NO. 1 OF THE NEW NEWNES MAGAZINE

PRACTICAL MECHANICS

OCTOBER

6D.

RAY CONTROL OF MECHANISM

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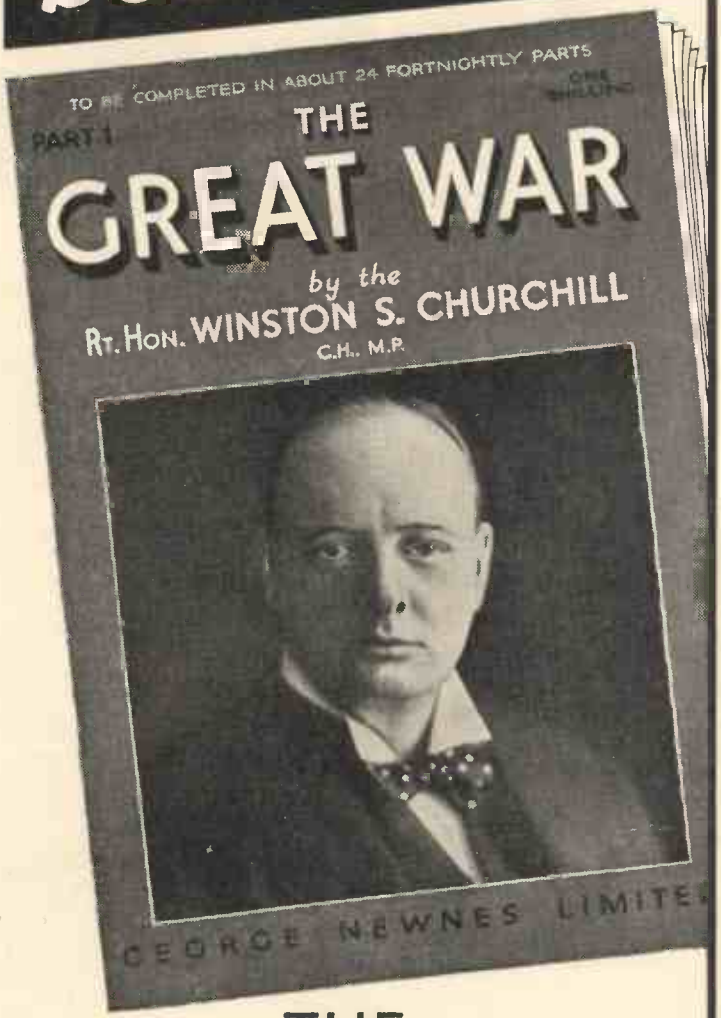

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by the Rt. Hon. WINSTON CHURCHILL

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F. J. CAMM

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This Remarkable Age

THE remarkable mechanical and scientific age in which we live has arrived so stealthily that few realise the vast extent to which it has penetrated our everyday lives, our habits, our homes, our hobbies and recreations. The occupants of the remotest dwellings now think and talk in technical terms about technical matters in their everyday conversation, and subjects formerly only discussed in technical and scientific circles form now the practical plaything of the multitude. And the world's heritage of knowledge daily grows richer and more fascinating as wonder upon wonder is revealed to us by our scientists and our practicians.

Only Twenty Years Ago!

TWENTY years ago the aeroplane was but a qualified success, the all-pervading ether was a mere scientific fantasy, wireless telephony the dream of cranks, electricity and magnetism little more than the basis of a school-room lecture, chemistry a complete mystery to the majority, and television practically unheard of.

To-day almost everyone has a wireless set and can discuss the principles upon which it functions. Television is an accomplished fact and aircraft has become an accepted means of locomotion. Almost everyone is interested in electricity and chemistry to-day.

Even More in Store

BUT vast as are the strides which science has made in the last twenty years, even more wonderful are the scientific and mechanical surprises which will arrive in the immediate future. The wonder of to-day is the commonplace of to-morrow. This interesting age invites this new publication, NEWNES PRACTICAL MECHANICS, which arrives when all the old orders of thought are changing, creating in the minds of the public a fresh and more intelligent outlook and interest in things mechanical—an outlook with a strong mechanical bias, which eagerly awaits the practical style of journal which it is our earnest intention to supply.

Our Range of Subjects and Policy

THE range of subjects with which NEWNES PRACTICAL MECHANICS will deal is bounded only by the limits of science itself. It will be a cardinal part of our policy to cater for those who wish to make things for themselves; to keep the reader acquainted with up-to-date information on everything new in the various branches of mechanics, and, in short, to foster the interests of those whose hobbies deal with matters practical. Every article will be written in everyday language from which highly technical phraseology has been rigorously excluded.

Our Experts and our Laboratory

ONLY acknowledged experts will serve our readers; skilled designers and accomplished writers will contribute practical articles on every practical subject. A well-equipped science laboratory and workshop staffed by enthusiastic experts will test the latest devices and design the various pieces of apparatus and models, the construction of which will be entertainingly described in NEWNES PRACTICAL MECHANICS.

Our Free Technical Advice Bureau

A VALUABLE service available to readers will be our Technical Advice Bureau, which will answer through the post, free of charge, every reader's questions on scientific and mechanical matters coming within our province. Realising that most people to-day are of an inventive turn of mind, we have commissioned a qualified patent attorney to advise readers on their inventions, marketing possibilities, validity, and to provide other helpful information.

Our wireless section will deal with the very latest in receiver construction; and the fields of model making, microscopy, electricity, chemistry, mechanical experiments, patents and inventions will find a place in our pages.

The latest tools, devices, novelties, methods, facts, figures, formulas, and money-making ideas, will regularly be featured.

New ideas from readers are invited and will be paid for if used.

A New Style of Illustration

COUPLED with the wealth of information which it is our intention to supply, we conclude with a word about the new and fascinating style of illustration which we propose to employ. Technical diagrams will be avoided wherever possible, and believing that illustrations are often of greater value than the printed word in conveying an idea a modern style of illustration in both line and half-tone will be introduced to illustrate the text.

It is with every confidence of its immediate success that we place No. 1 of NEWNES PRACTICAL MECHANICS, the only journal of its kind, before the present mechanically inclined generation.

Our Presentation Volume

A FINAL word. Readers should send in their reservation forms *at once* for our attractive and fascinating presentation volume, "Encyclopædia of Popular Mechanics." This is only available to regular readers, and particulars are printed on pages 28 and 29. Do not miss this opportunity of obtaining this specially prepared volume.

THE MONTH'S SCIENCE SIFTINGS

A "new" star lately has been discovered by a well-known theatrical comedian.

Sir William Rutherford has recently "exploded" the theory of the so-called "hidden power of the atom." There is no latent power in the atom.

An aeroplane has been developed which will land on a level keel without the attention of a pilot.

It is now possible to reproduce entirely by electrical means the sound of nearly every musical instrument.

The sound of either musical instruments or the human voice can be made synthetically by drawing various-shaped lines on paper; the paper is passed before a light-sensitive cell connected to an amplifier and loud speaker.

A new internal combustion engine has been evolved which does not require any cooling system. It is claimed to have an efficiency of 60 per cent., as compared with the 25 per cent. of the ordinary air or water-cooled motor.

In a recent television test of a troupe of dancers infra-red lighting was tried, to the surprise and disgust of the engineers who were "looking-in." The artists appeared nude, their attire being transparent to the infra-red rays!

It is thought possible to produce natural lightning discharges by firing a rocket into the ionised atmosphere between two clouds.

An aerial motor cycle has been designed by a French aviator. Stability is maintained by the balance of the pilot, and the machine can land with a horizontal run of only 3 feet.

The LATEST Novelties

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

Handyman's Paint Spray

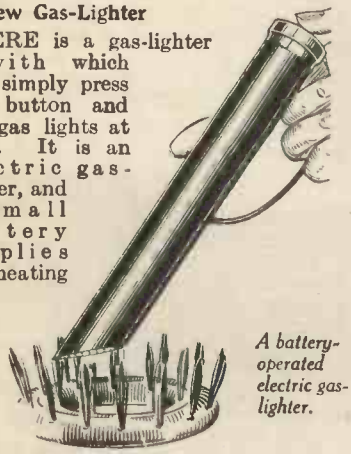
THERE can be no doubt that the spray method of painting will eventually and entirely oust the old and inefficient brush method. The paint spray completely atomises the paint and forces it into crevices which the brush cannot reach. A

A cheap cellulose paint-spraying outfit, which screws on to the tin of cellulose paint.

well-known firm of paint manufacturers has recently marketed a cheap spraying apparatus which clips on to their tins of cellulose paint. With one of these spray-on outfits you get a spray gun and a 4-oz. tin of black spraying cellulose for 4*s.* 6*d.* The end of the gun screws on to the top of the tin of paint, and it is immediately ready for use. The paint is thus economically used. [1]

A New Gas-Lighter

HERE is a gas-lighter with which you simply press the button and the gas lights at once. It is an electric gas-lighter, and a small battery supplies the heating



A battery-operated electric gas-lighter.

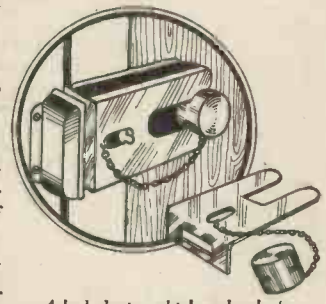
element necessary for ignition. Adequate guarantees are issued with these lighters, which cost 2*s.*, by post 2*s.* 3*d.* The makers claim that the cost of refills works out at one farthing a week. Certainly much cheaper than matches or flints. [2]

Burglar-proof Your Door

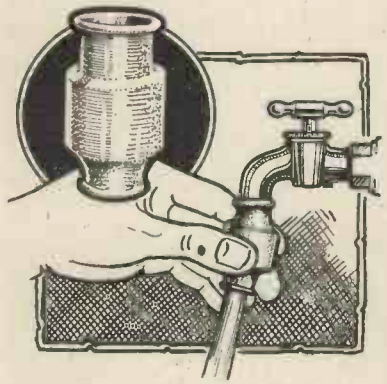
IF the lock of your door is of yale pattern, it may be rendered burglar-proof at the cost of 2*s.* 6*d.*, in the manner shown in the sketch. The circular cover is placed over the inside knob of the lock; with the guard in position it is impossible to open the lock of the door except with the key. [3]

A Flexible Anti-splash Filter

A NEW anti-splash filter fitted in a second to the kitchen tap effectively gets rid of the splashing problem. The body of the filter is made of flexible rubber and thus the stream of water may be directed in any required location. A gauze filter is included in the body. [4]



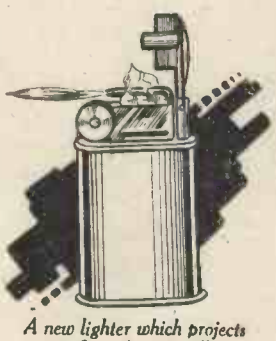
A lock device which makes lock-picking impossible.



An anti-splash device for the tap.

A New Type of Petrol Lighter

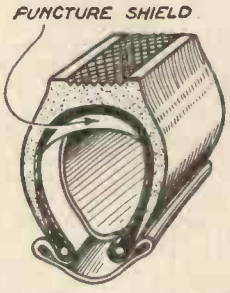
WE expect that many of our readers are pipe smokers or prospective pipe smokers, and are interested in flint lighters; and that is our excuse for drawing attention to the new form of lighter shown in the sketch here. The ordinary type of petrol lighter produces a vertical flame, and as such it is extremely difficult to light a pipe with it, because the flame will project vertically from the wick in whichever position the lighter is held. This lighter projects a horizontal flame, and is particularly suited, therefore, not only for lighting pipes, but for cigarettes as well. The principle is similar to certain types of blowlamp. It is an interesting reflection that the flint lighter, which is really a recrudescence of the old flint-and-tinder box, should be so popular to-day and should largely have ousted a device, namely, the match, which superseded it. [5]



A new lighter which projects its flame horizontally.

Unpuncturable Tyres

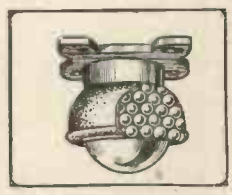
IT is claimed that unpuncturable tyres, made by a new electro-hydraulic process, give 50 per cent. greater mileage than the usual form of pneumatic tyre. Inside the tyre is a puncture-proof shield which prevents nails, flints, etc., from piercing the tread. This shield will not, of course, prevent pointed objects from piercing the wall of the tyre, but the manufacturers have sufficient faith in their product to guarantee their tyres for two years. They cost 3*s.* 11*d.*, or by post 4*s.* 5*d.* [6]



This illustration shows a section of the puncture-proof tyre referred to.

A Ball-bearing Castor

A NEW style of ball-bearing castor has one large ball turning on a number of smaller balls. There are no less than 250 of these small balls in each cap. [7]



A neat and new ball-bearing castor

A Security Latch

THE sketch shows a device for locking doors independently of the lock itself. It is also intended to lock from the inside doors normally locked from the outside, or to lock doors which have no lock at all. The piece of perforated strip metal shown at the bottom of the sketch has a catch bent in it, and this catch fits into the slot provided for the normal door-latch. The door is then closed and the spike, which is attached to it by means of a spring, is passed through one of the holes nearest to the door. It is thus impossible for the door to be opened from the outside. [8]

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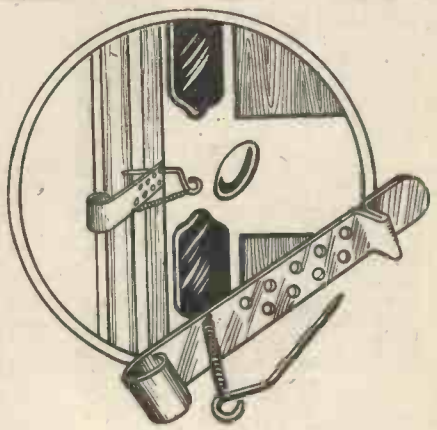

A security door latch.

1st ARTICLE

Ray Control of Mechanism

By MAJOR RAYMOND PHILLIPS, O.M.E.

How to Control Various Movements by Means of Light Variations

Fig. 1.—The author with the special signal mentioned in this article.

QUITE apart from commercial applications of the science, Ray Control of Mechanism provides an interesting hobby, and incidentally opens up a field with vast possibilities.

Radio now plays an essential part in our everyday life, and excites no wonderment. Light control is used to a far greater extent than many people imagine. "Television" and "Talkie Pictures" are forms of light control.

The author's latest handbook, "Ray Control of Mechanism," is written in such simple language that those with only an elementary knowledge of technical matters can readily understand its contents. In this article it is proposed to describe and illustrate further advanced examples of light-ray control, as with the apparatus involved experiments can be conducted entirely free from the restrictions which apply to all forms of wireless control.

A new experiment recently conducted by the writer has created considerable interest. It involves the control of a model train by an "impulse" system of light control. Demonstrations with the apparatus have been given before large audiences, but a description of the whole system has not previously been published. "All mains" apparatus is used, but "battery operated" instruments will function equally well. Coloured lights projected from a model signal control the whole system. The colours used are diffused ruby, clear orange, and clear signal green. The different colours are produced by projecting white light through special glass filters fitted in the "spectacle frame" of the miniature signal. The clear orange light affects the selenium cell, the other two colours producing no effect. A special interlocking relay opens and closes circuits connected with the model train system. Fig. 1 shows the miniature signal mounted on a tripod.

The author uses "Raycraft" light control apparatus for controlling his model train system. The A.C. "all mains" apparatus comprises a selenium cell, mains transformer, relay, valve, grid leak and condenser, variable resistance. and smoothing condenser. Fig. 2 is a diagram of the circuits. A high-tension battery is shown in circuit with the selenium cell. This battery has now been replaced with a metal rectifier.

It will be noted that the arrangement is a form of one-valve amplifier, and its function is to amplify the variation in current passed by the selenium cell when there is a sudden change in light intensity. This happens when the miniature signal is lowered, and the clear orange light is momentarily projected on the selenium cell. The variation in current is sufficiently strong to cause the relay which is connected in circuit with the anode of the valve to function. The current holding the relay contacts in position is obtained from the mains transformer, and is rectified by the valve, which acts as a half-wave rectifier. The pulsating direct current is smoothed by a 2-mfd. condenser across the relay.

Fig. 3 is a circuit diagram of the apparatus arranged for battery operation. The apparatus functions in exactly the same manner as that arranged for "all mains" operation except, of course, that current is supplied from batteries instead of electric light mains; consequently an ordinary, and not an indirectly heated, valve is used. The transformer and smoothing condenser are not required.

It will be noted that a supplementary relay controls the main circuit connected with the model railway system. This is necessary because the contacts of the relay (forming part of the light control apparatus) are not arranged to close the circuit carrying

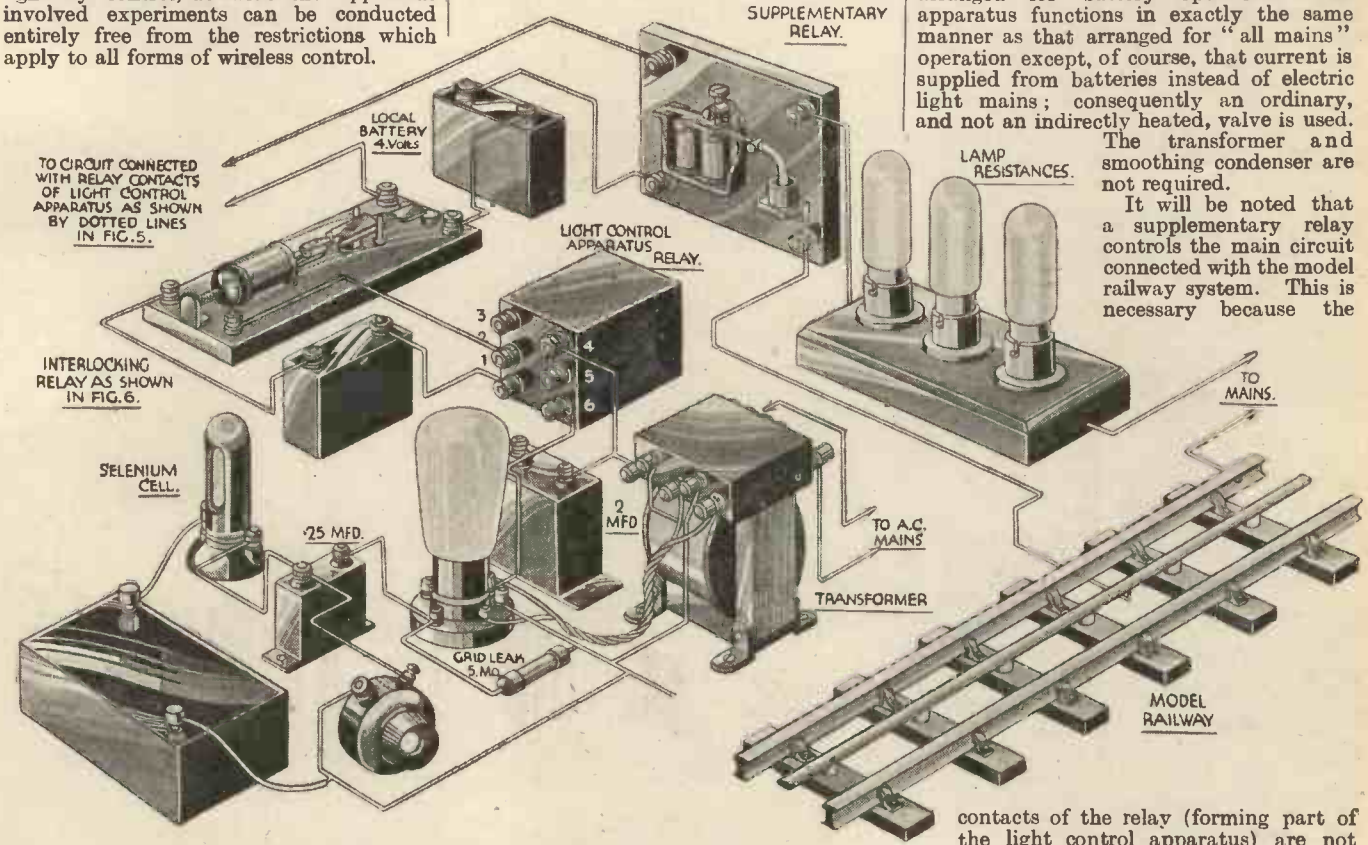

Fig. 2.—This illustration shows the complete arrangement of parts for the controlled train system.

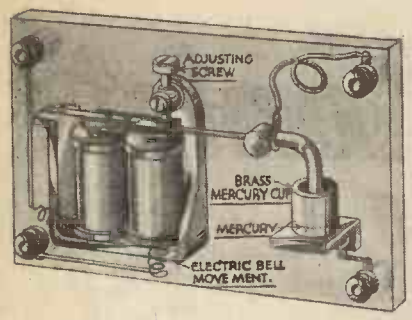

Fig. 4.—The conversion of an ordinary bell magnet into a relay.

current for a model electric locomotive. To pass such a current would seriously damage the relay.

The author's model railway is "mains" operated—current being passed through a lamp resistance. The electric motors fitted to the model locomotives are arranged to function with either "direct" or "alternating" current. A transformer can, of course (if desired), be used with alternating current. Transformers are generally arranged to supply current at an E.M.F. of 6 to 20 volts.

A very simple supplementary relay suitable for model control and other purposes can be made by adapting a good quality electric-bell movement (3-inch gong), as shown in Fig. 4. It will be noted that a hole is drilled and tapped in the bell hammer, into which is screwed a short length of No. 12 gauge brass or copper wire. One end of the wire is screw threaded, and the other end is bent to a suitable shape so that it will dip into mercury contained in a brass or copper cup, as shown in the illustration.

The bell movement should, of course, be entirely removed from its existing baseboard, and the "make and break" contacts disconnected from the electro-magnet windings. A new baseboard should be made in the form of a bracket, and fitted with four terminals. Two of the latter should be connected with the electro-magnet windings, the other two being connected with the mercury cup, and contact rod respectively. The relay is very simple to construct, and one of similar type has been used by the writer for many of his experiments. Such a piece of apparatus is very useful in cases where it is desired to "open" or "close" circuits carrying moderately heavy circuits.

The screw contact of the electric bell movement can be used for the purpose of adjusting the distance between the armature and electro-magnet cores, so that the mercury contact (in the mercury cup) can be adjusted as desired.

Another new experiment with light control of a model train conducted by the author involves the use of an infra-red ray which is, of course, invisible. The ray is produced by placing an infra-red filter in the path of projected white light so that the shorter wavelengths of lights are filtered out. "All mains" apparatus is used and the circuit involved is similar to that shown in Fig. 2, except that the interlocking relay mechanism is not affected. An extra circuit, clearly shown in Fig. 2, is connected with the contacts of the relay fitted in the "all mains" Raycraft apparatus. Normally, the contacts are closed so long as an infra-red ray is projected on the selenium cell. When the model train crosses the path of the ray the relay contacts are opened. This causes the supplementary relay to open the circuit connected with the model train system. As

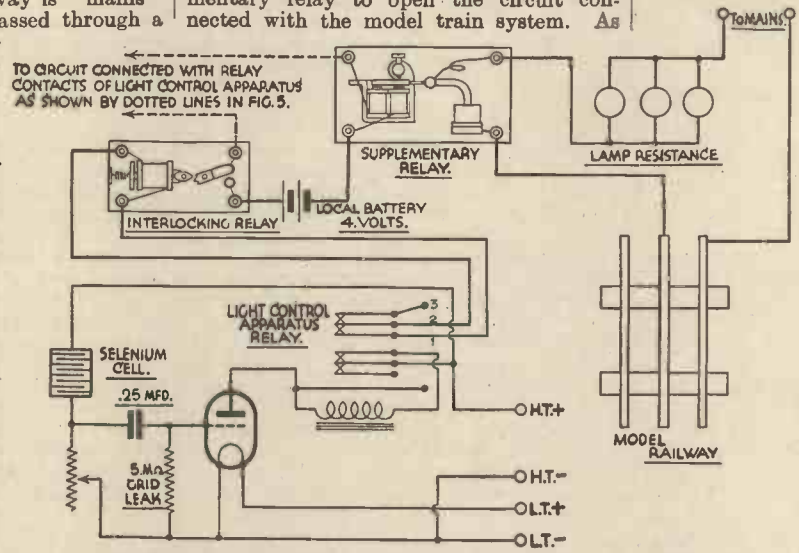

Fig. 3.—The complete circuit arrangemen of the controlled train system.

electric current is then cut off, the train comes to a standstill. The stoppage only lasts a few seconds, for the current is again automatically switched on. The current then causes an electro-magnetically operated reversing switch (fitted to the electric motor of the model locomotive) to function, with the result that the train runs backwards. The effect is startling, and always astonishes spectators, but the explanation of the apparent mystery is simple.

