions of Shoemaker's Handballs

Shoemaker's handballs are made from sawdust and water. They are composed of a mixture of sawdust, water, and gum arabic. The gum arabic is added to increase the stickiness of the mixture. The handballs are made by mixing the sawdust and water together, and then adding the gum arabic. The mixture is then allowed to stand for a short time, and then the handballs are made by rolling the mixture into balls. The gum arabic is added to increase the stickiness of the mixture, and the handballs are made by rolling the mixture into balls.
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A power-driven sensitive drilling machine which will prove a useful acquisition to a workshop. The chief features of this type of machine are as follows: It has a 3-in. three-jaw chuck, measures 5 1/2 in. from the cheek to the bottom table, 3 1/2 in. from the bottom table 5 x 5 in., the machine is 18 1/2 in. in height and weighs only 19 lbs. It is not workable by hand or foot, and costs 35s. [30]

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 consist 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 x 4 x 1/2 in., and when opened 12 x 4 in. It is marketed under the name of the "Marpleset," and can also be supplied in roll-up leather cases, 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 3s. 6d., this instrument is sure to prove popular. [33]

A Useful Engineer's Indicator

The indicator shown in plan and side view will register to one 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]

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 hard surface is required. The size of the face is 6 x 2 1/2 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 6s. 9d. [35]

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 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 10s. 6d. [36]
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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 to appear in intervals similar to that seen 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 wet.

Some years ago I read a comment on the danger of operating in factories of wheels in motion appearing motionless and it seemed that if this were due to some effect of the artificial lighting, it would be advisable to consult a well-known contributor to " Practical Mechanics." The following is highly satisfactory, and is stated to be the exact arrangement may not have been done before, in view of what has already been done, although it may be possible to obtain a patent of a kind for the invention, the most important being mere protective coverings for same. The sleeves and cuffs of shirts, these years to protect the sleeves and cuffs of shirts, these years.

Non-Reflecting Glass

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

Detachable Sleeves for Shirts

Sir,—Can you enlighten me as to the validity, novelty and worth of the proposed invention of 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 of detachable sleeves for shirts may be considered 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 years to protect the sleeves and cuffs of shirts, these years.

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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 glutton to show that such monopolies were the earliest discoveries and inventions which undoubtedly gave to England commercial supremacy cannot be but interesting to the majority of readers. It is generally supposed that many of these early inventions which, if not so successful as the inventors hoped, may appear to our wiser minds to-day, they opened the door to later inventions which were far more successful than the inventions of the sixteenth and seventeenth centuries. Early inventors were always sanguine of success, not in this way differing greatly from the modern inventor, and so we may give to these early experiments the credit of having once and again been successful. Many of the early patents were not so successful as the inventors hoped, but 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 (1603-1625), it was the custom of the Sovereign to award some particular person a monopoly for some particular art or business, that is, the right to make or sell such articles or to have the sole right to carry on such particular business or trade. Such monopolies, covering even the necessities of life, were so freely granted by Elizabeth (1558-1603) as to be evidence of the richness of such monopolised articles, serious abuses which were brought to the attention of Parliament, but Elizabeth was sufficiently well-advised 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, probably from Italy, where they were already manufactured. The workmen who had gone to France with Lee, brought back to England by some of the Sovereign's workmen, Lee died in poverty in Paris in 1610. The stocking frame in 1589. The stocking frame, as is known, is a machine which mechanically produces a looped stitch in the hosiery industry. Lee set up a works at Alverton in Nottingham, near Nottingham, but met with little success, and was discouraged by Queen Elizabeth on appealing to her for assistance in the course of 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 in 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. 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.)
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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's offices are at 54 Grafton Street, W., and there is also a branch at 43 Tottenham Court Road. They have just issued a very comprehensively illustrated catalogue of electrical apparatus and toys, etc. No matter what electrical device you may require, you will find something to suit your requirements in the pages of this thoroughly comprehensive and fully illustrated catalogue. Wireless components, batteries, meters (all types), telephone equipment, cast iron cookers, electric light fittings, electric supplies, etc., are all listed at reasonable prices. In this catalogue you can find 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 absolutely free of charge upon application. [27]

Radio Components
MISSISSIPPI DURABRAND & CO., LTD., 206 Boulevard High Street, London, S.E.1, the well-known wireless manufacturers, recently issued a catalogue of wireless components, etc., for the home constructor. Their pamphlet on short-wave radio is most comprehensive, 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 "Monode" radio receiver, which incorporates many novel features. The home constructor will also welcome their component lists which cover a wide range, including various resistances, valves, capacitors, chokes, etc. Their pick-up is now available as a complete unit, including control, volume control, etc., and is well worth trying. GET THE R.T.I. "1934 PRICE LIST. 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]

High Vacuum Valve Co. Ltd., 113-7 Farringdon Road, London, E.C.1, the well-known firm of valve manufacturers, have recently issued a catalogue of their new range of valves, including all the latest and most modern types. They are fully recommended by a number of wireless enthusiasts 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 be a long way towards still further increasing the popularity of Class "B" amplification, since it makes for economy both in price and running expenses, besides simplifying construction and effecting a saving of space. Write at once for their complete list of valves, which is obtainable free of charge upon application. [29]

Warneford Model Aeroplanes
C. J. MEL, 137 High Road, Greenhithe, have recently issued an interesting pamphlet which includes a complete list of many model aeroplanes and goggles. These are models in a series of thirty different designs. They are all made of wood and are really perfect. This catalogue is illustrated, and is obtainable free of charge upon application. [30]

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