Fig. 5 shows the arrangement of the projection lamp, selenium cell,

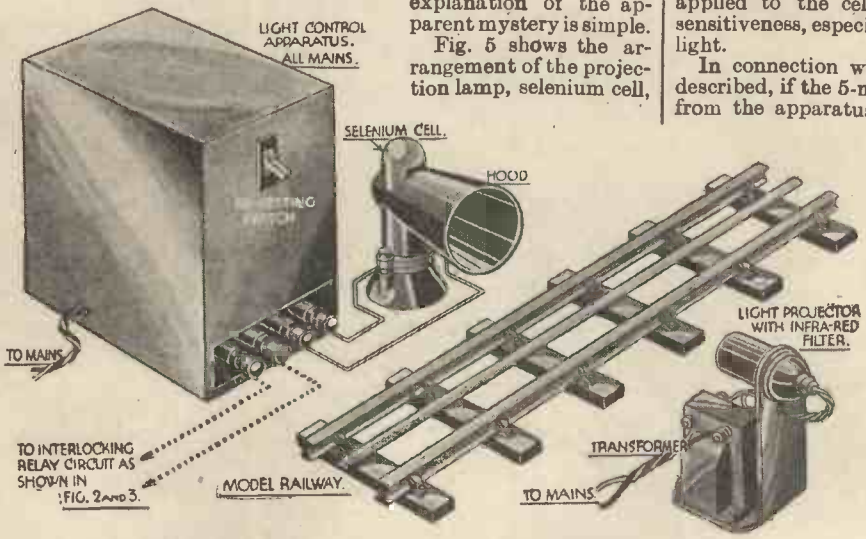

Fig. 5.—An automatic reversing arrangement operating by a selenium cell.

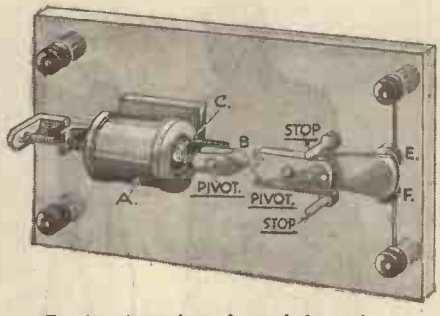

Fig. 6.—An easily made interlocking relay.

and model railway for this experiment. On referring to the circuit shown in Fig. 2 it will be observed that a ·25-mfd. condenser is placed between the selenium cell and grid of the valve. Further, a grid leak (5 meg.) is placed in circuit between the grid of the valve, and one terminal of the high-tension battery. When the infra-red ray is suddenly cut off, the relay contacts open because the ·25-mfd. condenser receives a charge due to the sudden change of light intensity. This affects the grid of the valve and causes current to flow in the anode circuit and operate the relay, thus opening its contacts. When the condenser discharges itself through the 5-meg. grid leak (which only occupies a few seconds) the relay contacts close and current is again switched on to the model railway system by the supplementary relay. The whole apparatus then remains normal with the infra-red ray projected on the selenium cell. The selenium cell used for this experiment is a hooded Raycraft bridge, as shown in Fig. 5. A hood is absolutely necessary for the success of the experiment so as to prevent the cell being affected from other light sources in the immediate vicinity. The lowering of the resistance of a selenium cell varies according to the intensity of the light falling upon it. Such a cell is, of course, extremely sensitive to white light. Within limits the voltage applied to the cell largely determines its sensitiveness, especially when using invisible light.

In connection with the experiment just described, if the 5-meg. grid leak is removed from the apparatus, the model train after cutting off the ray would remain at a standstill until the light ray was again projected on the selenium cell.

It is most interesting to watch a model train set in motion by a light ray projected from a miniature railway signal, and stopped when the train itself cuts off an infra-red ray projected across the model railway.

The interlocking relay constructed by the author for use with a miniature railway signal is shown in Fig. 6.

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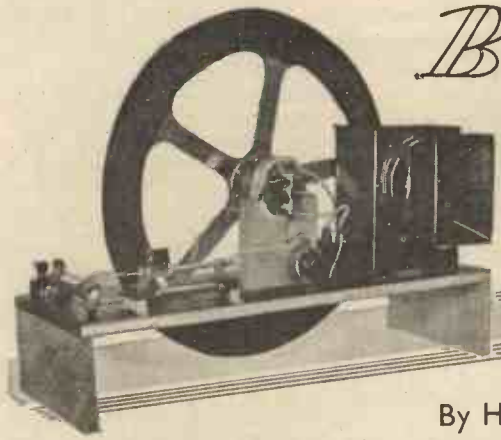


Building the PRACTICAL MECHANICS TELE-DISCOVISOR

A Simple and Efficient Machine for Looking-in, specially designed for "Practical Mechanics"

By H. J. BARTON CHAPPLE, Wh.Sch., B.Sc., A.M.I.E.E.

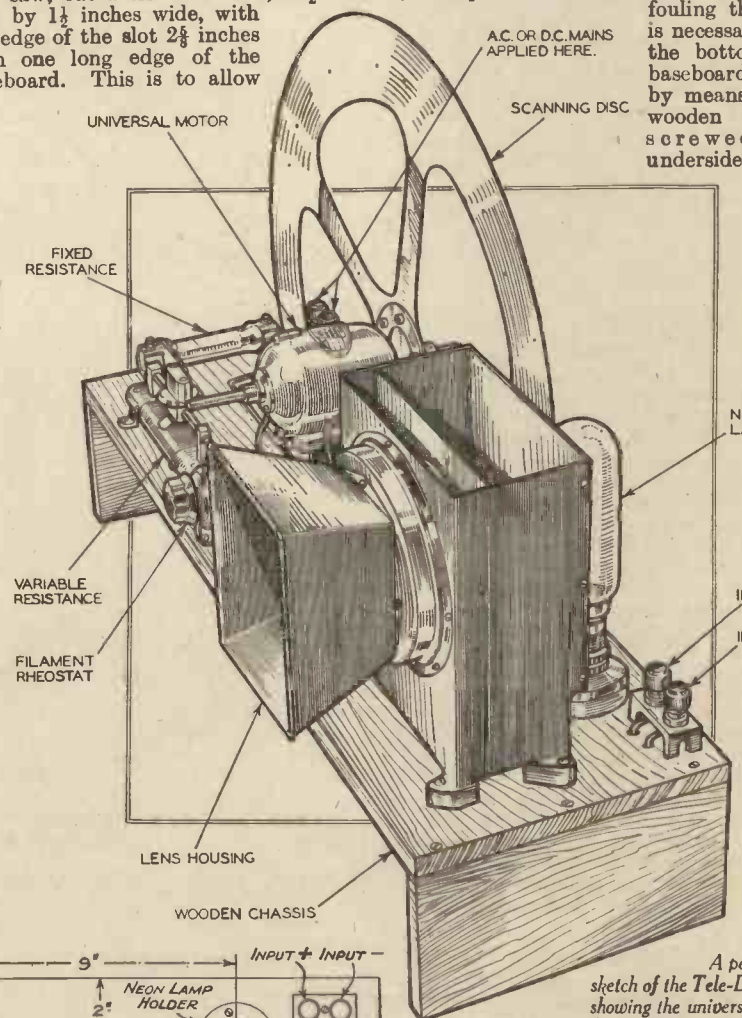
UNDOUBTEDLY the last few months have seen an enormous growth in the interest given to television, and many who viewed the advent of this new science with avowed scepticism have become converted to "lookers." At the moment the B.B.C. are providing a television service on four nights of the week, the vision signals being broadcast from the London National station on 261 metres, and the accompanying sound from the Midland Regional station on 398 metres.

The design here described is of the simplest possible character, and admirable for initiating the newcomer into the mysteries of the art. There is not space here to deal with even the barest elements of the theory underlying television transmission and reception. So let me straightaway show every interested reader how he can make up his first assembly of television apparatus at a cost of about £5.

Materials Required

One Universal motor, complete with stand. (John Salter.)
One disc blank complete with boss. (Mervyn Sound and Vision Co. Ltd.)
One Seradex 150-ohm 50-watt sliding resistance. (Trevor Pepper.)
Four Type B terminals marked A.C. mains (two), input + and input −. (Belling and Lee Ltd.)
Two terminal mounts. (Belling and Lee Ltd.)
One reconditioned lens box assembly complete. (Baird Television Ltd.)
One used neon lamp with bakelite holder. (Baird Television Ltd.)
One 255-ohm 60-watt Type Z2 Zenite resistance. (Zenith Electric Co. Ltd.)
One interference filter unit, type 220/001. (Dubilier Condenser Co. (1925) Ltd.)
One 6-ohm filament rheostat complete with mounting bracket. (Peto-Scott Ltd.)
One wooden chassis. (Peto-Scott Ltd.)

This chassis can be obtained already slotted from the firm mentioned above, but for those readers desirous of making their own chassis, they can do so from the following details. It is ⅝ inch thick, while the dimensions are 27 inches long by 9 inches wide. With the aid of a keyhole saw, cut a slot as shown, 17½ inches long by 1½ inches wide, with one edge of the slot 2⅝ inches from one long edge of the baseboard. This is to allow the 20-inch diameter disc to run freely when rotating at its normal speed of 750 revolutions per minute. Also to prevent the disc fouling the table it is necessary to raise the bottom of the baseboard 4½ inches by means of thick wooden sidepieces screwed to the underside.



A perspective sketch of the Tele-Discovisor showing the universal motor finally decided on.

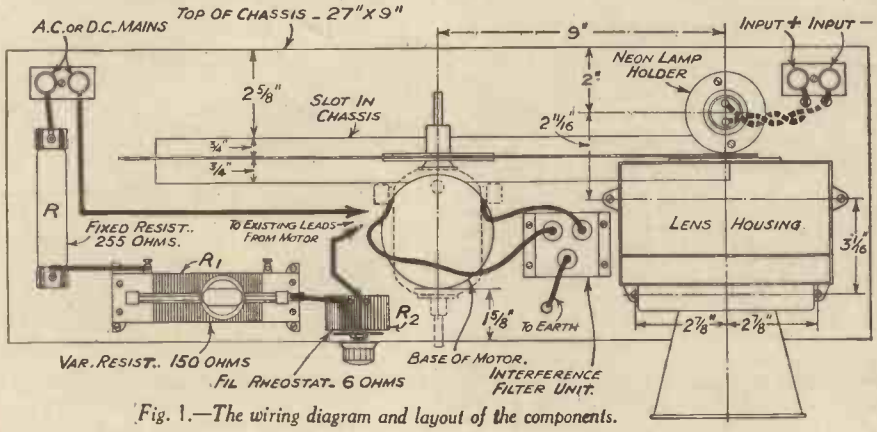
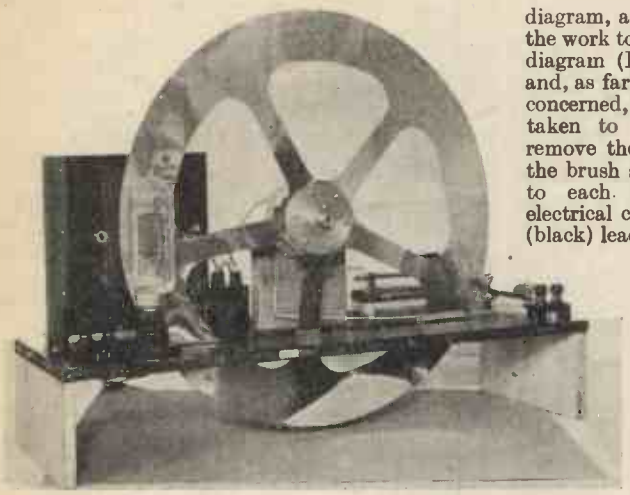


Fig. 1.—The wiring diagram and layout of the components.

Marking Out

In the course of my experiments in building this apparatus I have tried out several different designs; in fact, the actual photographs accompanying this article indicate one form which I tried out. The finished product, however, as finally settled upon, is shown in the perspective line drawing, and it is this illustration to which the description refers.

It is necessary to pay particular attention to all the dimensions given in the drawings, at least in so far as the motor, neon lamp and lens assembly are concerned, for, unless



A photograph of the rear of Tele-Discovisor.

this is done, the resultant image will be masked off and the full benefit of the machine not obtained. First of all then, turning to Fig. 1, mark off a centre line across the baseboard and arrange the centre of the metal motor support over this with the front edge $1\frac{5}{8}$ inches from the baseboard front. This will eliminate any slight tendency for the motor shaft to "whip" when the disc is mounted in place. Note also that the brass bush of the motor must be at the front.

Completing the Assembly

Now the height of the shaft centre above the top of the baseboard is 6 inches, and, in consequence, both the horizontal centre line of the lens box assembly and the plate of the neon lamp must coincide with this. With the two components specified, therefore, it will be necessary to raise them $\frac{5}{8}$ inch by means of wooden distance pieces. Be sure and mark off the screw holes accurately as in the dimensioned plan, and have the bakelite neon lamp-holder turned round to such a position that the flat neon plate is parallel to and nearest the disc. Incidentally, the connections to this holder are made *through* the baseboard, and in consequence two holes to accommodate the wires must be drilled for this purpose.

It is now a simple matter to add the Zenite fixed resistance R, the Seradex variable resistance R_1 and the filament rheostat R_2 in position as shown, using the small right-angled bracket to hold the last-named. Finally, add the Dubilier interference filter unit and the terminals on their mounts. The necessary wiring is quite a small matter, as one can gather from the illustration and theoretical diagram, and this is the next part of the work to complete. The theoretical diagram (Fig. 2) will help you here, and, as far as the interference unit is concerned, the two red leads must be taken to the motor brushes. Just remove the end caps accommodating the brush springs and connect a lead to each holder so that a good electrical contact is made. The third (black) lead of the unit must be taken to a convenient earth point, the object of the unit being to filter out any interference which might evidence itself on the final television image as a result of motor commutation.

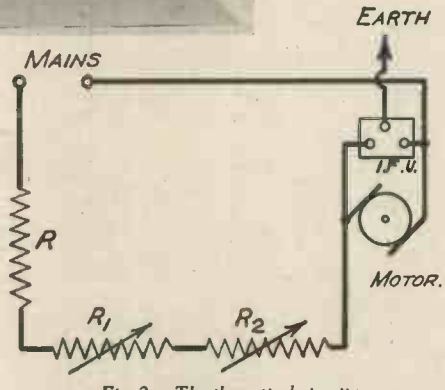


Fig. 2.—The theoretical circuit.

Marking and Punching the Disc

The disc is supplied by the Mervyn Co. in "blank" form. With the type of television transmissions now broadcast by the B.B.C. using the Baird process, thirty-line scanning is used, the scanning being carried out vertically. It is therefore necessary to use a thirty-hole disc with the apertures set round the edge of a single-turn spiral.

Since there are thirty disc holes, it follows that the angular separation between each hole is 12 degrees, and in the Mervyn disc blank supplied these radial markings have been carried out so as to assist the amateur. It must be noted also that the radii have been scribed on the back of the disc.

Each hole is extremely small, actually $\frac{28}{1000}$ inch with this 20-inch disc, and square in shape, so the first task is to make a suitable punch. Obtain a 1-inch length of 0·028-inch square silver steel rod, perfectly flat on each side and with sharp corners. This must be hardened and tempered in the usual way, and fixed in a brass holder about 2 inches long with about $\frac{1}{4}$ inch of the punch exposed, as indicated in Fig. 3. If the constructor does not feel equal to making a punch of this nature, he could obtain one from advertisers in this journal, particularly Messrs. Peto-Scott Ltd.

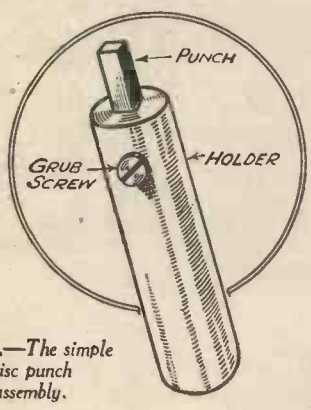


Fig. 3.—The simple disc punch assembly.

Correct Alignment

There are several ways in which the hole positions can be marked off on the radii before punching, but in the case under review I think the simplest plan to adopt is the following: Remove the aluminium boss from the disc, taking care to mark both disc and boss with a scribed line so that the latter will be replaced in exactly the same position. Now stick a piece of paper over the bush hole of the disc and find the disc centre by continuing two or three radial lines towards the centre, and noting their point of intersection.

Next take a strip of stiff cartridge paper and mark off on its edge a distance XY of 9·5 inches, since the outside edge of the first hole is just $\frac{1}{2}$ inch inside the disc periphery. From one end of the marked distance of 9·5 inches measure off YZ of 0·84 inch and then very carefully divide this into thirty divisions of 0·028 inch each, as shown in Fig. 4.

With the disc flat on the table, having the scribed radii uppermost, place the point X exactly on the disc centre and lay the paper strip towards the left of the disc, and make a mark with the scriber on a radius where the point Y comes. This will correspond to the hole 1 shown in Fig. 5. Move the paper round in an *anti-clockwise* direction until the edge coincides with the next radius, and then, with the point X

(Continued on page 40.)

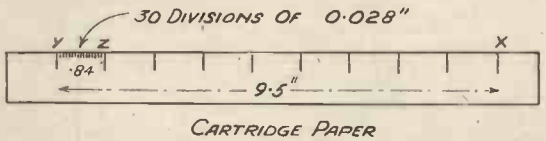
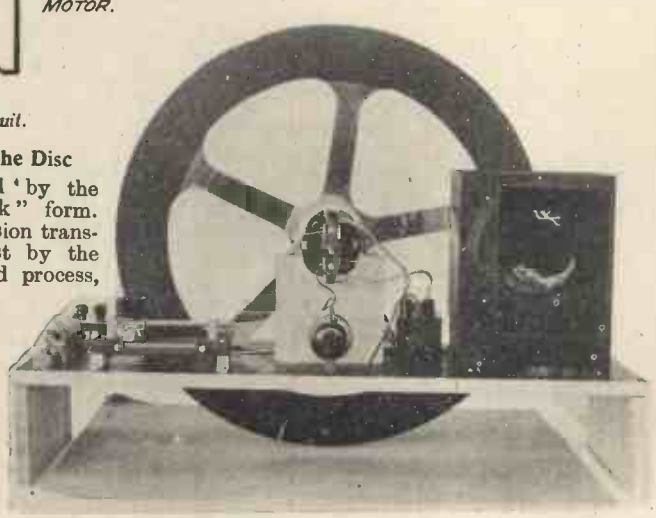


Fig. 4.—The dimensioned marking off strip for hole positioning.



A front view of the apparatus.

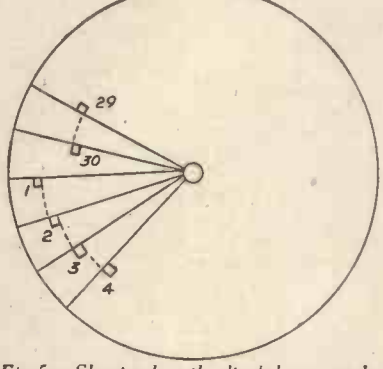


Fig. 5.—Showing how the disc holes are marked off and punched on the back of the disc.

Movie Making for the Beginner

The Author of this article will advise readers regarding cine-cameras and kindred matters.

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

Editor of "Home Movies and Home Talkies"

An acknowledged expert in Amateur Cinematography here explains how simple, cheap and fascinating Cinematography is

EVERYONE can now own a movie camera, for with the rapid growth of the hobby prices have come tumbling down to a very popular level.

A little while ago, on the way home by train, I sat next to a friend who had recently returned from his holidays. Talking of holiday memories, he produced from his breast pocket a wallet of photographs, and together we ran through his holiday haul. One snapshot in particular pleased us both. It showed an angler on the pier struggling to land a very big fish with an excited audience watching. "If only I had had a movie camera for that!" sighed my friend.

"Well, why didn't you?" I replied at once.

"My dear fellow!" he answered. "What do you think I am—a millionaire? I don't mind an ordinary camera, but movie-making is much too expensive for me!"

And so here, once more, I came across the old fallacious argument which so badly needs killing. Just because, in the early days, it was an expensive matter to take moving pictures in the home and just as now, if you want to, you can spend a good deal of money on the hobby, far too many people think that this most fascinating of all pastimes is beyond their reach. I saw an excellent opportunity to disabuse his mind, and in case by any chance you may be thinking the same as he did, I am going to repeat the conversation.

"I can't make out some of you people," I said. "What did you pay for your camera—a fiver?"

"About that," he answered. "Six guineas to be precise, and the case cost me a little more on top of that."

"Well," I said, "You can buy a good movie camera for that money or even cheaper."

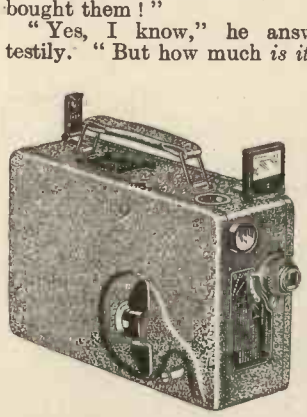
"Yes, but look at the running costs!" he countered. "Twenty-six shillings for a roll of film, isn't it? That puts it right out of the running for me."

"Half of the wrong ideas about the cost of home movie-making," I said, "come from a complete misunderstanding of what real running costs are, not only of home cine work, but of still photography. You mention twenty-six shillings as the cost of a roll of film, and while this is true for one size of film for use in cine work, this figure includes *everything*—buying the film, getting it developed, preparing it for projection, and even putting it on and providing the metal reel, while the length of film is such that you can make on one reel a moving picture record of your whole holiday. Actually, however, there are cheaper films than this, but, before we talk about that, let me ask you how much you've spent this holiday on your present hobby, and just what have you got for it? No evasion, now! Let us see what you've spent and what you've got, and I'll bet you a packet of twenty cigarettes I'll show you how you could have made a better movie record for less money."

"Done!" exclaimed my friend, producing from his pocket an old envelope and a pencil. He paused for a moment, and I noticed his fingers move as he checked off the number of rolls he had bought. As he did this the smile began, almost imperceptibly, to fade from his face. "Well," he said, "there were eight rolls of film. How much is that?"

"You ought to know," I said, "you bought them!"

"Yes, I know," he answered rather testily. "But how much *is it*, anyway?"



One of the many types of cine-camera on the market and obtainable for a reasonable sum.

"What did you use, the ordinary or the double-speed film?" I asked.

"Double-speed," he answered.

"Well, that makes ten-and-eightpence for films," I said. "You got them developed at a chemist's, I suppose?"

He replied that he did.

"That's another four shillings," I said, "with twopence each for the prints, making a further ten-and-eightpence. Did you get any extra prints?"

"How d'you mean?" he said.

"Don't look so innocent!" I replied. "What about that girl at the boarding house who thought your pictures were so sweet and wanted a set of those you took on the boat?"

"Who told you?"

"Nobody," I responded, "but it always happens. Anyway, if it isn't a girl it's your mother-in-law, or a chap at the office, or the people you met on the pier—nearly everyone finds someone else who wants copies, and they rarely pay for them. How many extra prints did you get?"

"Well, there were three lots in duplicate," he said, "that makes a further four shillings, and then I had half a dozen enlargements at a shilling a time after I came home. We've had that one of Marjorie and the children enlarged and it looks very well, too."

"As far as I can make out," I said, looking at my own calculations, which I had made simultaneously with his. "You took eight spools of film each with eight exposures on it—that makes sixty-four. How many bad ones?"

"Well, I suppose there are a couple of dozen that are not worth having," he replied. "All the good ones are here as you noticed."

"Sixty-four minus two dozen gives forty," I said. "What's in that parcel on the rack, another album?"

"Well, you must keep them somewhere, mustn't you?" answered my friend in rather an aggrieved tone. "You don't grudge me that, do you?"

"I'm not grudging you anything," I said. "All I'm trying to do is to show you that most people who talk so glibly about the expense of home movie-making, as if it were much more costly than ordinary snapshot photography, are talking through their hats, and as I want another packet of cigarettes I don't see why you shouldn't pay for them. How much was the album?"

"Half a crown," he answered. "You're a persistent blighter, aren't you?"

"Half a crown added to all this lot shows that your forty good pictures have cost you just over eightpence each, and when we sit here looking at them, or if we were to go through them when you've put them in the album, five or six minutes would be quite long enough to enjoy them all. Now let us suppose you have a six-guinea movie camera (I have deliberately chosen one at the same price that you paid for your still camera). An excellent little projector to show the films costs another two pounds fifteen. This makes nine pounds one for all the apparatus you need. If you don't want to pay as

Two strips of film showing the relative sizes of the 9½ mm. and the 16 mm. cinematograph film. Both pieces of film are actual size.

(*Continued on page* 46.)

ASTRONOMY FOR AMATEURS

ABOUT SIMPLE EQUIPMENT

By N. DE NULLY

THE fascination of probing the mysterious depths of illimitable space and examining at closer quarters the many marvels scattered about the sky can be enjoyed without the slightest technical knowledge and at comparatively small initial expense, free from further cost in the way of maintenance and renewals. The only instrument essential is a small astronomical telescope with an achromatic object glass (the large lens at the upper end) of not less than 3 inches aperture and mounted on a rigid stand. It should be provided with at least three eyepieces magnifying about 60, 100 and 200 diameters respectively, as well as a "dark cap" or solar prism to serve as a protection to the sight when looking at the sun. If the mounting is fitted with slow-motion handles to compensate for the rotation of the earth and enable a celestial object to be held continuously in view, so much the better; otherwise, after a little practice it can be done nearly as steadily with the hands. A good alternative to the 3-inch refracting telescope would be one of the reflecting type having a mirror of 6½ or 8½ inches in diameter. Either of the two latter would give results much superior to the 3-inch, and, in the case of the 6½-inch, would probably cost but little more, besides adding considerably to the comfort of observing; the relatively small extra outlay would therefore be well worth while. Larger instruments, of course, show more details

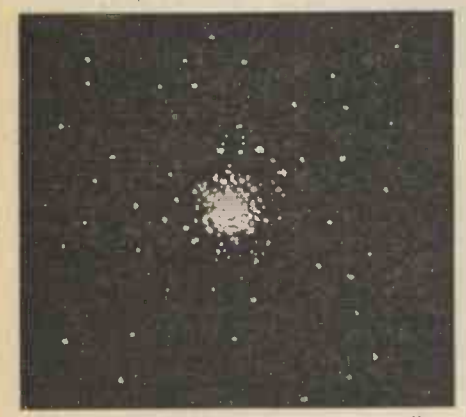


Fig. 3.—The Great Star Cluster in the constellation Hercules as seen through a 3-inch telescope. Visible to the naked eye on dark clear nights as a tiny luminous spot and is estimated to contain 100,000 stars.

and have greater light-grasp which permits of higher magnification under exceptionally favourable atmospheric conditions; but the sizes mentioned will generally be found adequate for the purposes of the amateur on most nights of the year, owing to the cloudy climate of these islands.

Astronomical Telescopes

Various makes, either new or second-hand, can be purchased from dealers or through the medium of the exchange and mart columns of certain journals, and great bargains may be frequently picked up in this way. One of the many popular books on astronomy is also recommended, to facilitate a clear and comprehensive description of the subject divested of mathematical calculations or abstruse theoretical speculations. An acquaintance with the principal constellations and their chief components can easily be acquired by the aid of a star atlas. It is possible to obtain quite cheaply a useful abridgment at 1*s.* 6*d.* under the title of

Fig. 2.—Sunrise on the walled stairs and ring mountains near the south pole of the Moon (as seen through a 3-inch telescope).

"Stars at a Glance," and also a very handy revolving planisphere for 2*s.* The latter is an ingenious cardboard device by which the aspect of the heavens on any night and at any hour can readily be displayed, by merely turning the dial to the required date and time. Thus the approximate location of a celestial body can be determined.

Fig. 4.—The earth-like planet Mars (seen through a large telescope).

It will surprise many to discover how much can be revealed by only a good opera

Fig. 1.—The ringed planet Saturn as seen in a large telescope. Note the Great White Spot and shadow of the ball on the rings, also the inner or "crape" ring.

glass. On clear moonless evenings the starry fields will be seen marching slowly in stately review from the east, each night disclosing fresh tracts of spangled sky as those first perceived disappear in the west. Numerous brilliant stars will attract the attention and the faintly luminous arch constituting the Milky Way will be very noticeable at certain periods. It should be realised that every scintillating point is actually a glowing sun, and that the areas of hazy light are made up of others, more distant and closely crowded, but too remote to be separately perceptible. In big instruments views of these "sun-cities," as Sir James Jeans styles them, are simply astonishing. Assuming that the intending amateur astronomer is equipped with at least a 3-inch telescope let us consider what may reasonably be expected from it. By day there is usually the sun, and its dazzling disc might be searched frequently for "spots," the "dark cap" or solar prism being first carefully screwed on to the eyepiece. If neither of these accessories are available a piece of heavily smoked glass must be interposed in front of the eyes, or there will be grave danger to the sight; the same precaution must be taken with a hand telescope, binocular or naked vision.

The Moon

Then there is the moon, which almost nightly invites the possessor of a small telescope to roam over its fairyland of glistening mountain ranges, vast walled plains and gigantic crater-like formations set in extensive shining tracts strewn with innumerable hillocks and ridges, every peak and eminence casting its inky shadow on the brightly lighted surrounding surface. No words can paint the weird and entrancing spectacle of the sun "rising" along the broken line marking the progress of the advancing day. At certain periods, too, our fellow planets may be seen in the evening and morning skies, especially the earth-like Mars, giant Jupiter and unique ring-encircled Saturn.

Fig. 5.—The giant planet Jupiter showing belts and four principal moons (as seen through a 3-inch telescope).

An Intriguing Article about Light

How to Build an Efficient— Polariscope

BY CHARLES EARLE

Scientific Facts Simply Explained by our Technical Staff

Polarised Light is the Aladdin's Lamp of Science. In this, and the succeeding article, the treasure cave of Light is opened for you while instructions for building efficient and practical Polariscopes of various types, and at extremely low cost, are given in detail.

AS nearly everyone knows, white, or "ordinary" light consists of a mixture of all the colours, violet, blue, green, yellow, and red, as shown in Fig. 1, and when light falls on an object which absorbs or passes all waves except one, that particular one becomes visible to the eye and we say the object is blue, red, or whatever colour applies. So much for what is quite elementary knowledge. What is not so clearly understood, however, is that substances which we term "transparent," actually do offer a certain amount of resistance to the rays of light, so that the normal speed of light—which, in the open air is about 186,000 miles per second—is materially slowed down where it passes through glass, crystal, celluloid, water, or any other transparent substance. Every one has, at one time or another, noticed that if a straight rod is put into clear water, it appears as though it were bent at the point where it breaks the surface. This "bending" applies also to a ray of light falling obliquely on a transparent object, but the short, or violet rays are bent more than the long, or red rays, and it is because of this peculiarity that light, passing through a prism or bevel of glass, is seen spread out into the familiar rainbow spectrum. This progressive bending of light is known as *refraction*, and is the basis of all optical science.

Now, while all transparent substances refract light, there are some which do so in a most unusual manner, dividing the beam into two distinct rays, one of which is refracted in a much greater degree than the other. The ray which is refracted in the usual way is known as the "ordinary," while the second, whose degree of refraction is variable, is termed the "extraordinary" ray. The two most usual substances used to produce this effect are Iceland Spar (which is crystallised carbonate of lime) and Tourmaline, the former being by far the more commonly used.

If a crystal of this spar be placed over a figure, design, or other mark on paper, the image seen through the spar will be distinctly double, as shown in Fig. 2, where the effect is demonstrated utilising the first two letters H and O. If a dot be made in ink and viewed in this manner, two distinct dots are seen, and if the spar be rotated the second dot will appear to travel round the first, just as the moon appears to encircle the earth, while first one, then the other, of the dots will alternate in shade from dark to light.

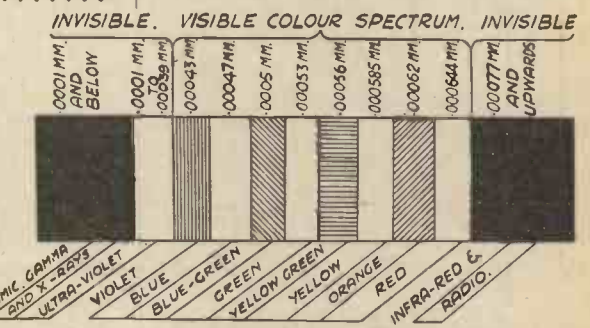


Fig. 1.—The visible and invisible spectrum with types of rays and approximate wavelengths in mm.

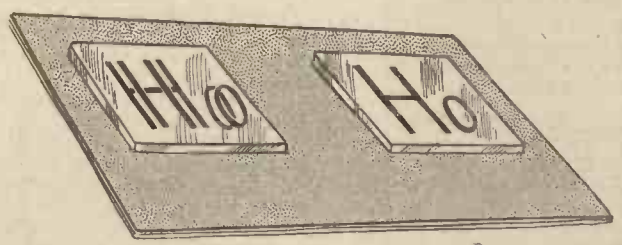


Fig. 2.—Diagram to demonstrate the "double ray" of such crystals as Iceland Spar, Tourmaline, etc. At "A" the letters "Ho-" are viewed through a piece of such spar and show a double image. At "B" the letters are seen through a piece of ordinary glass.

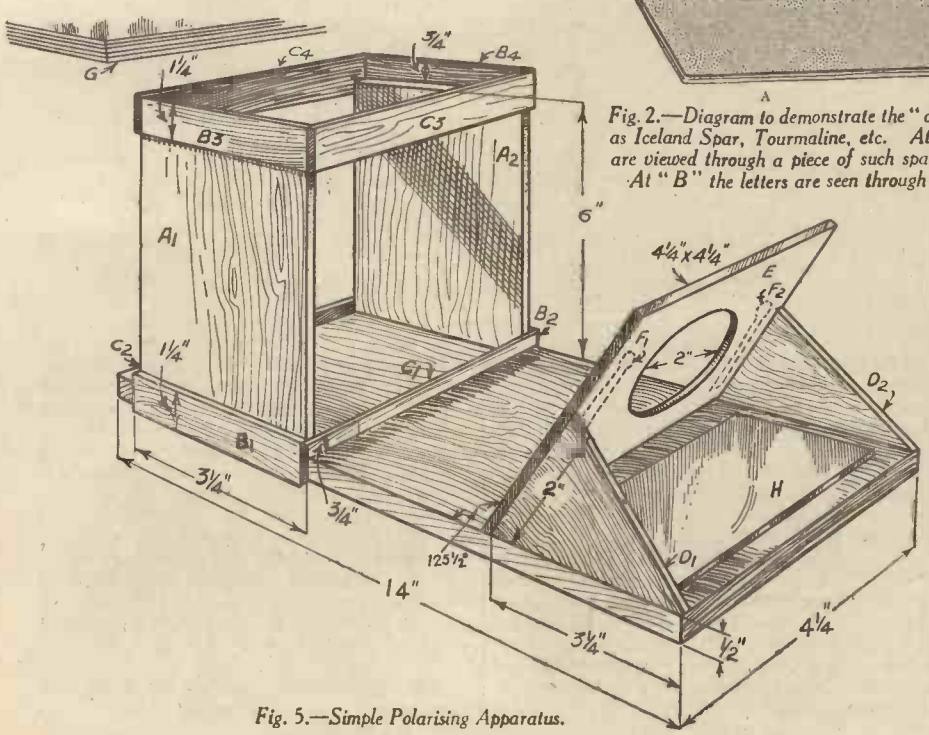


Fig. 5.—Simple Polarising Apparatus.

Polarising the Light

The phenomenon just described is the basis of the Polariscope, and it is by adapting the principle in such a way that one type of ray is discarded, or thrown out during its passage through the prism, that we are able to project a light ray which is moving, or vibrating in one plane only. In other words, instead of the light radiating in all directions like the spines on a cactus, it is made to radiate in one plane like the ribs of a fan.

To produce this effect, a very eminent optician named Nicol evolved a special prism which is shown in diagrammatic form in Fig. 3. He cut a crystal of Iceland Spar into two halves as shown, and after polishing the faces of cleavage as well as the outer faces, rejoined them to form a prism as shown at ABCD. The joined faces at AD were cemented with Canada balsam, which formed, within the prism, a surface capable of reflecting the "ordinary" ray out

through the side of the prism (see EFG), while the "extraordinary" ray was permitted to travel on through the whole prism emerging as depicted at EH, and now constituting a ray which could vibrate in one plane only, otherwise polarised light.

Now for a very remarkable effect. If two of these Nicol prisms are placed end to end and looked through in the direction of a source of light, they appear perfectly clear and transparent while their axes are in the same plane, but if one of them be rotated till its axis is at right angles to the other, we will find, on looking through them, that the light, however powerful, has totally disappeared, just as though it had been extinguished.

An Explanation of the Phenomenon

Fig. 4 gives an illustration of the reason for this seemingly magical phenomenon. If two grids of wire with very fine gaps between the bars are placed with both sets of wires running in the same direction and parallel, we can see through them, but if one is turned at right angles to the plane of the other, the part where they overlap seems solid. This is roughly what has

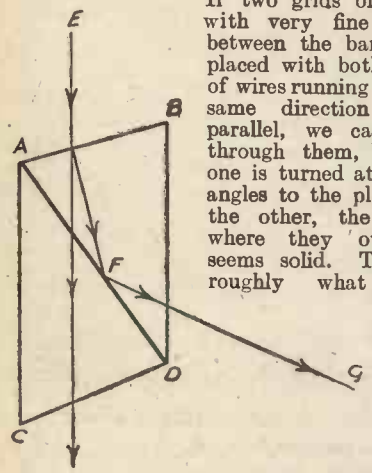


Fig. 3.—Diagrammatic sketch of Nicol's prism. A crystal of Iceland Spar is cut in two halves as shown at AD. The faces are polished and cemented together again with Canada Balsam. The paths of the ordinary and extraordinary rays are shown by the arrows. The pile of glass plates in Fig. 5 takes the place of this somewhat expensive prism.

happened in the case of the two prisms. The first one has stopped all light except that travelling in a horizontal plane; when we rotate the second it is in a position to pass only light in the vertical plane, but there is none to pass (having been screened out) so the result is no light at all!

When two prisms are used in this manner the first is termed the "polariser" and the second the "analyser." This combination, with certain additions and refinements, constitutes the instrument known as the "polarimeter," a device of great service in laboratories and particularly valuable in the sugar industry, for sugar has a peculiar property of rotating, or twisting, the polarised ray, and this fact is turned to account in the testing of the various types of sugars.

We will discuss the technical uses of polarised light in more detail later, but the reader should, by now, have a grasp of the general principle of the polariscope.

Colour Displays of Amazing Beauty

The most commonplace objects, when viewed by polarised light, acquire a coruscating variety of dazzling prismatic colours which is almost beyond description, and which must be seen to be believed. A few drops of a solution of such common substances as salt, sugar, borax, soda, copper sulphate, and a hundred other everyday compounds, will, if placed on a glass slide and viewed by this magic light, reveal a positively unearthly beauty of kaleidoscopic and ever varying colours which no photographic or colour-printing process could ever hope to reproduce with the faintest approach to fidelity. Actual crystals, splinters of glass or pebble, thin slivers of ores or rock; in fact almost any substance, will yield the most amazing results, while a small piece of mica or talc will be a positive revelation, changing as it does its entire colour scheme as the flexible material is bent or pressed.

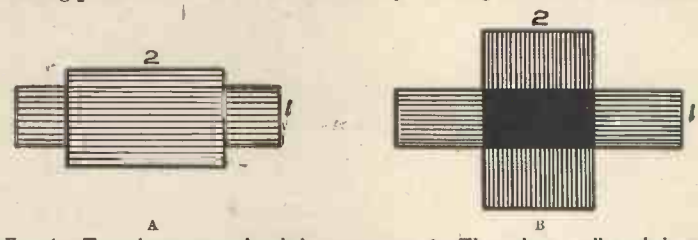


Fig. 4.—Two clear prisms, but light cannot pass! The polariser allows light to pass in one plane only. At "A" both prisms are in the same plane, so light passes through both without impediment. At "B" prism No. 2 has been rotated to the vertical plane and, as No. 1 prism has already stopped the passage of vertical rays, the overlapping prisms show total darkness, though each is quite transparent. The illustration shows the parallel case of two very fine wire grids.

Making a Polariscope

The professional instrument is a luxury quite beyond the average pocket in these days, but there is no reason why readers should not share in the wealth of beauty and colour available.

Fig. 5 shows a very simple, yet quite efficient, apparatus which can be made from the odds and ends of "junk" hoarded by most hobbyists. The only item which need be got specially is the square of black glass, and this can be obtained quite cheaply from any good glazier. Ordinary "mirror" is *not* recommended. The construction is perfectly simple and straightforward, while the drawing is practically self-explanatory. The greatest care should be exercised in cutting the triangular pieces D1 and D2, for the optical properties of the instrument are, to a very great extent, dependent on the angle of 54½ degrees being as nearly exact as possible.

The bundle of old glass plates (which must be thoroughly clean) may be from six to nine in number, as thickness varies, you will, however, soon find out what suits you best. These plates are simply dropped into the opening formed by B3, B4, C3 and C4, and rest on the upper edges of A1 and A2.

The rays of light (natural or artificial fall on the square of black glass (H), and are reflected through the object under examination, this being clipped into place on the stage (E). The rays then pass to the glass-plate bundle, which here does duty for the more expensive Nicol prism, and the effect is viewed by looking down on the glass plate which is uppermost. The box-like carrier has been arranged to slide along the base-board, so that the best position may be found before it is fixed, and also to allow for adjustment in case the all-important angles of the subject-carrying stage should not be quite exact.

The instrument shown will give ample satisfaction, and will well repay the trifling cost of construction. It is, of course, a polariser *only*. In the next issue we will give details for the making of more ambitious instruments with analysers attached, and also outline a series of instructive and fascinating experiments which may be performed at little or no cost to the operator.

List of Materials for Polariser

A1, A2.—2 pieces of ⅜″ wood, each 3½″ × 6″.

B1, B2, B3, B4.—4 pieces of ¼″ wood, each 3¼″ × 1¼″.

C1, C2.—2 pieces of ¼″ wood, each 4¾″ × ¾″.

C3, C4.—2 pieces of ¼″ wood, each 4¾″ × 1¼″.

D1, D2.—2 pieces of ⅜″ wood, each 2″ × 3½″ with contained angle 54½°.

E.—1 piece of ⅜″ wood, each 4¼″ × 4¼″ with centre hole, diameter 2″.

F1, F2.—2 spring strips screwed at one end (to grip slides).

G.—1 pile of six cleaned photographic ¼″ plates (3¼″ × 4¼″).

H.—1 square of black glass about 3″ square.

I.—1 baseboard of ½″ wood 4½″ × 14″.

THE RAY CONTROL OF MECHANISM—(*Continued from page* 6).

It will be observed that the core of a solenoid A is loosely attached to a pawl B. The latter is kept in alignment with the core by means of a weak spring C. The pawl engages with a lever D, one end of which is shaped like an inverted "V." The other end of the lever is arranged to slide over two contact studs, E and F, thus opening or closing a circuit connected with such studs. Each time the clear orange light ray is projected on the selenium cell by the miniature signal, the solenoid A is energised by current from a local battery controlled by the relay fitted in the light-ray apparatus. The pawl B thus engages with the lever D, and pushes the latter either to the right or left. The circuit connected with contacts E and F is therefore opened, or closed. The movement of the lever D is "definite," because each time current is cut off from the solenoid A the core with pawl B is drawn back by the spring C, and the lever D remains in the position in which it was last placed by the pawl B until the solenoid A is again energised.

The interlocking relay just described is used by the author for a number of his experiments, including wireless, and light-ray control, also control by sound waves. The instrument is simple to construct, and with a little ingenuity in arranging circuits, amateurs and others will find that extraordinary effects can be produced.

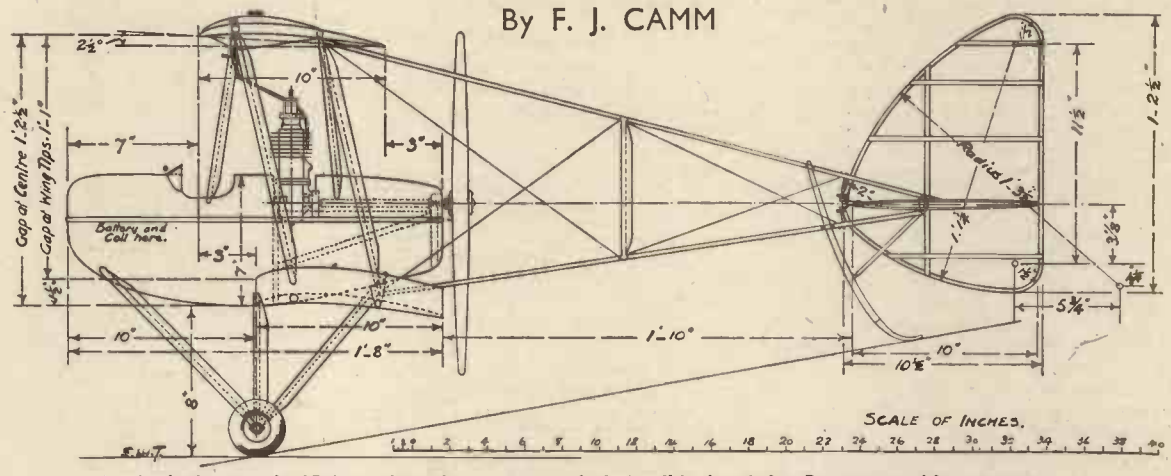
It is not generally known that light control can be used for controlling model electric motor boats over short distances. Battery-operated apparatus would, of course, be used for the purpose, and the selenium cells would have to be "housed" to protect them from being affected by "stray" light. An electric torch capable of projecting a powerful beam of light can be used for controlling the apparatus. The circuit shown in Fig. 3 could be used for the purpose, but it would be necessary to construct a "selector" or control switch.

Another interesting article on Light-Ray Control will appear next month.—Ed.

ENGINE-DRIVEN MODEL AIRCRAFT

COMPRESSED-AIR, STEAM, AND PETROL ENGINES ARE NOW USED TO PROPEL MODEL AEROPLANES

By F. J. CAMM



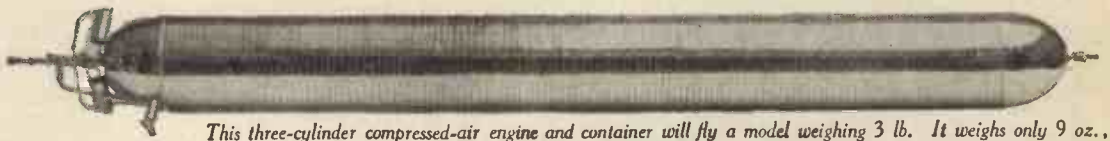
A side elevation of 0-2P-1 aeroplane, the construction of which will be described in PRACTICAL MECHANICS.

IT was in 1871 that Penaud introduced his beautiful little rubber-driven model aeroplanes, and elastic as a form of motive power for model aircraft has been almost universally employed ever since. Within the last two years, however, many other forms of motive power have been successfully introduced, namely, compressed air, steam and petrol. The early experimenters, Hargreaves, Langley and Stringfellow, all used engines driven either by compressed air or steam, but, except in a few isolated cases no one has developed, until recently, a satisfactory power unit for model aircraft.

Whilst elastic has many advantages, it also has many drawbacks, not the least of which is that it is impossible to make a model which looks like the real thing, owing to the length of fuselage required to accommodate the elastic motor. It will be realised that in order to obtain a long length of flight it is necessary to have an elastic motor of fair length. Another disadvantage is that it is not possible to concentrate the weight at the front of the machine as with a full-size aeroplane. A further drawback is that the power is greatest just after the model is launched, but from that moment it gradually gets less. Compressed air has this drawback too, but in all other respects it is superior to rubber. There have been several successful steam engines of the super-heated type, but more recently the greatest success has attended the use of miniature single-cylinder two-stroke petrol engines. Although these are only of 15 c.c. capacity (about 1 in. bore × 1 in. stroke) they are remarkably efficient little machines, and are capable of flying a machine a distance limited only by the amount of petrol carried. The ignition system consists of a coil of the trembler type and a dry battery. There have been several flights by petrol-engined models of over ten minutes duration. Obviously it is necessary to build a much larger model for these engines, but the interest in watching a power-driven model fly is far greater than with the elastic-driven counterpart.

The construction of such engines is well within the scope of the amateur, and it is the intention to describe the construction of several successful power-driven model aeroplanes, operated by compressed air, steam, and petrol in subsequen issues of PRACTICAL MECHANICS.

The illustrations on this page show some of the little engines to which I have referred. The petrol engine shown is three-quarters full size, and its complete weight is only 32½ oz., including petrol tank, carburetter and coil. The compressed-air engine is full-size.

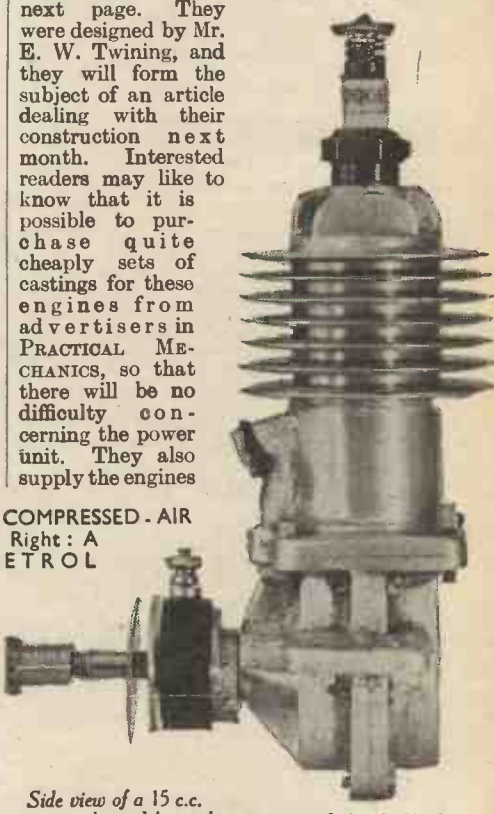


This three-cylinder compressed-air engine and container will fly a model weighing 3 lb. It weighs only 9 oz., but will drive an 18 inch propeller.

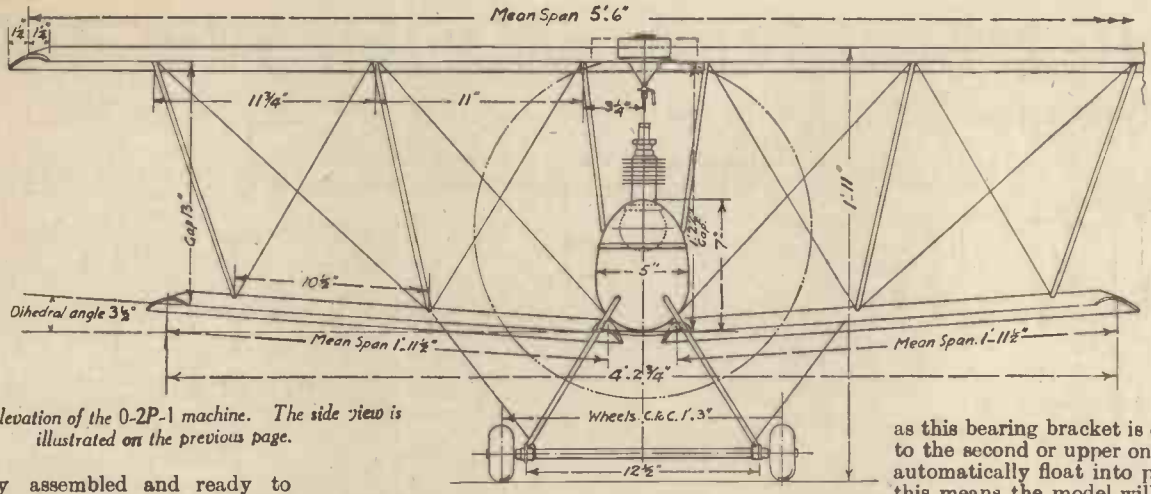
Two successful designs with the petro engine fitted are shown above and on the next page. They were designed by Mr. E. W. Twining, and they will form the subject of an article dealing with their construction next month. Interested readers may like to know that it is possible to purchase quite cheaply sets of castings for these engines from advertisers in PRACTICAL MECHANICS, so that there will be no difficulty concerning the power unit. They also supply the engines

The Author's model compressed-air engine.

Left: A COMPRESSED-AIR ENGINE. Right: A 15 c.c. PETROL ENGINE.



Side view of a 15 c.c. two-stroke model aeroplane engine made by the Author.



A front elevation of the 0-2P-1 machine. The side view is illustrated on the previous page.

completely assembled and ready to run. I recommend those readers who are interested in this subject to join one of the many model aircraft clubs scattered over the country and inspect the various models made and flown by the members.

I append a table showing the weights of the various units of the miniature petrol engine here illustrated.

WEIGHTS OF VARIOUS UNITS

	oz.
Carburetter	½
Engine without plug, but complete with clamping plate, nut and washer	15
Twining plug	½
Lodge plug	1
Bosch plug	1
Propeller, 18 inches diameter, 20 inches pitch	3½
Coil with leads	6½
Weight of flashlamp battery	4
Tank, with tap and petrol pipe (capacity of 1 gill)	½

Model Aeroplane Records

For the information of readers new to model aircraft, I append a list of the records to date.

FUSELAGE MACHINES

Rising off ground, J. W. Kenworthy, 5 mins. 12 secs.
Rising off water, G. Merrifield, 90 secs.
Hand launched, A. M. Willis, 18 mins. 2 secs.
Speed, C. H. Debenham, 33·25 m.p.h.
Glider, T. H. Ives, 50·8 secs.

FUSELAGE FARMAN TYPE

H.L., C. A. Rippon, 13·2 secs.

SPAR MACHINES

Twin Pusher Type:
R.O.G., S. C. Hersom, 247 secs.
R.O.W., S. C. Hersom, 65 secs.
H.L., T. D. C. Chown, 145 secs.

Tractor Type:
R.O.G., D. A. Pavely, 111·2 secs.
R.O.W., S. C. Hersom, 43 secs.
H.L., D. A. Pavely, 110·6 secs.

Farman type:
R.O.G., C. A. Rippon, 32·4 secs.
H.L., C. A. Rippon, 37·8 secs.
Glider: H.L., C. J. Burchell, 53·4 secs.
Auto-Gyro: H.L., D. A. Pavely, 25·8 secs.

COMPRESSED-AIR MACHINES

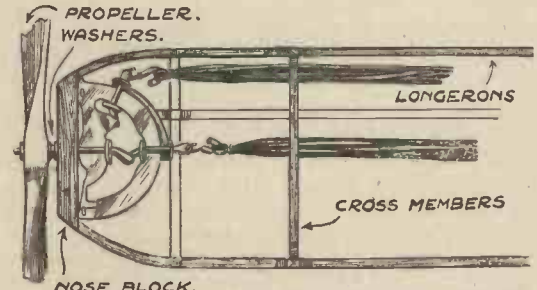
Fuselage: R.O.G., D. A. Pavely, 67·6 secs.

Non-fuselage: R.O.G., D. A. Pavely, 70 secs.

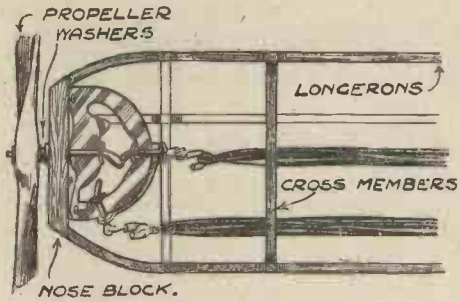
PETROL-DRIVEN MACHINES

R.O.G., C. E. Bowden, 86·8 secs.
H.L., C. E. Bowden, 3 mins. 55·4 secs.

H.L. Pterodactyl type: F. B. Baggs, 90 secs.



An ingenious gadget which enables two skeins of elastic to be used. The second only comes into operation when the first is unwound, so that double the length of flight is obtained.



In upper sketch the first skein has unwound and the second has dropped into place. The lower sketch shows the two skeins fully wound.

Obtain Double the Flight from Your Model

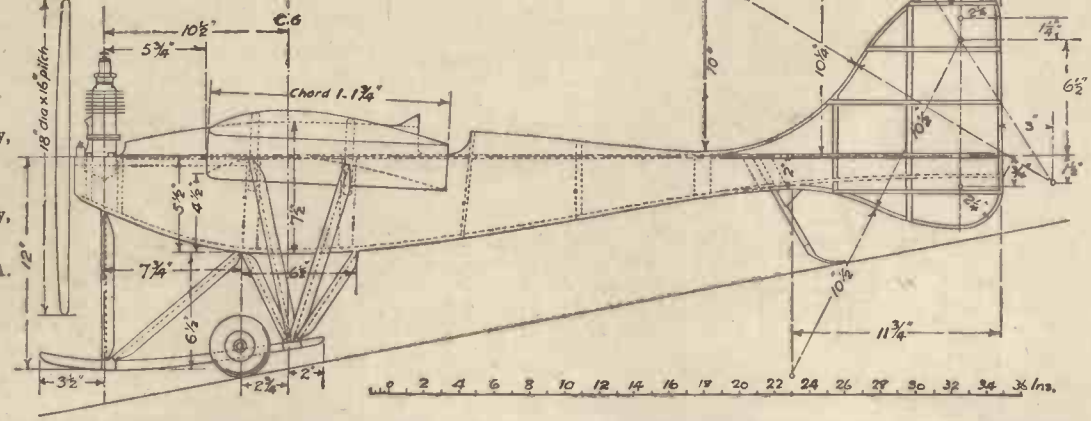
The ingenious gadget you see illustrated above enables two skeins of elastic to be used separately to drive the single airscrew. Both skeins are fully wound and occupy the positions shown in the lower sketch. It will be obvious that when the bottom skein has unwound the tension will release it from the notch in which its bearing bracket seats, and as this bearing bracket is connected to the second or upper one this will automatically float into place. By this means the model will fly twice as long as with the single skein. It is only necessary to ensure that the first skein has a sufficient number of strands to enable the propeller to run out whilst the model is in the air. The second skein can consist of a smaller number of strands, just sufficient in fact to keep the model afloat; the first skein can be used to get the model up to a good altitude and the second skein to maintain it at that altitude. It is, of course, only suitable in the form shown for fitting to fuselage models, but I have no doubt that readers will be able to devise a similar idea for spar machines. The gadget will make a useful addition to any fuselage model.

CLUB REPORTS

Club secretaries should note that we shall be glad to publish Club Reports not exceeding 250 words in length. These should be of general interest and should be received here not later than the 14th of each month for inclusion in the subsequent month's issue.

"MODEL AEROPLANES AND AIRSHIPS"

A splendid little handbook on the subject of model aircraft and containing 96 pages and over 120 illustrations is obtainable for 1/2 post free from the publishers of this journal; its title is "Model Aeroplanes and Airships," and it explains not only how to make model aeroplanes, but also model gliders, winders, flapping-wing models, airships and kites.



Side elevation of a petrol-driven tractor monoplane, the construction of which will also be described in PRACTICAL MECHANICS

How to provide your own programmes through your wireless receiver

Home Broadcasting

BY OUR RADIO EXPERT

THERE are undoubtedly many occasions when the programmes transmitted from any station within range of your wireless set are not of a type suited to the mood of the moment. You may be having a family-reunion, or a birthday party, for instance, and when the usual familiar recreations have been exhausted and no fresh pastimes can be thought of, the wireless is often resorted to to provide musical items for a short time. It is impossible to arrange the type of music suited to the gathering and therefore the wireless receiver does not fulfil its purpose of providing the entertainment required. One way out of such a difficulty is the installation of a gramophone reproducer to work in conjunction with the L.F. portion of the receiver, and many well-known manufacturers are now producing such an instrument. Where the wireless receiver is of an old pattern, or has been constructed at home, and no provision has been made for this purpose, the conversion is not at all difficult. The ideal method is, of course, to alter the wiring slightly and to fit some sort of a switch so that the receiver may be made to function in either manner with no tedious connections to be made or removed.

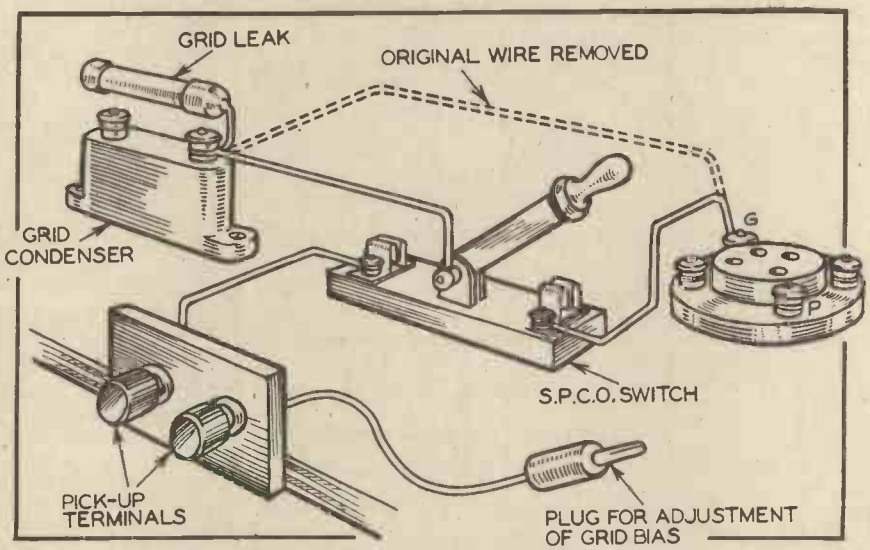


Fig. 1.—This diagram shows the simple connections which enable your receiver to operate from a gramophone pick-up or a microphone for home broadcasting.

Altering the Wiring

The electrical reproducer (known as a pick-up) must be included, in every case, between the grid of a valve and the filament (or cathode). As the valve must operate as an L.F. amplifying valve a small measure of grid bias must be applied, and, in the case of battery-operated receivers, this is most conveniently carried out by plugging one lead from the pick-up into the grid bias battery at an appropriate tapping. The following should be the method of carrying out the conversion for making the pick-up a permanent installation. First of all, at the rear of the receiver one of the small terminal blocks should be fitted, and two terminals mounted on the block. With the average pick-up obtainable to-day, two L.F. stages should be ample for normal volume, and, therefore, the pick-up should be inserted in the grid circuit of the second valve from the output end of the receiver. The lead which is joined to the grid terminal of this valve-holder should next be disconnected, and it should be connected to one terminal of a single-pole change-over switch mounted in any convenient position. The arm of the switch should be joined to the now vacant grid terminal, and the remaining connection from the switch taken to one of the newly-fitted terminals. The other terminal is joined to the biasing lead above mentioned. If now the pick-up leads are connected to the two terminals, the switch will enable the receiver to function as a reproducer of radio programmes or gramophone records. The actual connections are clearly illustrated in Fig. 1. If the valves are of the indirectly-heated mains type, the pick-up should be joined to the cathode and a suitable biasing resistance included in that lead.

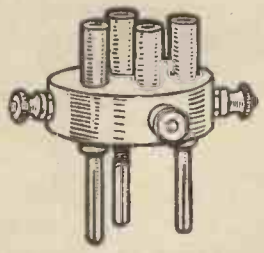


Fig. 2.—The valve socket adaptor.

Controlling the Volume

Many pick-ups are sold complete with a volume control included on the rear of the carrier arm and this is already wired into the pick-up leads and gives adequate control over the volume of the output. Where, however, one of the instruments which does not include this accessory is employed, the maker's instructions must carefully be adhered to in order not to spoil the quality due to the use of a control of the wrong value. If there is any doubt about the best method of controlling volume, or uncertainty exists regarding the correct method of fitting the pick-up, our Queries Department will be pleased to render advice free upon receipt of details. It is necessary of course, to give a fairly full description of the circuit and the requirements regarding volume required, etc.

The Microphone

The enjoyment of the wireless receiver may be rendered very much greater by utilising a microphone in place of the pick-up, and there are one or two instruments now available to the public at a really remarkable price, and which are highly efficient pieces of apparatus. The new G.E.C. Home Broadcaster, for instance, has a very high degree of sensitivity. It is mounted on rubber suspensions and is very compact. It has a self-contained volume control, and is supplied with an adequate length of metal-screened lead. This should be cut to suit the conditions under

(*Continued at foot of page* 26.)

Fig. 3.—This is a very efficient and cheap microphone for home broadcasting made by the G.E.C.; it costs only 18s. 6d.

HALF HOURS WITH THE MICROSCOPE

The first of a series of chats on the Use of the Microscope from a Non-scientific Point of View.

By W. J. DELANEY

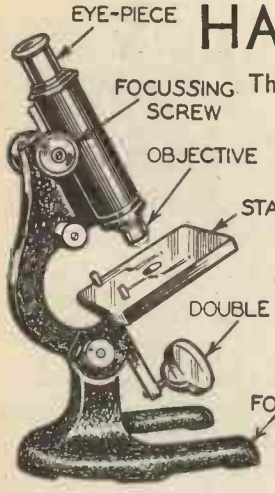


Fig. 3.—A complete microscope showing the names of the various principal parts.

THE microscope is regarded by many as an instrument used by doctors and scientific research workers for the study of disease. How many people realise that it offers, apart from this valuable use, a source of not only enjoyment but educational interest to everyone, from the youngest schoolboy to the oldest person whose eyesight is sufficiently strong to enable a few minutes to be spent at the eye-piece of this wonderful instrument. If you have never viewed any of the marvellous inhabitants of the world, which are normally too small to be seen other than through the medium of this instrument, I would draw your attention to the illustration in Fig. 1. Although only a sketch this gives some little idea of the object, which always appeals to me as one of the marvels of the Universe. As the drawing shows it is perfectly spherical in shape and dotted all over with minute tufts of hair. It is transparent, a most brilliant green in colour, and contains a number of similar but smaller replicas of itself. It moves through the water in which it is found in a slow, stately, rolling motion, and possesses neither mouth nor other animal features. Yet it is not a plant. It is one of the order of lower things which may be found in practically any still pond or stream. However, before introducing you to other interesting items we must first briefly discuss the instrument.

What the Microscope Is

In its simplest form the microscope is nothing more nor less than a magnifying glass, or series of magnifying glasses. Fig. 2 illustrates the arrangement in diagrammatic form, from which it will be seen that a metal tube is fitted with small lenses at each end. The lower end is fitted with a lens which magnifies the object situated immediately beneath it, and the upper end is fitted with a lens which magnifies the view produced by the first lens. From their use these two lenses are named the "object glass," or, more correctly, the "objective," and the "eye-piece." Actually the lenses have to be built up in a special manner to avoid various forms of distortion, but this article is merely an introduction to a hobby and

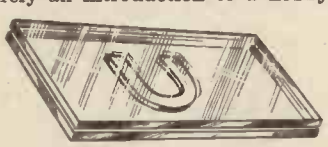


Fig. 4.—An easily-constructed device for viewing live objects in liquids. A small piece of "U"-shaped rubber is cemented between two plates of glass 2 in. long by 1 in. wide.

will not treat with the optics and finer points of the system, for which purpose the reader is recommended to study one of the technical text-books. By suitably choosing the objective and eye-piece any degree of magnification may be obtained, but for normal use only reasonably small powers should be employed, not only to avoid eye-strain but also to enable a better understanding of certain objects to be obtained. When using some of the higher powers the magnification is so great that the depth of focus is very shallow, which means to say that when viewing, for instance, the head of a fly only the very top surface may be seen clearly, the depth of the eye, for instance, being much greater than the depth of focus,

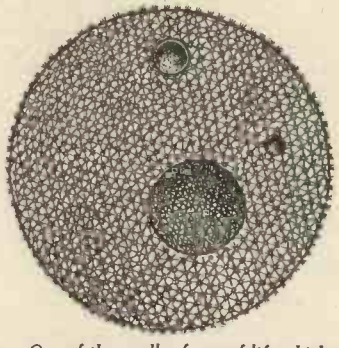


Fig. 1.—One of the smaller forms of life which may be found in any standing water. This illustration is about 100 times the size of the actual object, but the illustration can give no idea of the beauty of the original.

and the instrument has to be focused in the same manner as an ordinary field glass in order to view the eye from top to bottom. However, more of this anon.

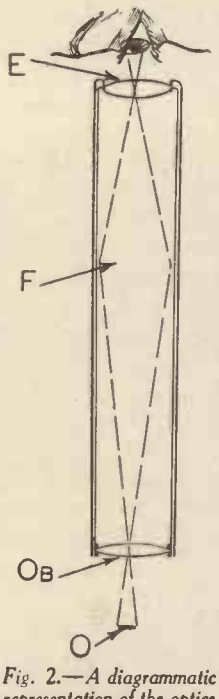


Fig. 2.—A diagrammatic representation of the optics of the simple microscope. The objective lens (OB) casts a magnified image of the article being viewed (O) to a point inside the tube (F), where it is further magnified by the eye-piece (E).

Choosing a Microscope

If you have not yet obtained an instrument I would recommend that you get into touch with one or two firms who specialise in the sale of various makes of instrument, when you will more readily be able to see the various types which may be obtained and the prices which are asked. Unless you intend to take up the study seriously, quite a simple microscope will suffice, and may be obtained for quite a reasonable figure. The type known as a "Students' Microscope" will serve admirably. Light is essential for viewing every type of subject, whether you are making a surface inspection or examining the inside of an object. Daylight certainly suffices in the majority of cases, but, where the microscope is to be used at night, an artificial light will be necessary, and although an electric light bulb may be used I prefer the softer light from a small oil lamp, focused by means of a good lens. Fig. 3 shows a complete outfit from which the various terms may be read. Only those which are required for the subject of these articles have been given, as there are many high-sounding names applied to various parts of the microscope which are not at all necessary unless the study is to be made as a scientific hobby and not an interesting recreation. To enable an inspection of live objects in liquid to be made the reader will have to acquire what is known as a live box, and although these may be purchased, they are, in the main, much too elaborate for haphazard use, and I prefer to make my own. The only requirements are two photographic plates (or one large one cut up) and a small piece of flat rubber. An old bicycle or motor car inner tube serves admirably. A "U"-shaped piece is cut out and stuck flat on a piece of glass with Durofix or similar adhesive. The other piece of glass is then cemented over the rubber, thus leaving a small "U"-shaped portion which will hold liquid. The size will depend upon the power of the microscope, and the thickness of the rubber also will depend upon the general use. For the subjects which I shall deal with in these articles the measurements given in Fig. 4 will do nicely, and the ordinary inner tube will provide sufficient separation between the two pieces of glass. In addition to these essentials, a piece of glass tubing should also be obtained. A length of about 8 inches, and an internal diameter of about ¼ inch, will be found most suitable, and to enable some suitable subjects to be taken from a pond or stream a special collecting net must be made up. For this purpose nothing is simpler nor more efficient than the arrangement shown in Fig. 5. A conical bag of ordinary muslin or linen is fitted round a metal ring exactly like a child's ordinary fishing net. At the lower end of the net an ordinary glass test-tube or small bottle is held in position by a rubber band. The net must, of course, be sufficiently fine to prevent the passage of small objects through its mesh. Obtain your instrument, and make up the above-described accessories, and next month I will tell you how to view some most interesting items from a pond or stream, which will afford you not only amusement, but will prove an education.

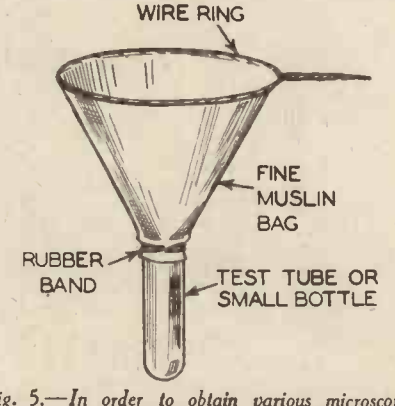


Fig. 5.—In order to obtain various microscopic bodies from water a simple net constructed as shown above will be found invaluable.

THE UNIQUE POSITION OF PELMANISM

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"I have been granted a rise in salary and am anxious to thank you for the tremendous help I have received from the Course." **Bank Clerk.**

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"Have been very successful in my examinations, passing all subjects with a good margin of marks." **Cadet.**

"I may add that so far the Course has been working positive wonders." **Civil Servant.**

"I am sure my new engagement is entirely due to it." **Actress.**

"I think, considering my age, that it is extraordinary what effect it has had." **Clergyman.**

"Physically and mentally, Pelmanism has reorganised me." **Army Officer.**

"I have lost that inferior complex from which I often suffered." **Nurse.**

"You will be interested to know that C. 35114 has been awarded the degree of M.A. with first-class honours." **Student.**

You are sure to be interested in at least one of the people who, in "The Science of Success," speak highly of Pelmanism from practical experience. It may be a prominent personality who has captured your imagination, or it may be a neighbour who has earned your respect. Get a copy of "The Science of Success" now—write at once. Pelmanism may be mastered by giving to it 20 or 30 minutes a day for about three months. It is intensely interesting, and the results begin to show within a week. It is taught by post. The benefits last a life-time.

UNDERSTANDING YOUR CAMERA

SOME FASCINATING FACTS ABOUT THE LENS

THE amateur photographer who experiences a high percentage of failures among his negatives would do well to study the main principles on which his camera works. Naturally, detailed instructions for all types of camera cannot be included here, but a good method of dealing with underlying principles is to compare the popular cheap snapshot camera with a more expensive type.

Every amateur, even if he has the cheapest and simplest of cameras, will find on occasions that he has obtained results that could not be surpassed by the most elaborate and expensive instrument. He may therefore feel inclined to wonder why any camera need cost more than a few shillings when he can sometimes obtain results equal to those of a camera costing anything up to £50 or so. The explanation of this is of course that the cheap camera is far more limited in its scope than the expensive instrument, but within its limitations the cheap camera will give equally good results.

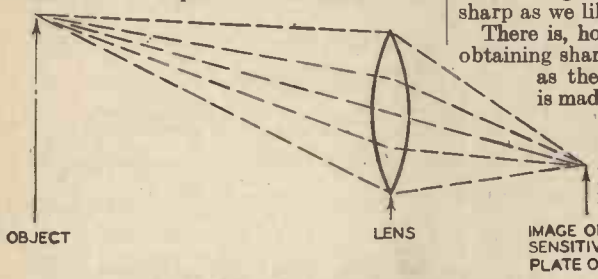

Fig. 1.—The lens on a cheap snapshot camera.

The Lens

Consider first the lens. On the popular snapshot type of camera of the cheaper kind this is invariably a single lens (like an ordinary magnifying glass), which forms an image in the manner shown in Fig. 1. Every point on the object which is being photographed radiates divergent light rays in all directions, and some of these rays fall on the lens, passing through the glass into the camera. The lens, however, has the property of bending (or "refracting," to use the proper word) the rays of light together again so that the bundle of diverging rays which enters the lens comes out on the other side as a converging bundle of rays, which come together more or less to a point called the focus. Every point of the object forms a corresponding point of light on the other side, and the combination of all these points forms the image. Fig. 1 shows the rays from one point only, for the sake of simplicity, but a similar set of lines can be drawn between every point of the object to the corresponding point of the image. The resulting image is in every case upside down.

The Diaphragm

Unfortunately, however, a single lens, used as shown in Fig. 1, will not bend all the rays of light accurately to the same point, so that instead of obtaining a sharp point the rays will be spread over a small disc; this remark applies to every point on the image, which therefore appears "fuzzy" on the negative. This effect, however, may be avoided to any extent we desire by using only the rays near the centre of the bundle, the outer rays being cut off by means of a diaphragm of thin metal in front of the lens (Fig. 2). A hole is formed in the centre of the diaphragm to let the central rays through, and the smaller we make the hole the sharper will be the image, so that even with a single lens we can get negatives as sharp as we like.

There is, however, a serious objection to obtaining sharpness by this means, because, as the aperture in the diaphragm is made smaller, the amount of light entering the camera obviously becomes less and the exposure must therefore be increased.

Working Aperture of the Lens

The amount of light entering the camera depends upon the ratio between the lens aperture and the focus. In the case of a single lens a sharp picture will not be obtainable if the diameter of the aperture exceeds about one-eleventh of the focus, *i.e.*, with a lens of 5½ inches focus the aperture in the diaphragm should not be more than ½ inch. Under such circumstances we should say that the lens works at an aperture of F/11. At this aperture good snapshots may be taken in bright sunlight only, and with less favourable conditions of lighting a time exposure is necessary.

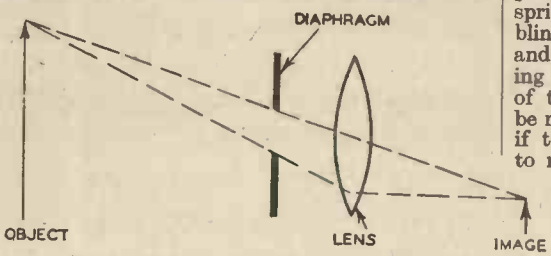

Fig. 2.—A thin metal diaphragm used to cut of the unwanted rays.

The aperture is usually adjustable on all except the very cheapest cameras by means of an ingenious device called an iris diaphragm. This may be seen in front of the lens in the case of a single lens, or between the glasses in the case of a compound lens. It consists of about eight or ten plates of very thin metal and has the appearance shown in Fig. 3.

Rapid Lenses

A compound lens will work at a considerably larger aperture than F/11, several modern lenses having a working aperture of F/3 or thereabouts. The area of the aperture will then be about thirteen times that of the lens working at F/11, therefore exposures can be made in one-thirteenth of the time with the modern lens, some of which are even considerably faster than F/3. These lenses are naturally comparatively expensive, and are therefore only fitted to expensive cameras. The reader will understand from this how it is that Press photographers, with expensive cameras, can obtain good photos in dull or rainy weather.

Focussing Arrangements

Another point in connection with the lens is that of focussing. The larger the lens aperture the more accurately must the focussing be done. With a single lens in a small camera it is quite possible to do without any focussing arrangements, but with a large aperture lens some focussing adjustment device is essential. Focussing may be done either by means of a scale marked in feet or a "reflex" camera may be used. In this form of camera focussing may be done visually right up to the moment of exposure. The image is reflected by a mirror which is moved away at the moment of exposure.

The Shutter

Cheap cameras invariably have a simple form of shutter working in front of the lens if the latter is a single one, or between the glasses in the case of a compound lens, some arrangement being provided for holding the shutter open for time exposures. The camera must of course not be allowed to move during exposures, so that with a time exposure the camera must be rested upon a rigid support, and even for a snapshot exposure it is best to do so if convenient.

With a fast lens, however, a fast shutter can be used, and for serious high-speed work the focal plane shutter is advisable. This, as its name implies, works directly in front of the sensitised plate or film. It consists of a roller blind, the full width of the picture, drawn across the plate by a spring; there is a slit right across the blind enabling light to reach the plate, and the exposure is adjusted by altering the spring tension and the width of the slit. Both these adjustments can be made outside the camera. For instance, if the slit takes one-fiftieth of a second to move across a plate 4 inches wide and the slit is ¼ inch in width, the exposure will be one-eight-hundredth of a second. This type of shutter gives a fuller exposure in the same time compared with a lens shutter, because the lens is fully open all the time.

In conclusion, if you have a cheap camera, don't waste films or plates by taking snaps unless the sun is shining brightly, and don't get too close to the object being photographed or the result will be out of focus.

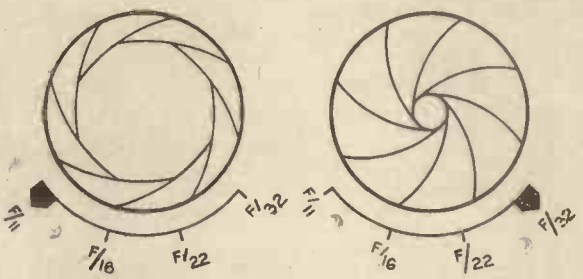

Fig. 3.—The iris diaphragm consists of eight or ten plates of very thin metal, as shown here.

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The PRACTICAL MECHANICS Wireless Experimenter

THE AIR KING THREE

A new and economical Three-valve Battery Receiver of High Efficiency

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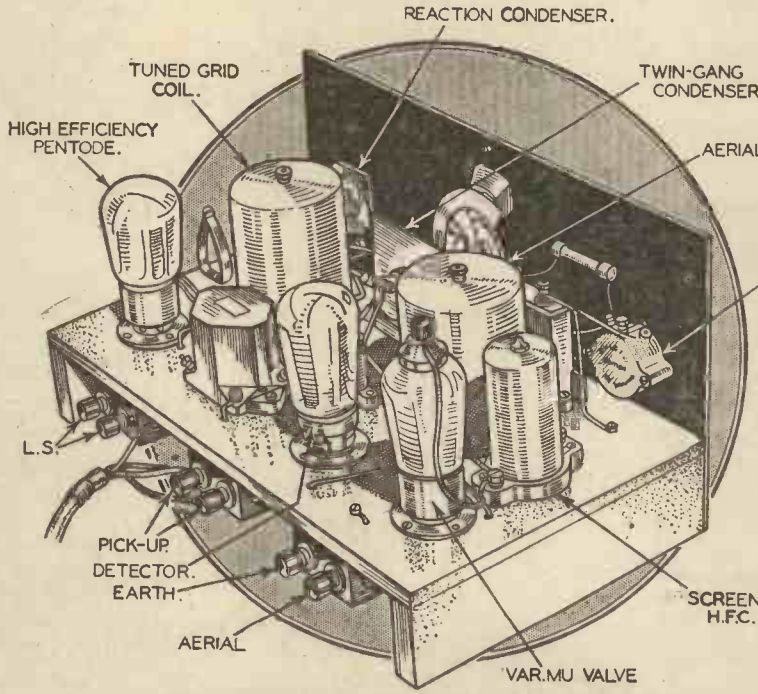
Selectivity and Simplicity

IN designing the present receiver it was decided that, provided ample selectivity for all normal requirements could be secured, low cost and simplicity of construction and operation should be the main features. Iron core tuning coils were at once ruled out on the grounds of their expense, whilst it was considered that band-pass tuning should not be employed, due to the fact that it would necessitate a fair amount of initial "matching," which often proves a stumbling block to the average amateur. It might seem that the elimination of these more modern refinements was a retrograde step, but the results obtained from the finished receiver prove otherwise. By choosing suitable air-core coils of high efficiency and carefully designing the circuit around them it has been found possible to achieve a measure of efficiency even greater than that shown by many receivers of more complicated and expensive design. The wiring is delightfully easy by means of our Free Gift Transfer Print. Illustrations showing how to use this are given on p. 20.



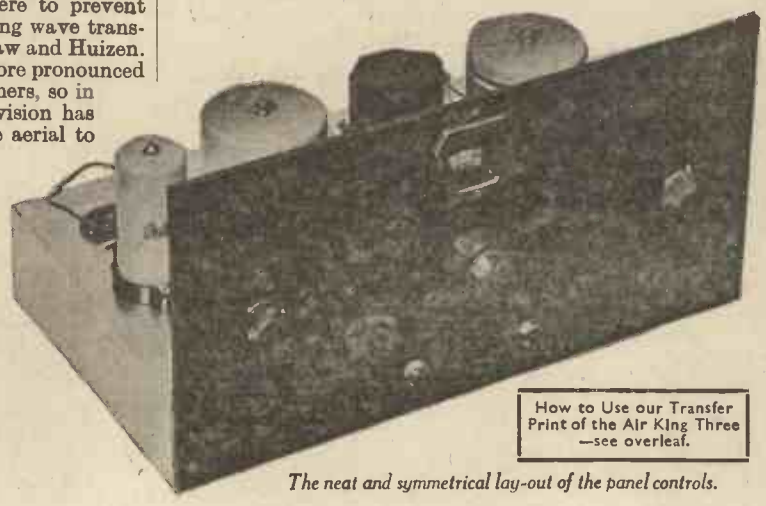
This drawing shows the attractive lines of the Air King Three.

No "Break-through"

It has been mentioned that selectivity was one of the main points considered, but allied to this the question of "break-through" of the local medium wave station when listening on the long waves was given careful thought. Many otherwise selective receivers suffer from "break-through," and this is often sufficiently severe to prevent the good reception of such long wave transmitters as Radio Paris, Warsaw and Huizen. This form of interference is more pronounced in some localities than in others, so in the set to be described provision has been made for connecting the aerial to a special tapping on the first coil, when required, so that "break-through" can entirely be overcome in the very simplest manner.

Ample Output—Easy Tuning

Not only has the set a long range, due to the use of an efficient variable-mu screened grid amplifier, but it is capable of giving the extremely good undistorted signal output of 500 milliwatts. Additionally, however, there is a useful volume control acting upon the variable-mu valve by which the strength of the most powerful station can, if necessary, be reduced to a whisper without in any way affecting the quality of reproduction. Tuning is very easy and is carried out by operating a dual gang condenser by means of a single knob. But in order that the very best may be obtained from the set on weaker and more distant stations a trimmer is provided, and this is easily adjusted through a small knob which is concentric with the main tuning control. There is a reaction control, and although this is not required when listening to the more powerful transmitters, it is useful in getting the best from distant stations and provides a convenient means of increasing selectivity.



How to Use our Transfer Print of the Air King Three —see overleaf.

The neat and symmetrical lay-out of the panel controls.

Low Current Consumption

Due to the use of a complete system of decoupling and voltage-regulating resistances, there are only two high-tension leads and these may be connected to the battery specified or to any eliminator giving an output of about 12 milliamps. at 120 volts. When using the 108-volt H.T. battery the current consumption is between 7 and 10 milliamps., depending upon the setting of the variable-mu volume control, and therefore the battery can be expected to last for three or four months before replacement becomes necessary. The low tension current is only 0·4 amp., and thus the accumulator will last for approximately 100 hours on each charge.

One rather important refinement of this set is in the use of an entirely new metallised wooden chassis and internally metallised cabinet. The former has all the advantages of an aluminium chassis but is much easier to deal with and somewhat more rigid. It simplifies the wiring very considerably, since a number of "earth return" leads can be attached directly to it by means of screws. The cabinet is instrumental in reducing to a minimum any direct pick-up from the local station and also tends to eliminate interference from electrical apparatus. It need not be mentioned that both the cabinet and the complete receiver are of very handsome appearance, since this is evident from the photographs reproduced on this and the following pages.

Cheap to Construct

In spite of the many novel features referred to above, and though the set is probably as good as any three-valve battery receiver available, it can be built complete with loud speaker, batteries,

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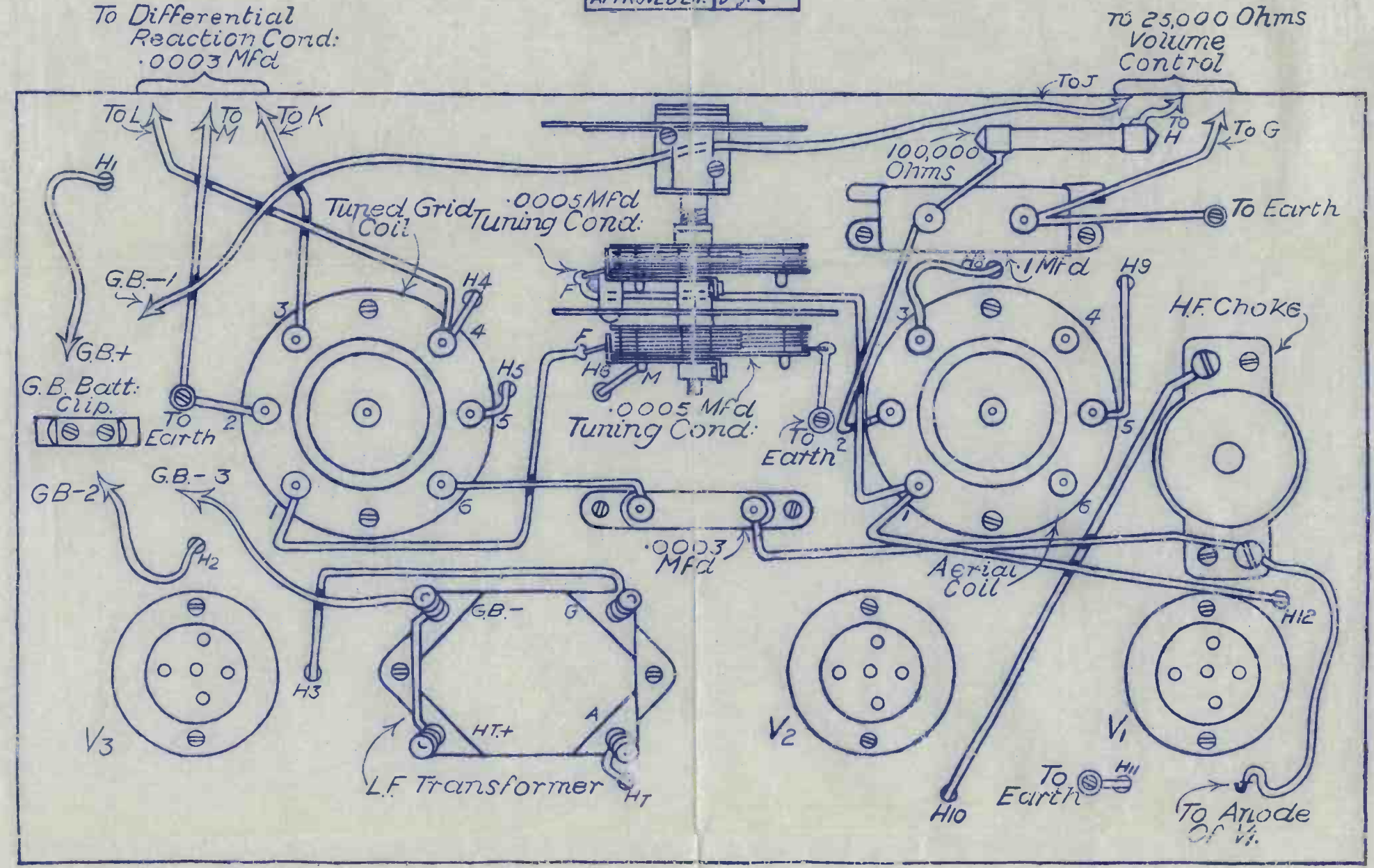

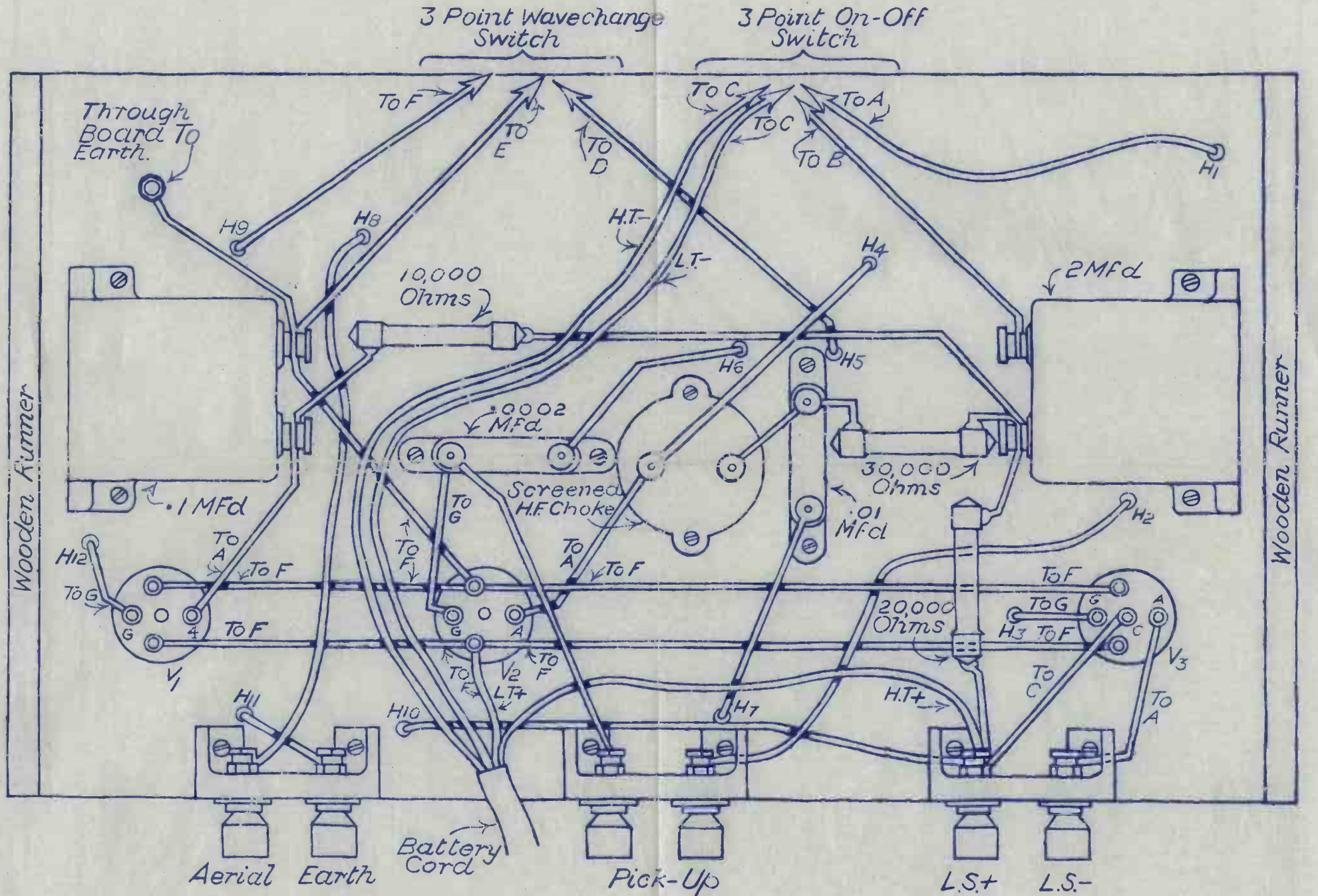
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To F
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H9
H8
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H4
10,000 Ohms
2 Mfd
H6
H5
.0002 Mfd
30,000 Ohms
Screened H.F. Choke
.01 Mfd
.1 Mfd
H2
H12
To G
To A
To F
To F
To A
To F
To F
To G
To F
H3 To F
20,000 Ohms
V1
V2
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The completed Air King Three in the Peto-Scott Cabinet.

cabinet and valves for the low figure of £7 10*s*. 0*d*.; the set itself, without valves, batteries, etc. costs only £3 10*s*. These figures show that the set is distinctly cheap and they are a challenge to those amateurs who maintain that it is now cheaper to buy a ready-made set than to build one.

The Circuit Described

For the benefit of those readers who are interested in the more technical side of receiver design a brief description of the circuit will not be out of place. Firstly, it is obvious that three valves are employed, and these are arranged as variable-mu high frequency amplifier, followed by a leaky-grid detector and a pentode. A single circuit aerial tuner is normally employed and the aerial lead is connected to a tapping on the medium wave winding. When "break-through" is experienced on the long waves, however, the lead-in can be transferred to a separate terminal, which is the end of a smaller winding coupled to the tuned winding and joined to a tapping on the long wave coil; the smaller winding acts, in effect, as an "anti-break-through" choke. The grid bias on the variable-mu amplifier is controlled by means of a 25,000 ohm potentiometer connected across the G.B. battery, a 100,000 ohm resistance and ·1 mfd. condenser being used for decoupling purposes. Notice the rather unusual, but effective, method of deriving the screening grid potential: the screening grid is connected through a 10,000 ohm decoupler to the junction of the coupling and decoupling resistances in the detector anode circuit. Thus the detective valve, H.F. choke and coupling resistance act as one "arm" of a fixed potentio-meter, whilst the decoupling resistance forms the other.

Tuned grid coupling is used between the V.-M. and detector valves, and to improve selectivity the anode lead is joined to a tapping on the tuned grid coil. Reaction is applied to the latter coil and is controlled by a ·0003 differential condenser, which gives a smooth variation over the entire wave-range and has practically no effect on the tuning. Pick-up terminals are provided in the detector grid circuit, so that the detector and pentode valves can be employed as a gramophone amplifier if desired. With the idea of keeping the wiring as simple as possible it was decided not to fit a pick-up switch and therefore it is necessary to de-tune the receiver when using it for reproducing gramophone records. The coils are not fitted with self-contained wave-change switches so a three-point push-pull switch is used to operate on both coils.

Three-quarter rear view of the Air King Three.

In order to improve the bass response of the set and to ensure really good quality, resistance-fed transformer coupling is used between the detector and pentode; by employing this system it is possible to use a small and low-priced transformer with every success. The moving-coil loud speaker specified is fitted with an output transformer and this is connected directly in the anode circuit of the last

(*Continued on page 22.*)

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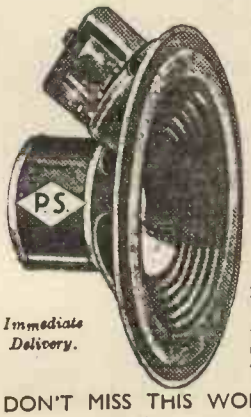

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1 **PETO-SCOTT** Ebonite panel, 14 × 7 in. drilled	4	6
1 **BURNE-JONES** "Magnum" dual gang ·0005 mfd. bakelite dielectric tuning condenser, type 1138	10	6
1 **BULGIN** 25,000 ohm volume control potentiometer, type No. V.C.34.	3	6
1 **BRITISH RADIO GRAM** ·0003 mfd. diff. reaction condenser	2	6
2 **BULGIN** "Junior" three-point switches, S.39	1	0
1 **GOLTONE** screened H.F. choke, type SHF	4	0
1 **GOLTONE** dual range coil, type G.G.C.	5	9
1 **GOLTONE** dual range coil, type G.G.R.	5	9
2 **CLIX** 4-pin chassis mtg. type valveholders, standard	1	4
1 **CLIX** 5-pin air-sprung type valveholder	1	3
1 **"ATLAS"** 4 : 1 L.F. transformer, type P.S.1	5	6
1 **BULGIN** "Midget" H.F. choke	2	3
2 **T.C.C.** ·1 mfd. fixed condenser, type 50	3	8
1 **T.C.C.** 2 mfd. fixed condenser, type 50	3	6
1 **T.C.C.** ·0003 mfd fixed condenser, type 34	1	3
1 **T.C.C.** ·0002 mfd. fixed condenser, type 34	1	3
1 **T.C.C.** ·01 mfd. fixed condenser, type 34	3	0
1 **DUBILIER** 2 megohm grid leak with wire ends	1	0
4 **DUBILIER** 1 watt resistances, 10,000, 20,000, 30,000 and 100,000 ohms	4	0
3 **BELLING-LEE** terminal mounts	1	6
6 **BELLING-LEE** terminals, type R marked	1	3
1 **BELLING-LEE** four-way battery cord	1	9
4 **CLIX** "Master" wander plugs marked	0	6
1 **BULGIN** G.B. battery clip, No. 1	0	6
2 coils Glazite, length flex, screws, etc.	2	9
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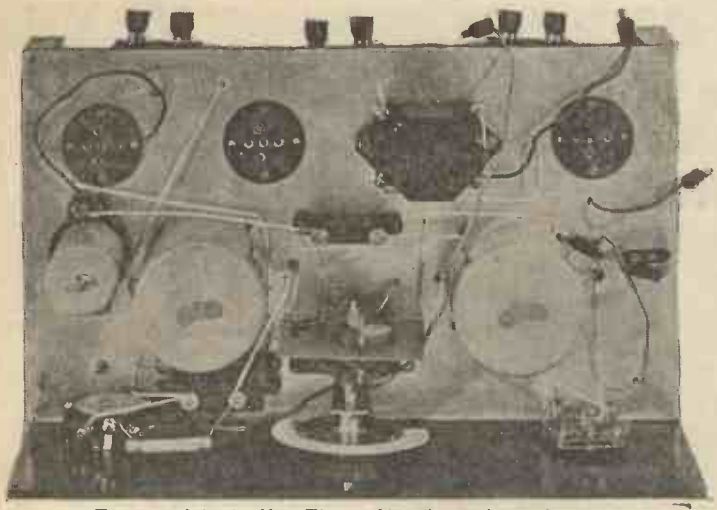


Top view of the Air King Three. Note the simplicity of wiring

(*Continued from page 20.*)

valve. A three-point on-off switch is employed so that the volume control potentiometer is entirely disconnected from the G.B. battery when the set is not in use and thus wastage of current is avoided.

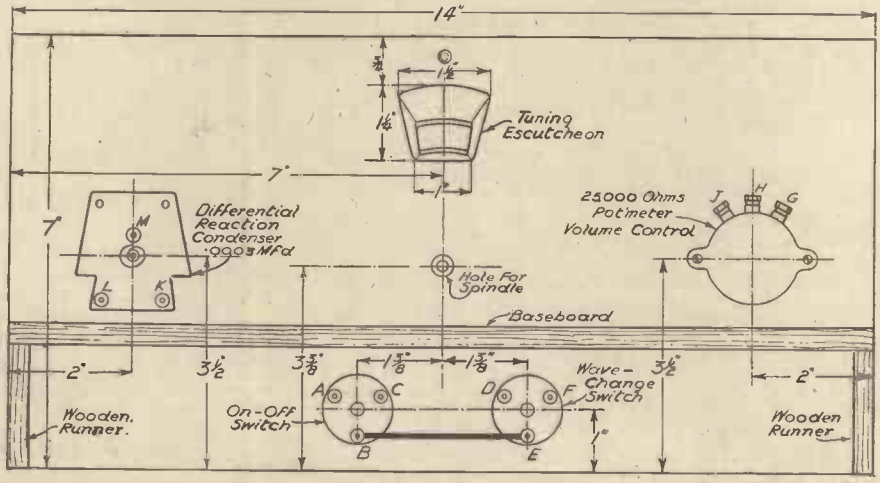
List of Components for the "Air King Three"

One Peto-Scott "Metaplex" Chassis, 14 × 8 × 2¼ in.
One Becol Ebonite Panel, 14 in. × 7 in.
One Burne-Jones "Magnum" Dual-Gang ·0005 mfd. Bakelite Dielectric Tuning Condenser.
One Bulgin 25,000 ohm Volume Control Potentiometer.
One British Radiogram ·0003 mfd. Differential Reaction Condenser.
Two Bulgin "Junior" Three-point Switches.
One "Goltone" Screened H.F. Choke.
One "Goltone" Dual Range Coil, type G.G.C.
One "Goltone" Dual Range Coil, type G.G.R.
Two Clix Air Sprung Type 4-pin Chassis Mounting Valve Holders, Standard type.
One Clix Air Sprung Type 5-pin do. do. do.
One "Atlas" 4 : 1 L.F. Transformer, type P.F.1.
One Bulgin "Midget" H.F. Choke.
Two T.C.C. ·1 mfd. Fixed Condensers, type 50.
One T.C.C. 2 mfd. Fixed Condenser, type 50.
One T.C.C. ·0003 mfd. Fixed Condenser, type 34.
One T.C.C. ·0002 mfd. Fixed Condenser, type 34.
One T.C.C. ·01 mfd. Fixed Condenser, type 34.
One Dubilier 2 megohm Grid Leak with Wire Ends.
Four Dubilier 1 watt Resistances; 10,000, 20,000, 30,000 and 100,000 ohms.
Three Belling Lee Terminal Mounts.
Six Belling-Lee Terminals, type R.; marked "A," "E," "P.U.," "P.U.," "L.S.+" and "L.S.−."
One Belling-Lee Four-way Battery Cord.
Four Clix Master Wander Plugs; marked "G.B.+," "G.B.−1," "G.B.−2," and "G.B.−3."
One Bulgin G.B. Battery Clip.
Two Coils Glazite, length flex, screws, etc.
One Peto-Scott "Air King" Cabinet.
One Hivac Valve, type V.S.210.
One Hivac Valve, type D. 120.
One Hivac Valve, type Y.220.
One Peto-Scott P.M. Moving-coil Loud Speaker.
One Ediswan 108-volt High Tension Battery.
One Ediswan 9-volt Grid Bias Battery
One Ediswan 2-volt 40 a.h. Accumulator.

Easy Wiring

After assembling the components in the positions indicated by the Transfer Print, the next step is to connect up the components by means of lengths of "Glazite" insulated wire. Start by connecting together the filament terminals on the valve holders and then work from the aerial end of the chassis towards the last valve. Several wires pass through the baseboard from one side to the other, but these can easily be followed by observing the numbers of the holes marked on the Free Transfer Print; the holes are best made one by one as the time comes to put on the appropriate wire. It will also be noticed that several wires are attached to the metallised baseboard by means of ¼-inch round head screws with small washers under their heads; these are common earth returns, and by connecting them in this way the wiring is considerably simplified. In most cases connections are made by looping a bared end of the wire and fitting it under the head of the terminal, but the leads to the tuning condenser and to one end of the 10,000 ohm S.G. decoupling resistance are soldered, since in these instances terminals are not fitted. No doubt all readers have had experience of soldering, but they will not object to the reminder that the iron should be really hot, otherwise there is some little danger of damaging the condenser and of loosening the tinned wire connector on the resistance. Additionally it might be added that flux should be used very sparingly, since it is liable to "splutter" on to nearby components and to reduce their efficiency by providing a leakage path.

All the other resistances than that mentioned above are attached by means of their own connecting leads. When all the other wiring has been done the grid bias leads, consisting of short lengths of single flex, can be attended to, and, lastly, the 4-way battery cord should be connected.

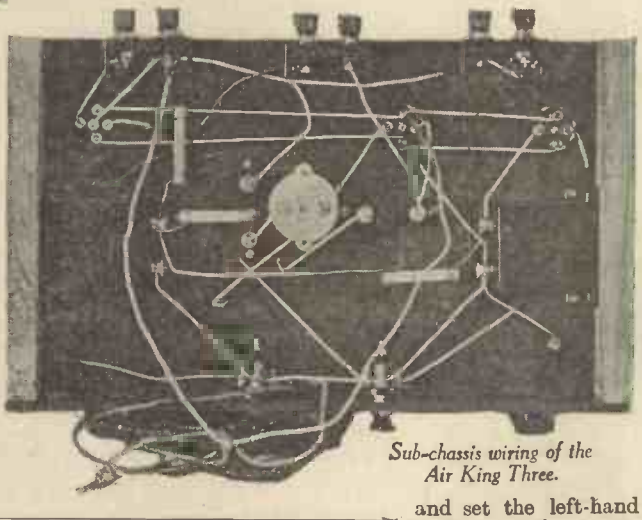


Back Of Panel Layout

Use this diagram to mark out the ebonite panel.

Connecting the Batteries and Operating

The receiver should now be ready for trying out. Fit the G.B. battery in the clip provided and insert the plugs into their appropriate sockets: "G.B. +" goes into the "+" socket, "G.B. −1" into the "9-volt" socket, "G.B. −2" into the "3-volt" socket, and "G.B. −3" into the 1·5-volt socket. Join up the aerial and earth leads, put plug "H.T. +" into the "108-volt" socket of the high-tension battery, insert the "H.T. −" plug into the "−" socket and connect the L.T. leads to the positive and negative accumulator terminals respectively. For all normal purposes the flexible lead from the aerial terminal should be connected to terminal 3 on the G.G.R. coil, but should "break-through" be experienced when listening on long waves, this lead should be transferred to terminal 4. To switch on, pull out the knob of the right-hand three-point switch



Sub-chassis wiring of the Air King Three.

and set the left-hand switch to the wave-band required (for long waves, push in; for medium, pull out). Set the reaction condenser to zero (counter-clockwise) and turn the volume control potentiometer to its maximum (clockwise) position. Now rotate the larger tuning knob until the local station is received and then bring it up to full strength by carefully setting the trimmer by means of the smaller knob. If signal strength is too great it can be reduced by means of the potentiometer control, whilst if it is insufficient it can be increased by rotating the reaction knob.

Increasing the Selectivity

Other stations can be received in the same way, although for the more distant ones it will probably be necessary to employ a certain amount of reaction whilst carrying out the initial "searching." When additional selectivity is required to enable two stations of nearly similar wavelength to be separated the setting of the volume control should be reduced as far as possible without cutting down the signal strength to too great an extent. At the same time the reaction condenser should be advanced as

(*Continued on page 46.*)

Wonders of the STRATOSPHERE

Topical interest attaches to this interesting article in view of Prof. Piccard's recent ascent

By RAYMOND ELLIS

THE recent world-stirring ascent of Professor Piccard, who rose about ten miles into the stratosphere from the earth's surface, has caused many people to ask the very pertinent question: "What is this Stratopshere, and what is the good of going up there, anyhow?" In the briefest possible phrasing, the Stratosphere is that portion of the earth's atmospheric envelope which is above the lower, or breathable, layer, known as the Troposphere.

A glance at Fig. 1 will give the reader some idea of how the gaseous sheath surrounding the globe is mapped out by Science. The belt marked "A" is the air we breathe, and extends for some 6¼ miles above the ground, becoming more and more rarefied as one ascends. The "no man's land" where the Troposphere tails off and the Stratosphere begins is aptly termed the Tropopause, while the true Stratosphere begins a little lower than the height attained by the intrepid Piccard.

As far back as 1898 an eminent French scientist, M. Teisserenc de Borth, carried out extensive experiments with sounding and recording balloons which he sent up to as high an altitude as 25 kilometres, and to his work we owe much of our somewhat sparse knowledge available regarding the upper reaches of the atmosphere. At first de Borth termed the upper stratum of air the "isothermal layer," but this term is now obsolete. As will be apparent from Fig. 1, the Stratosphere consists principally of nitrogen, therefore any human being ascending to this height must be, of necessity, equipped with adequate apparatus for the provision of oxygen and artificial heat, for, not only is the air quite unbreathable, but the temperature is such that animal life would become extinct immediately, the thermometer recording approximately 80 degrees below zero. This intense cold is well known to aviators at much lower altitudes, and a good instance is the special equipment which was found absolutely essential during the recent Mount Everest expedition.

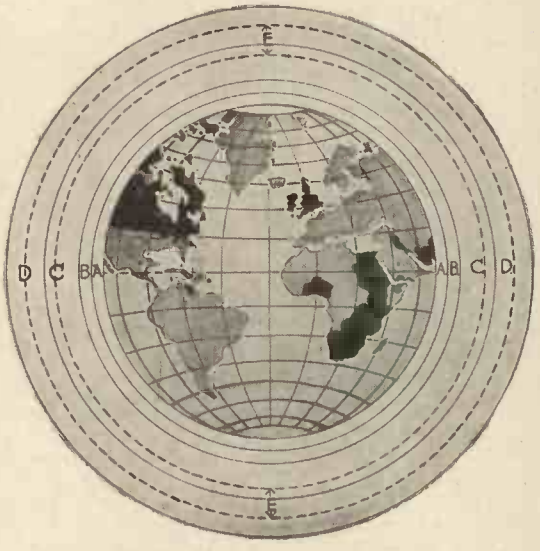


Fig. 1.—The world's gaseous envelope.

Height from Surface of the Globe.	*Name of Stratum.*
6¼ *miles* .	*A. Troposphere or Breathable Atmosphere. (Zone of winds, clouds, and weather change.)*
Variable .	*B. Tropopause. (Boundary between A. and C.)*
50 *miles* .	*C. Stratosphere. (Principally Nitrogen.)*
187 *miles* .	*D. Upper Stratosphere. (Hydrogen and Helium.)*
40 *to* 100 *miles.*	*E. Kenelly-Heaviside Layer. (Ironised Gas.)*

In the Stratosphere brilliant sunshine, icy cold and eternal calm prevail, for there are no clouds or winds, and the most tempestuous vagaries of the weather are confined to the lower realms of the atmosphere altogether.

The Stratosphere and a Murderous Weapon

This rarefaction of the air and eternal calm has resulted in proposals for a new and fearsome weapon of war on which experiments are even now in progress. Briefly, the idea is to launch powerful rockets into the Stratosphere each carrying a load of explosive, poison gas, or pestilent germs. Once beyond the confines of the lower atmosphere enormous ranges could be reached for the air resistance to the rocket is halved every 3½ miles up. Such a weapon, if practicable, would dwarf all the terrors of the recent war for, once in the Stratosphere, little propulsive effort would be required to make the projectile attain an incredible velocity. At Fig. 2 will be found a graphic idea of the use of this promised horror. Without heavy, immobile and expensive cannon the deadly rocket-shell would be capable of decimating the Berlin area of Germany from its starting point in London! In comparison, "Big Bertha," the terror of Parisians during the late war, might be regarded as a mere pop-gun. Fig. 4 shows the amazing difference in range of these two products of civilisation, while in Fig. 3 is depicted the actual type of rocket at present undergoing experimental tests by its inventor, Herr Zucker of Berlin. With a dead weight of over 200 lbs. this monster "firework" will attain a height of fifteen miles and a speed in excess of 600 miles per hour, yet dozens of these rockets could be constructed for less cost than a battery of field-guns. The more powerful charges would spend their energy in overcoming the high resistance of the Troposphere and the earth's gravity, while the smaller charges would build the speed up to a dizzy figure once the Stratosphere were reached.

Fig. 2.—Stratospheric bombardment by rocket shells.

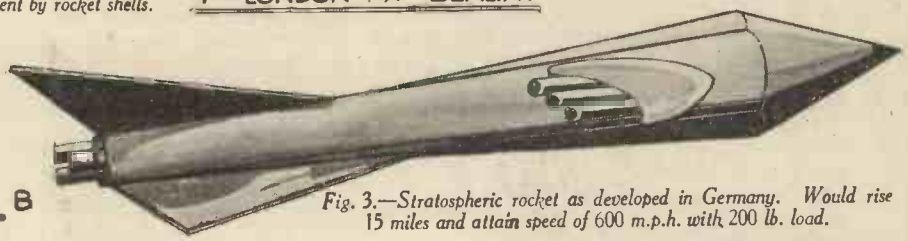


Fig. 3.—Stratospheric rocket as developed in Germany. Would rise 15 miles and attain speed of 600 m.p.h. with 200 lb. load.

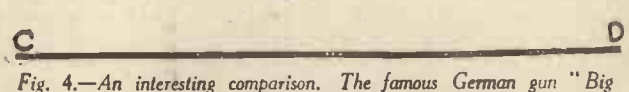


Fig. 4.—An interesting comparison. The famous German gun "Big Bertha" which so worried Parisians during the war was barely effective at 75 miles, while its enormous size and short life rendered it unprofitable for serious use. The rocket shell has no such drawback and has a range at least eight times as great.

The Heaviside Layer

There is one very mysterious fact about the Stratosphere which still awaits explanation. It has been

ascertained that the deadly cold maintained (and confirmed by Professor Piccard's tests) extends to about 60 kilometres above the surface of the globe, but, on going higher, instead of an increase in cold, a layer of relatively warm air is encountered, the temperature reaching as high as 30° Centigrade. This continues to about 150 kilometres up, and no explanation is forthcoming up to now; in fact, no theory can be advanced at all so far.

About 40 to 50 kilometres up is the Heaviside Layer, or, to be more precise, the Kenelly-Heaviside Layer. This layer is believed to consist of ionised gas and has been much in the public eye of late owing to its effect on radio transmission as it reflects the impulses or waves back to earth. This is particularly so with long-wave transmission, which is thrown sharply back, causing a zone of strong reception near to the transmitter, while shorter waves are reflected at a wider angle, giving rise to the phenomenon known as "skip-distance," causing areas of poor reception on the waves concerned. Ultra-short waves, on the other hand, appear to pass straight on through the layer and out into space, so, if we are ever to get into radio communication with the planet Mars, as some prophesy, it looks as though it will be through the medium of ultra-short wave transmission.

What the Heaviside Layer really consists of is much a matter of conjecture. The general belief is inclined to the ionised gas theory, but the idea of this ionisation being caused by ultra-violet radiation from the sun is hardly tenable inasmuch as the layer persists at night though 90 kilometres up instead of the day time 40 to 50 kilometres. This being so, the substance must be one that is capable of dissociation in the dark, and ozone has been suggested as filling the bill. One very ingenious investigator puts forward the theory that the upper part of the Heaviside consists of frozen hydrogen in minute particles. Hydrogen in this state has many of the physical characteristics of a silvery-looking metal, and this theory, unsupported as it is, might account for the reflection of radio waves as well as for the Northern Lights, or Aurora Borealis, the latter on the theory of diffraction of light rays setting up a prismatic display of colours. At the present state of our knowledge it is *all* theory as no definite information is available.

Electrical Power from the Stratosphere

During his ascent Professor Piccard investigated the Cosmic Rays and found, to his surprise, that the higher he rose the weaker was the Cosmic Radiation. This was the exact opposite to what theory had led scientists to expect, so another stratospheric enigma awaits solution.

During his ascent the Professor proved that a container of metal with a polished outer surface reflected the sun's rays and maintained an interior temperature equal to that of the surrounding air (in this case 75 degrees below zero), while a similar container with a black outer surface absorbed the solar rays and its interior rose to about 170 degrees above zero. These facts have resulted in a proposition which aims at utilising this temperature variation to provide cheap power as schematically shown in Fig. 5. The idea is quite simple and consists of a thermal engine driving a dynamo, the whole "works" being kept aloft in the Stratosphere by a suitable balloon.

The fuel would be a liquid having a low freezing point, such as alcohol, the pipes in the container "X" being heated by absorption of solar heat and the vapour generated utilised to drive the turbine as explained in the sketch. The exhaust vapour would be passed to the container "Y" for condensation by the low temperature induced through reflection of the solar rays from the polished casing and the condensed liquid passed back to "X" by the pump shown.

So far this is about the only really practical suggestion which has evolved from investigation of the Stratosphere, but we may safely expect further information ere long and surprising data may be expected in the very near future though the sort of thing foretold in Conan Doyle's fascinating story of the Stratosphere, "The Terror of the Height," is, we devoutly hope, highly improbable.

Although it has been possible in this article to do no more than explain briefly some of the wonders which further investigation of the stratosphere might have in store for us, it is hoped that even those readers who had never before considered the subject may have been given some edible food for thought. It is certain that further investigations into the upper atmosphere will be made in the very near future and scientists the world over are well aware of the immense possibilities that these experiments may hold in store. It will also be apparent that the untiring efforts of Professor Piccard and his confreres will no doubt be for the good of mankind; although they may be looked upon in ridicule by many, their true significance will eventually be apparent to the civilised world.

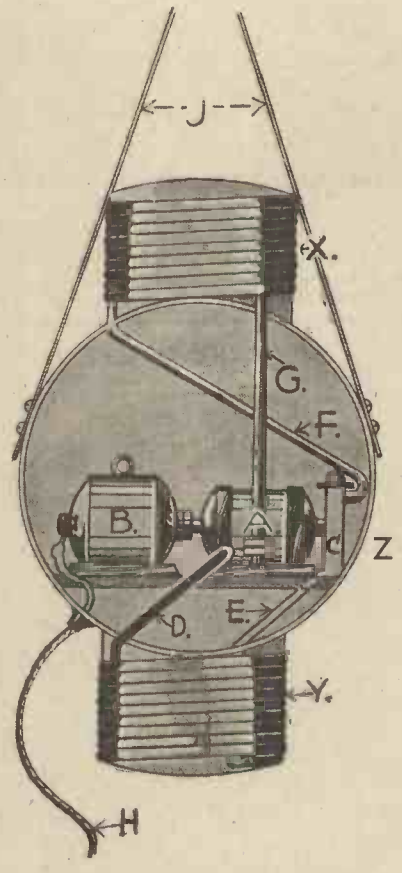


Fig. 5.—Diagram of a thermal engined power unit. The cloudless, windless stratosphere as a source of cheap power.

A. Turbine driven by vapour generated in "X."
B. Dynamo driven by Turbine A.
C. Pump driving condensed vapour back to "X."
D. Pipe conveying used vapour to "Y" for condensation.
E. Pipe from "Y" to the pump "C."
F. Pipe from pump "C" to "X."
G. Pipe from thermal boiler "X" to turbine "A."
H. Cable conveying current generated to land.
J. Stays for attaching unit to balloon.
X. Thermal boiler of coiled piping in absorbent metal casing.
Y. Thermal condenser of coiled piping in reflecting metal casing.
Z. Metal gondola housing unit and based on Prof. Piccard's sphere.

HOME BROADCASTING (*Continued from page* 15.)

which it is used, and the two leads from the terminals on the microphone should be joined to the pick-up terminals above referred to. To avoid hum and other parasitic noises, the metal screening should be joined to the earth terminal on the receiver. There is sufficient length of lead to permit of the microphone being installed in one room and the receiver and loudspeaker in another. The sensitivity, too, is of such a high order that it is possible to conceal the microphone behind some object in a room of average size, and hear a quite low-voiced conversation in headphones connected after two ordinary battery-operated L.F. stages. If, of course, high-powered mains-operated amplifiers are employed it is possible to hear a whisper at a distance of about 20 feet reproduced from a loudspeaker at substantial volume. To use this special microphone a small battery has to be included in two clips on the base and this must be replaced as it becomes discharged. Some very interesting novelties may be carried out with the device when the receiver is situated in one room and a loudspeaker is situated in some other part of the house. The microphone may be wired to the pick-up terminals and another speaker connected to the receiver in the same room. When a musical item is ended the change-over switch may be operated, and by speaking into the microphone some ridiculous remark may be made, or an imaginary appeal made giving rise to much amazement on the part of the distant listeners. There is, of course, a correct method of using these microphones, and there is no need to hold it a few inches from the mouth and shout into it. Everyone has a different type of voice, and a few experiments should be carried out when first fitting it in order to find the most suitable position for normal speech. It will be found generally that blasting is avoided by standing the microphone at a slight angle, and not arranging it directly in front of the head. Speak in a normal voice, slowly and distinctly. Do not attempt to hurry the speech, and, if your voice is at all on the high side, improved results will be obtained by slightly lowering the tone.

For the reproduction of musical items certain points must be carefully borne in mind. For instance, the ukelele will sound much "brighter" if the microphone is stood close up to the wooden body on a line with the bridge. On the other hand, the piano and the banjo both sound "cleaner" when the microphone is some distance away and the volume control is turned full on. It will not take long to find the proper positions for various particular instruments, and you may obtain many additional hours of enjoyment from the normal broadcast receiver by investing in one of these.

A SIMPLE PHOTO-ELECTRIC CELL

MADE AT HOME AT NEGLIGIBLE COST

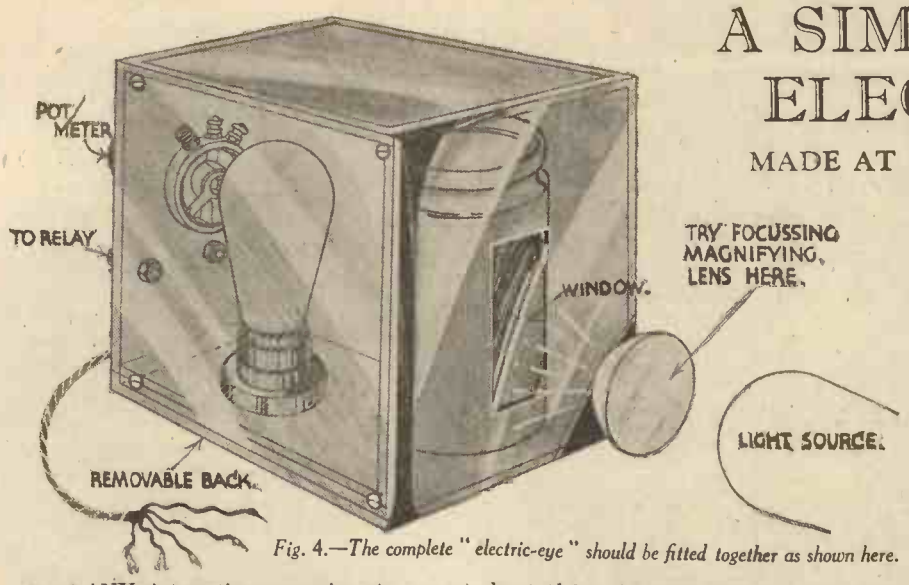


Fig. 4.—The complete "electric-eye" should be fitted together as shown here.

MANY interesting experiments may be conducted with the easy-to-make chemical "photo-cell" to be described. Although sixpence covers the cost of making, the cell is quite efficient and passes a current of several microamps. when light from an 80-watt lamp is directed on one of the plates or "electrodes."

Two thin copper plates, each measuring about 4½ by 1½ inches, form the electrodes; to these are soldered short flexible leads. Ebonite strips, about ½ by 1½ inches, space the plates at top and bottom; rubber bands support the assembly. This is placed in a clear glass jar or tumbler, and a solution, made with copper sulphate, 33 grains, distilled water, 3 ounces, added to the level of the top ebonite spacer. The cell is now complete, but before use should be placed in a dark cupboard for at least two days.

It is suggested that a wooden box be made to house the completed cell; this should be light-tight save for a front slot measuring 1 inch by 3 inches to expose one plate. Constructional details will be found in Figs. 1 and 2.

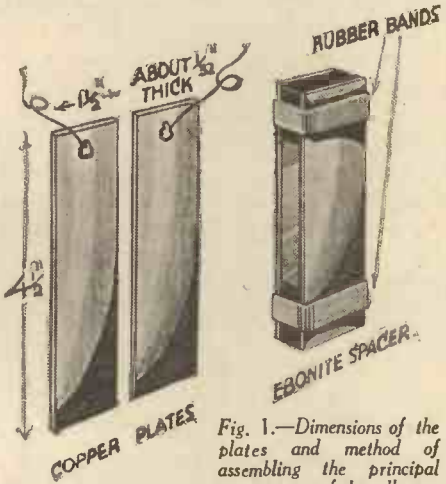


Fig. 1.—Dimensions of the plates and method of assembling the principal parts of the cell.

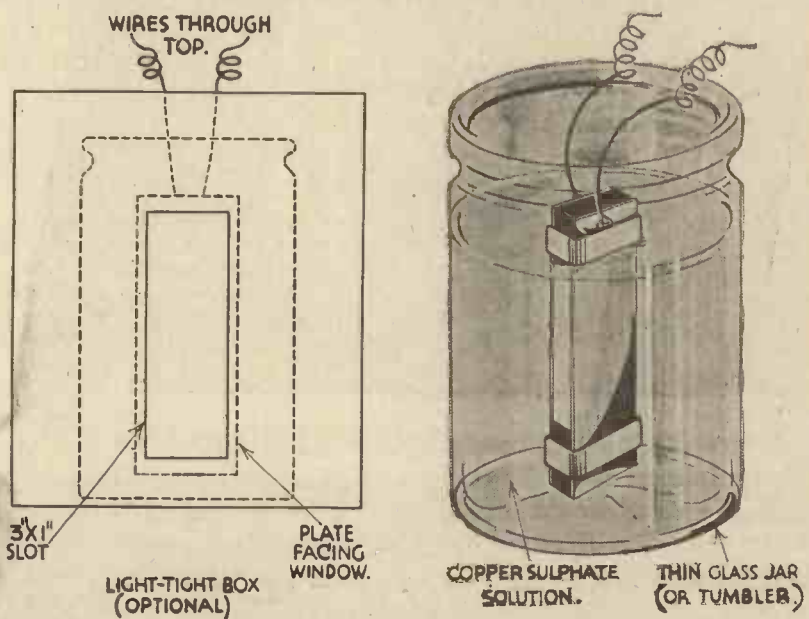


Fig. 2.—The completed cell is mounted in a light-tight box in the manner shown in these diagrams.

Practical Applications

If the photo-cell is connected in series with a neon lamp and battery, light from a 40- or 60-watt lamp falling on the exposed plate causes electrons to flow to the opposite plate, the cell becomes conductive and the neon lamp lights. Placing the hand or a cardboard screen between the lamp and the cell instantly extinguishes the light in the neon lamp (Fig. 3). To increase the minute photo-electric currents for the operation of a relay or similar device, valve amplification is essential. A suitable "electric-eye" circuit is given in Fig. 4. As there are but three components in the amplifier it could be accommodated in the same box as the photo-cell (as in Fig. 5). A small power valve, a 2-volt cell and 100-volt B battery complete the installation.

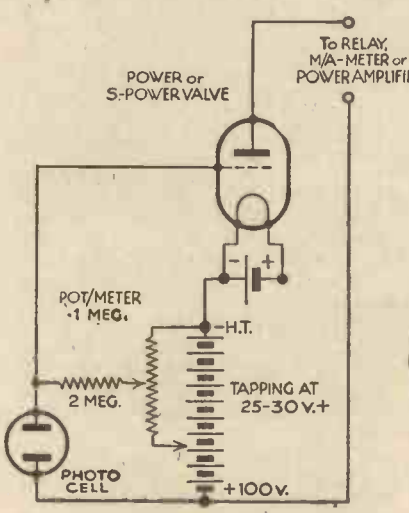


Fig. 5.—A circuit arrangement to increase the power of the cell and enable various apparatus to be operated.

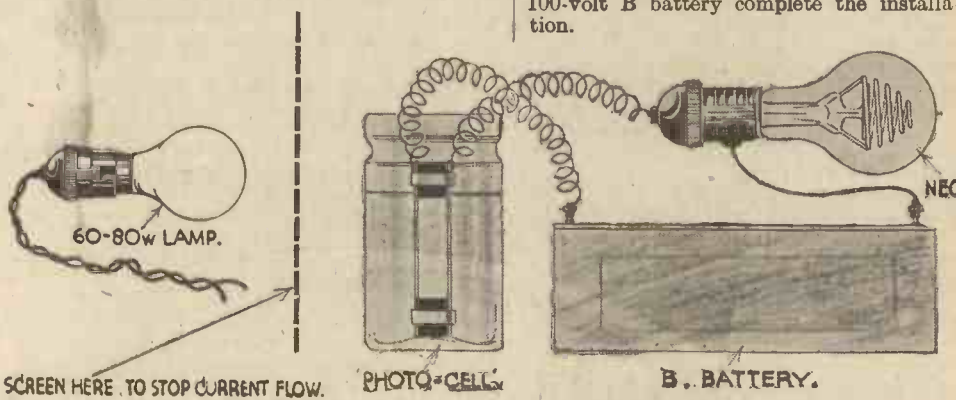


Fig. 3.—The complete circuit of the photo-electric cell for light experiments.

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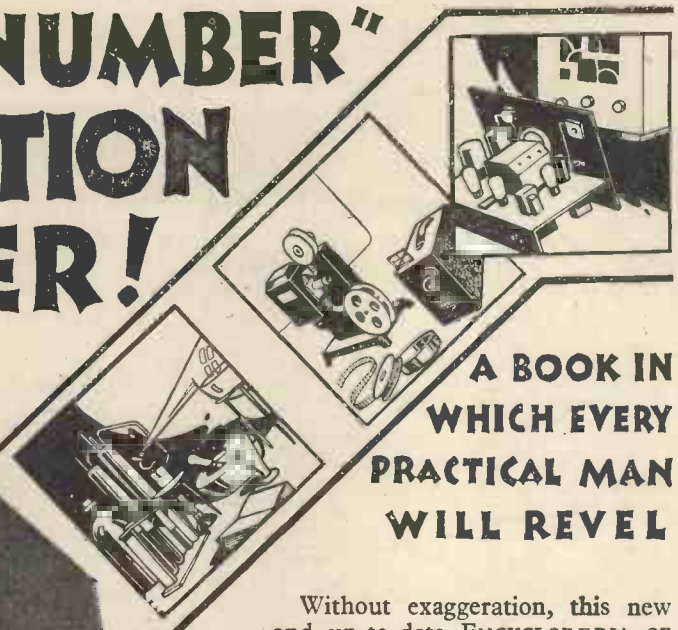

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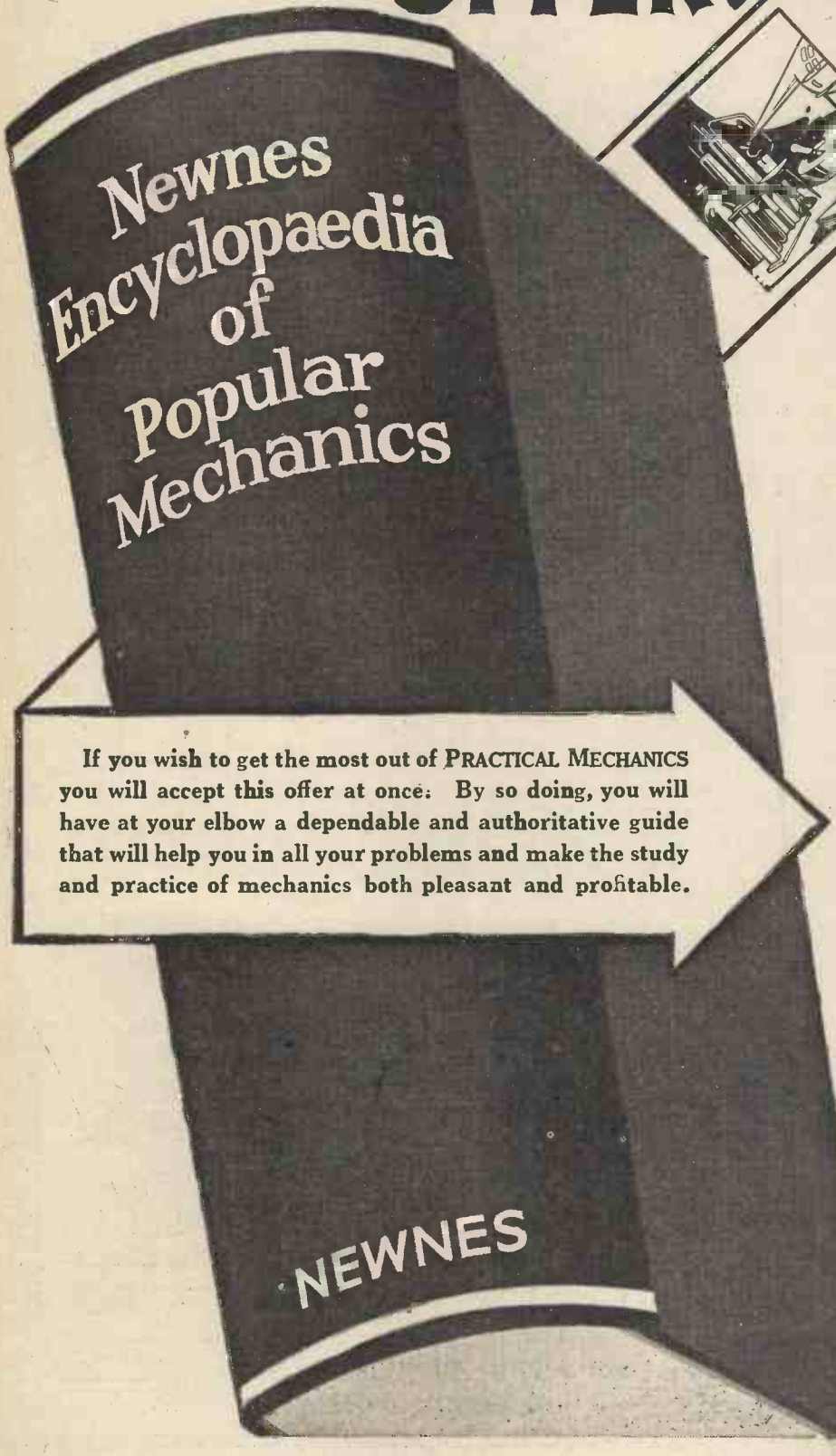

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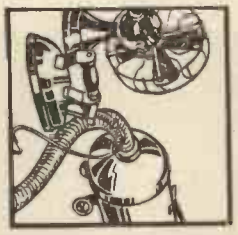

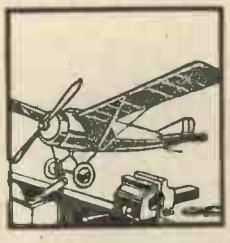


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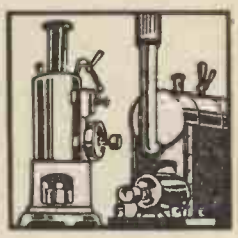

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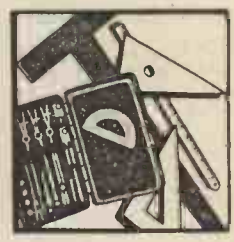

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MODEL RAILWAYS

A ½-INCH SCALE MODEL G.W.R. "CASTLE" CLASS LOCOMOTIVE

By E. W. TWINING

THE engines of the 4–6–0 type "Castle" class of the G.W.R. have become famous for the record speeds of which they have shown themselves capable in hauling the train which is known as the "Cheltenham Flyer," the fastest train in the world. As most model railway enthusiasts know, the class is not a new one but was inaugurated with the appearance of the "Cærphilly Castle" at the Wembley Exhibition of 1924. The "King" class, of which "King George V." was the first, is a much more recent design and has a greater tractive effort, but in some respects is not so suitable, and is rather more difficult for modelling purposes. For one thing the coupled wheels are smaller than those of the "Castle" class, and the bogie of more complicated form to reproduce. For these reasons the engine which the writer has chosen for making a ½-inch to the foot scale model is the particular engine appointed for hauling the Cheltenham train; namely, No. 5000, the "Launceston Castle." The accompanying drawings show, it is thought, every view possible necessary to give the details of construction.

Differences from Prototype

As, of course, is well-known, the "Castle" and "King" classes of engines have four cylinders; two outside, driving the centre-coupled axle, and two inside, connected to the leading coupled axle. In the present model, however, it was decided, in order to reduce complication, frictional losses, etc., to provide only two working cylinders, and these, although they are the inside ones, will have their connecting rods working cranks upon the centre axle. The outside cylinders, therefore, are dummies; that is to say, they will consist of the outer casing only, equivalent to the lagging around the real cylinders and valve chest. In the ordinary way inside cylinders would be operated by valves driven by two or more eccentrics according to the type of valve gear adopted. Inside, Walschaert's gear needs one eccentric for each slide valve, whilst Stevenson's required two, *i.e.*, four in all. To avoid the labour and complication of getting these eccentrics on a cranked axle a different form of gear has been adopted in the model. This gear is of the radial type and is not by any means new. It has been used in full-size practice on a number of railways, including the Great Western. Like the Walschaert's and several other radial gears, it has the merit of giving constant lead to the valve in all positions of the reverse lever.

The Drawings

Before proceeding with constructional details it would be well to refer to the drawings. Fig. 1 is an outside elevation showing the left-hand side, with a scale attached from which all measurements can be taken. Fig. 2 is a front, and Fig. 3 a back elevation. This latter shows all the cab fittings on the firebox back. The important drawing is that to be given later, which gives

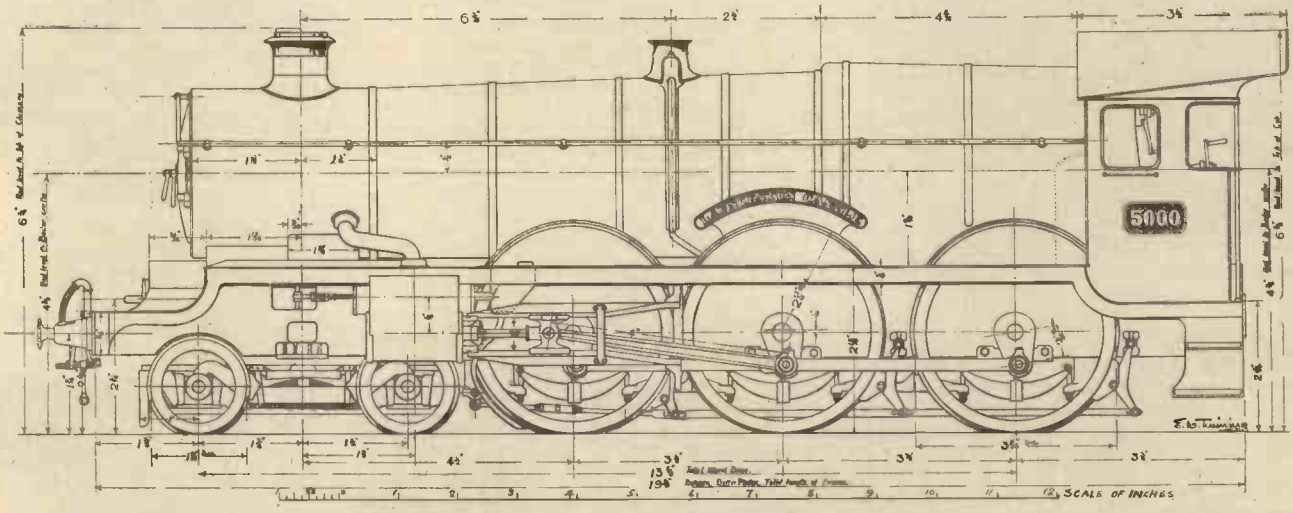
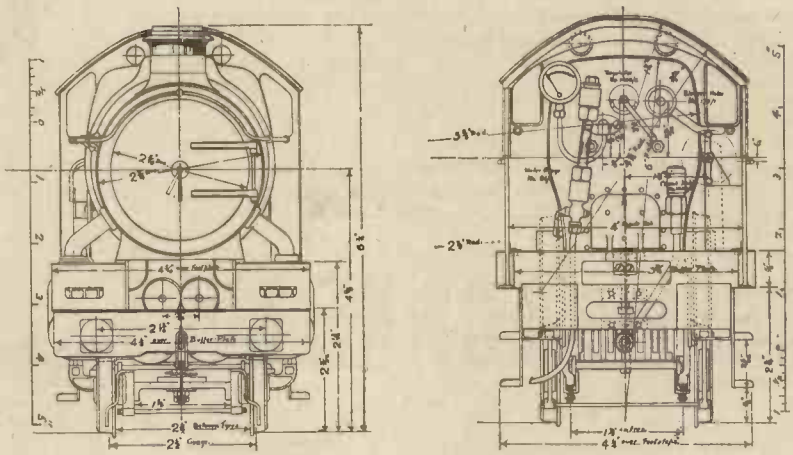


Fig. 1.—An outside elevation of the model, showing the left-hand side.



Figs. 2 and 3.—A front and back elevation.

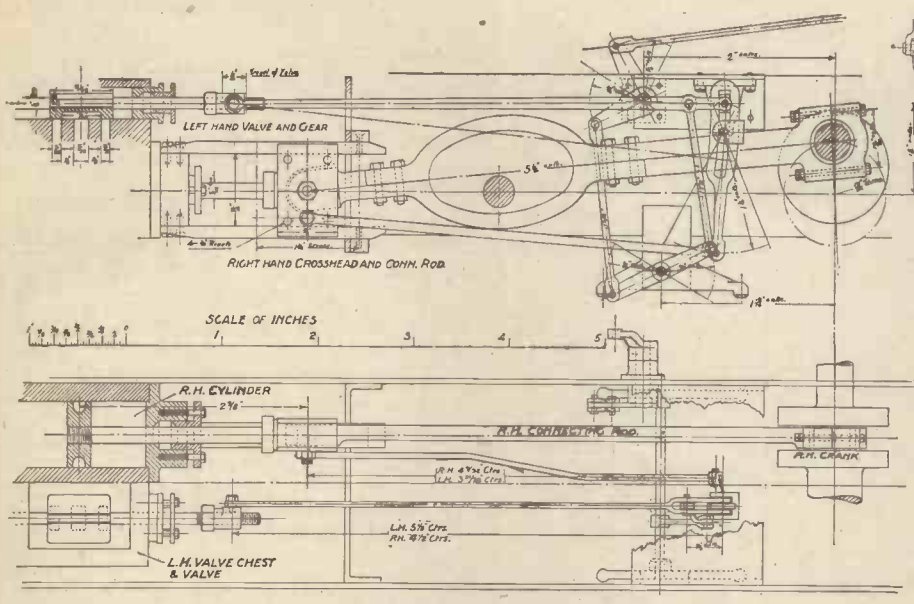


Fig. 4.—An enlarged detailed drawing of the motion and valve gear.

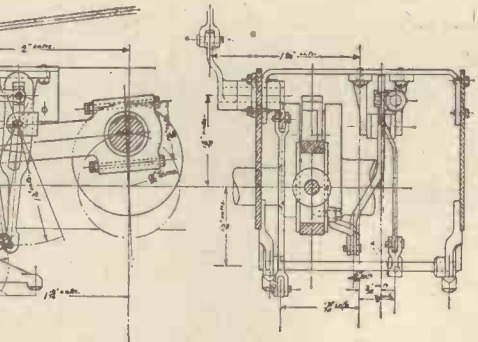
a longitudinal vertical section and sectional plan. The upper half in the plan shows a section taken on the line AA, see the section above, and the lower half is a section above the frames with the boiler and the valve-chest cover removed. In both of these plan views the firebox is cut through horizontally on different levels. The three views in Fig. 5 give, altogether, five cross-sections; the points at which these sections are taken being indicated by vertical lines appropriately lettered in the later drawings. Fig. 4 is an enlarged detailed drawing of the motion and valve gear, the principle of which will be referred to shortly. The side elevation of the tender, which corresponds in arrangement with Fig. 1, will be given next month, whilst a longitudinal section will show the hand pump, by means of which the boiler is fed with water. A general plan of the tender, and front and back elevations of the same will be given next month.

The Engine Chassis

Although this term "chassis" is not usually applied to locomotives it would appear to be a most appropriate one. This portion of the engine will naturally be the one to take in hand first. It will consist of frames, springing, wheels, cylinders and motion. The frames are cut from steel plate $\frac{1}{16}$-inch thick. They have a maximum depth of $1\frac{1}{4}\frac{1}{8}$ inches and an extreme length, between the buffer beams, of $19\frac{1}{8}$ inches. They are connected and braced together by the buffer beams at each end, the cylinders, the motion plate and a stay in front of the firebox. The wheels are of cast iron forced on to steel axles with the exception of the centre driving wheels. The axle for this may be either a steel forging or a pattern may be made and a casting obtained in malleable iron. If this crank axle is cast it *must* be malleable, ordinary cast iron would be of no use. The cylinders are of gun-metal, $\frac{3}{4}$-inch bore $\times$ $1\frac{1}{16}$-inches stroke. The cranks of the driving axle will, therefore, have a throw of $\frac{17}{32}$-inch. The cylinder centres are 1 inch apart. Above the cylinders are the valves, both in one steam chest. These valves have a travel of a $\frac{1}{4}$ inch and a length of $\frac{3}{4}\frac{1}{2}$ inch. The dimensions of the ports are given in Fig. 4. From this it will be seen that the valve, when in the central position, will have a lap at each end of $\frac{1}{32}$ inch.

The Valve Gear

The principle on which this gear operates is that it depends primarily upon the fact that the two cranks, which the cylinders drive, are placed at an angle of exactly 90 degrees one with the other. It follows, therefore, that when one piston is at the end of its stroke the other one is at the centre. As in theory all valves have to be driven from a point at right angles to the main crank, whether by return cranks and pins or by eccentrics or other means, such as that employed in Joy's valve gear, it follows that if the pistons are working as mentioned it should be possible, and is possible, provided the cylinders are sufficiently close together, to take the motion for the valve of one cylinder from the piston rod or crosshead of the other cylinder and let this motion operate an expansion link of the same type as that employed in Walschaert's gear. This is precisely what has been done in the present model, and Fig. 4 shows one cylinder, crosshead and connecting rod joined up by a link to the valve gear of the other cylinder. It will be seen from Fig. 4 that the two links from the crossheads are not made to cross each other, as might be expected. Instead of this the long arm projecting downwards from the expansion links do cross, and these are shown in the top right-hand cross section in Fig. 5. In a full-size engine there would be a further lever and link joining up, say, the right-hand crosshead to its own valve spindle above. This connection is required to give lead to the valve, but as it has not been thought necessary to include this in the present model the links of this connection are not shown. The connecting rods are cast in gun-metal. They are in two parts with a large elliptical opening near the little ends. This is to embrace and clear the leading coupled axle. Crossheads are also of gun-metal pinned to the piston rods and with steel plate cheeks on each side to take the gudgeon pin. All links and rods of the valve gear will be in steel.



The Boiler

The boiler is constructed chiefly of copper. If the smokebox tube plate, the firebox tube plate and throat plate are thought to be too difficult to flange from copper sheet, they may be of sound gun-metal castings, as will also the back plate of the firebox, which may, in any case, be made of gunmetal. Two methods are available of constructing the boiler. One is to tin all the lapped joints and thoroughly rivet, afterwards sweating with solder, and the other to polish the copper with emery cloth, rivet up, using a smaller number of rivets than by the first method, and afterwards silver solder every seam. The boiler should be tested on completion with a water pump to about 200 lbs. to the square inch; any leakages discovered being marked with a copying pencil, and, after emptying the water, re-soldered.

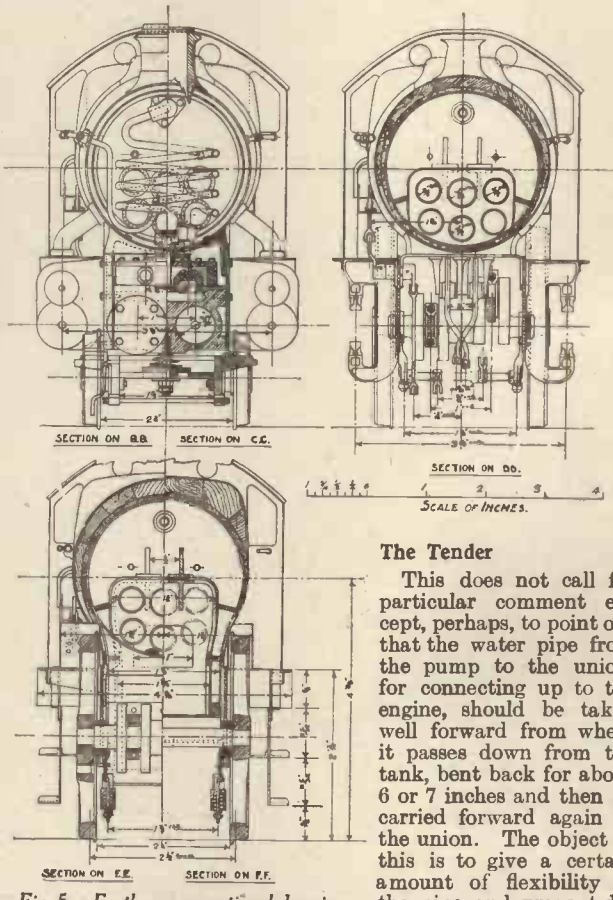


Fig. 5.—Further cross sectional drawings of the model.

The Tender

This does not call for particular comment except, perhaps, to point out that the water pipe from the pump to the union, for connecting up to the engine, should be taken well forward from where it passes down from the tank, bent back for about 6 or 7 inches and then be carried forward again to the union. The object of this is to give a certain amount of flexibility to the pipe and prevent derailment of the tender on

(*Continued on page* 46.)

An All-purpose Tool

Lathe Work for AMATEURS

1. THE LATHE AND ITS PARTS EXPLAINED

By F. J. CAMM

THE lathe is the most fascinating tool which the practical mechanic can possess. Until a few years ago they were so expensive that few could afford to possess one, but there are now so many excellent lathes on the market ranging in price from one guinea up to four or five pounds that every man with a practical hobby should certainly obtain one. A lathe is not an absolute necessity for good work, for it is always possible to improvise, but its possession opens up a greater and more interesting field for those who work in either wood or metal, and many operations can be performed which are impossible of execution by any other means. In most hand processes such as filing, chiselling, planing, etc., the action is that of a tool moving against a stationary piece of work. With the lathe, however, both the tool and the work move, and it is in the combination of these two movements that it is possible to turn work truly cylindrical and also to cut (as in facing operations) a flat surface.

The Scope of the Lathe

The lathe also combines the purposes of several tools; for example, by simple setting up, it is possible to cut gears, slots, to turn ovals, to plane, and shape, as well as to do drilling and to turn special forms by means of specially shaped tools. As an instance, if it is required to turn a knob, a tool is filed up to the profile required when a straight-in cut will form the knob. There is scarcely a mechanical operation which cannot be done in the lathe.

The appearance of work done in the lathe surpasses that done by improvised methods, and turning also eliminates a considerable amount of building up, such as is necessary when a lathe is not available. Pieces can be cut from the solid which in the ordinary way would consist of several pieces.

Whether you are interested in model making, pure metal turning, overhauling your car or motor cycle, or in general mechanics, a lathe saves a vast amount of time, and usually gives a superior result.

The Various Parts

It is the object of this series to explain the principles of the lathe and its tools, and how to perform the various operations. There are certain standard methods of doing work, but some jobs call for special set ups, and it is my object to explain in full every operation and every type of job which comes within the scope of metal turning.

This article starts at the beginning of things and describes the various parts of the lathe. Although each make of lathe differs in form, they all work on the same principle, and all contain the same elements or parts. A simple lathe merely consists of a head stock, a tail stock, a bed, a handrest, and a treadle. Cutting tools with handles, similar in appearance to ordinary woodworking tools are used, and naturally the scope of such a lathe is limited. Some lathes are known as "dead-centre" lathes. In these there is no rotating centre; both of them are stationary, and the work is revolved by means of a bow as in the old watchmaker's "turns." Such lathes are nowadays almost obsolete. Modern lathes are of the form of which the illustration on this page is a typical example. It will be seen that it has a head stock, a tail stock, a bed formed of two members known as shears (some lathe beds are, however, of one piece), a cone pulley for transmitting the power from the treadle or the driving motor, a lead screw by means of which the tool is traversed along the bed, change wheels which enable the relative speeds of the tool along the bed and the work to be varied (as in screw-cutting), a swing frame which accommodates the change wheels, and a back gear which gives a very slow rotational movement to the work (which is chiefly used for hard materials or work of large diameter, or for tapping, reaming, etc).

The Self-act and Hand Feed

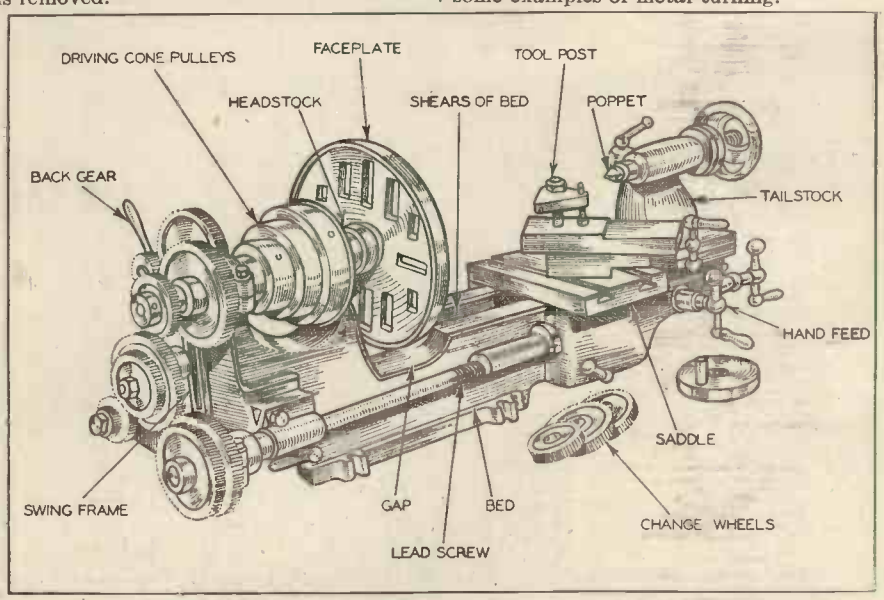
Some lathe beds have a gap near the nose of the lathe spindle so that discs of greater diameter than can normally be turned between centres can be operated on. A special nut is fitted to the slide rest so that the latter can be disconnected from the lead screw. Also when it is desired to feed the tool along the bed by hand one of the gears is removed.

The tail stock is adjustable along the bed to suit work of varying lengths. In certain operations such as in drilling, tapping and reaming, suitable holders may be attached to the tail stock and fed into the work by means of the tail stock spindle feed.

Lathe Terms

There are certain terms concerning the lathe which the beginner should memorise. These terms always appear in the specification of a lathe. The maximum *length* of work which can be turned between centres is always stated as "between centre capacity"; the maximum radius of work which can be turned between centres is termed the "centre height" (a 3-inch centre lathe will therefore turn work up to 6 inches in diameter), the tail stock centre is called the "back centre," and the radius of work which can be turned in the gap is called the "gap centre."

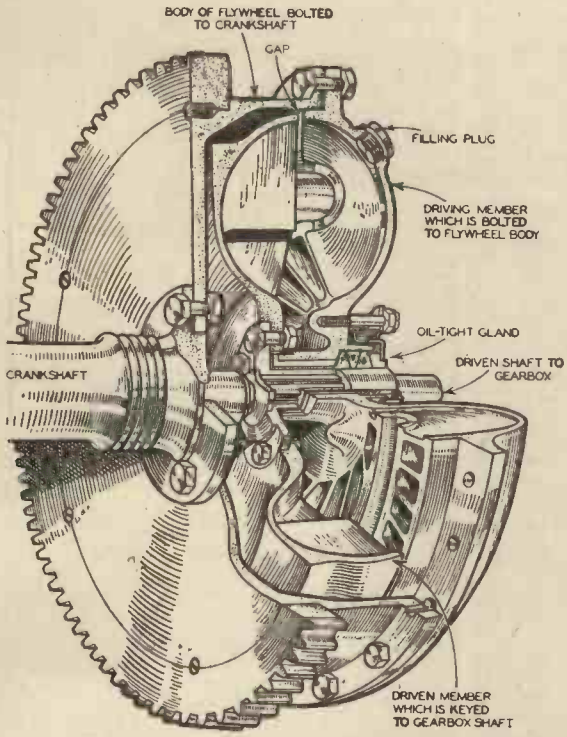
There are special lathes for special work, but these are chiefly of use for factory operation, and the amateur is not concerned with them. There are special lathes for boring, toolmaker's lathes, chasing lathes, and turret or capstan lathes. Naturally the amateur has to select an all-round lathe on which he can perform almost all lathe operations as well as a certain amount of grinding, milling, etc. He should choose a screw-cutting lathe with slide rest, back gear, of 3-inch centre height, and preferably with a back gear. Next month I shall deal with the practical uses of the lathe, and give some examples of metal turning.



This illustration shows a typical screw-cutting lathe suitable for amateurs.

HOW IT WORKS

I.—THE FLUID FLYWHEEL CLUTCH



Showing a pictorial section of the Daimler fluid flywheel. Note that the driving member is provided with specially shaped pockets. The driven member is provided with radial vanes which catch the jets of oil thrown from the run of the driving member and return it to the centre.

EVER since the introduction of the motor car by Daimler, Panhard, and Levasseur, the gearbox has been used as the essential torque converter in the transmission system of motor cars. It is by now generally known that its function is to permit a variation in ratio between engine revolutions and the rear driving wheels (the road wheels) to suit varying conditions, such as when starting from stationary, climbing a hill, reversing, etc. The introduction of the fluid flywheel, however, bids fair to revolutionise the gearbox—that device which, as its inventor said, " is brutal but it works." The fluid flywheel at once gets rid of the necessity for a clutch between the engine and a gearbox, but more important still it enables the load to be taken up and gear changing to be effected smoothly and silently even by those unskilled in the use of the gear lever.

With an ordinary gearbox a silent change is absolutely dependent upon the skill of the driver, and clean gear changing can only be gained after considerable experience. It is necessary to synchronise the speed of the spinning member in the gearbox with the part secured to the drive, and it is when the driver fails to obtain this synchronism that grating noises result.

The fluid flywheel in effect does this automatically. It is an automatic clutch, and it may be used in conjunction with an ordinary gearbox or with one of the new type of self-changing gearboxes designated by the term " pre-selector." The effects obtained with the latter arrangements are truly remarkable. For example, when the car is moving at, say twenty-five miles an hour, the driver may move the gear selector into the reverse position, when by depressing the pedal controlling the gear change the car will automatically stop and then reverse.

Its fundamental principle can best be explained by means of a simple experiment. If you partly fill a bowl with oil and then spin the bowl the oil takes on a concave surface (Fig. 1). If now the bow be divided up into a number of partitions somewhat like an orange cut in half each division being filled with oil, rotation of the bowl will cause the oil to be slung out until the bowl is empty. This brief explanation should be borne in mind when reading the following description (Fig 2).

Fig. 1.—On the left is a bowl of oil. On the right the same bowl being spun round. The liquid takes up the position shown. This is the germ of the fluid flywheel in its simplest form.

Fig. 2.—If the bowl is now rotating, oil will begin to fly upwards and outwards over the edge until the bowl is empty.

The Daimler Fluid Flywheel, a part section of which you see at the top of this page consists of only three parts, the engine flywheel, a driving member, and a driven member. The driving member forms the flywheel cover, and a series of cup-shape pockets are disposed inside it. The driven member is similar to the driving member, and is enclosed within the space formed by the flywheel and the driving member which it faces. It is rigidly attached to the gearbox shaft but is free to rotate within the flywheel casing on a bearing in the centre of the driving member. The interior of the flywheel is completely filled with oil.

When the car is stationary and the engine is running the rotation of the driving member causes the oil in the cells to be driven outwards towards the circumference of the flywheel so that it is expelled from the outer edge of the driving member into the corresponding cells of the driven member which is, of course, stationary. The oil in this latter member is inert, and it is therefore forced by the oil from the driving member through the cell towards the centre of the flywheel, where it returns again into the cells of the driving member. In fact, a true circulating motion is given to the oil.

It will be obvious that as the driving member is not stationary the oil passing from its cells into those of the stationary member will be slowed up, and some of its momentum will be given to the driven member which at once begins to revolve. When the driven member has attained its maximum speed for any given speed of the driving member the load on it always causes it to lag somewhat behind the driving member, and the centrifugal force in the driving cells is hence always greater than that in the driven member, so that oil circulation is maintained.

How the power is transferred from one member to another will be understood by remembering the enormous power of the water stream close to the nozzle of a fireman's hose.

In the fluid flywheel the driving member is in effect constantly discharging a series of such jets into the driven member, and the greater the speed of the flywheel the greater the power of the jet. At normal engine speed the oil needs very little retardation to produce the driving force, with the result that the lag which normally takes place between the driving and driven is negligible. At low engine speeds, however, the lag between the two members is considerable, thus producing the conditions where the engine can develop full torque with gears engaged but without moving the car. This condition occurs at approximately 600 revolutions per minute.

We are indebted to the Editor of " Modern Motor Repair " for permission to use the illustrations accompanying this article, and for information embodied in the text.

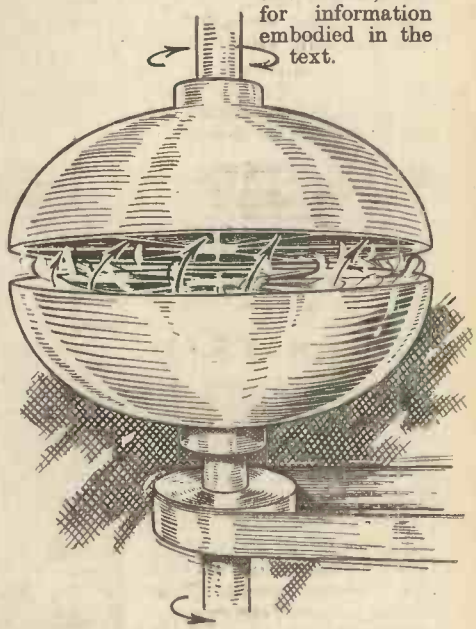


Fig. 3.—The oil from the lower bowl is caught by placing a similar bowl above it, as here shown.

HINTS ABOUT HOBBIES

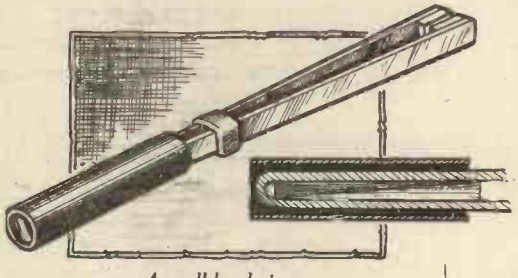
Enclose a stamped addressed envelope when return of submitted item is desired.

THAT HINT OF YOURS

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

A Small Hand Vice

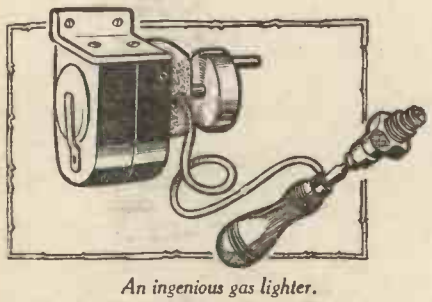
THE need is often felt for something to hold small objects whilst filing or soldering. The size of the hand vice illustrated may be altered to suit oneself, but those given will serve most small model makers. The jaws and spring should be made of steel, the choice of metal for the slider and handle is left to the maker. The jaws are made from steel strip of $\frac{1}{2} \times \frac{1}{4}$-inch section, two pieces $\frac{1}{2}$ inch long being cut off and filed to shape and fixed to the spring by hard soldering. The spring is a 15-inch length of $\frac{1}{4} \times \frac{1}{8}$-inch steel bent in the middle. The handle and slider are made from tubing of $\frac{5}{8}$ inch bore, the slider being made square by hammering on a square bar. The spring is bent sufficiently to grip work tightly when slider is moved towards the jaws.



A small hand vice.

An Ingenious Gas Lighter

AN old motor-cycle magneto can be turned to such good account that it will save the household several pounds in a year or so; as a perpetual gas stove lighter it has proved a great success.



An ingenious gas lighter.

Obtain a medium-size file handle, and in the tang hole fix the terminal of a sparking plug; the end of a rubber-covered wire will now be held securely when the plug is screwed in, the other end, of course, will be in the brush holder of the magneto. Attach a small bracket to the base of the magneto and screw this in an inverted position to the side of the stove. A small wheel with handle should replace usual sprocket. No return wire is required, the current being earthed back to the magneto *viâ* the side of plug and iron work of stove when it is held under the kettle, etc.

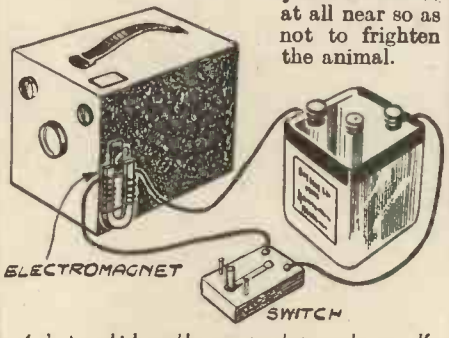
A Simple Method of Engraving on Metal

READERS have no doubt often been stumped to know how a name and address can be put on the metal tab on a dog collar or on any other article on which a tab is attached. Here is a simple method which will be found quite efficient. First of all melt a thin coat of candle wax on the tab and, after leaving it to set, space out the wording, and with a pin or penholder nib scratch the words on the wax, being careful to bare the metal; fill a shallow tin with nitric acid and leave the tab immersed for a few minutes; after doing same scrape off all wax and a perfect reproduction will be found on the metal tab.

Engraving on metal.

How to Take your Own Photograph

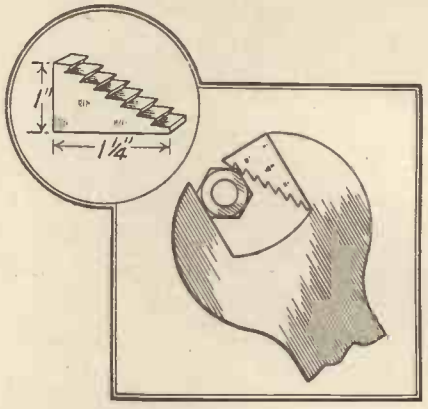
THE camera is placed upon a table in front of you. Affix an electro-magnet opposite the switch which operates the shutter of the camera. Connect up this with a battery and switch. The latter may be held behind you so that there is no visible movement of the body while "you are snapping yourself." Press the switch, thus closing the circuit, and the electro-magnet attracts the metal switch of the camera. Thus you are able to take photographs of yourself. This device may also be used when "snapping" very timid animals. The camera could be laid amidst some bushes and provided you have a long enough wire you need not be at all near so as not to frighten the animal.



A device which enables you to photograph yourself.

An Adjustable Spanner

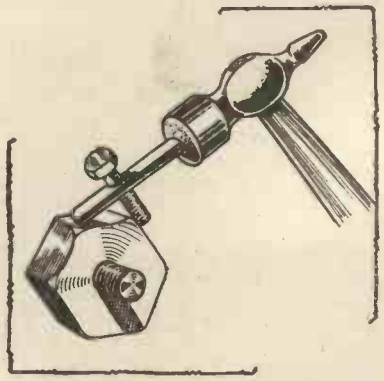
TO make the device shown you will require a piece of tool or key steel $1\frac{1}{2} \times \frac{1}{2}$ inch. Saw or file the steel to taper, and then cut the teeth with a smooth file. This device will also be found useful as a pipe wrench.



A simple device for making a spanner adjustable.

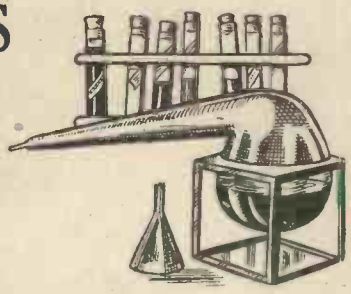
A Gadget for Loosening Awkward Nuts

MOST of us, some time or other, have seen a chisel used for loosening or tightening nuts which are awkwardly placed. To get over this difficulty the small tool illustrated in the sketch was designed. It is a piece of $\frac{1}{2}$-inch steel, the end of which is rounded and notched with a file. A hole is drilled about $\frac{1}{2}$-inch from the end and tapped to take a small setscrew. The end is then case-hardened. In use the notched end grips the face of the nut with which we are dealing and the set screw acts as a stop, preventing the tool from slipping. Unlike the chisel, this does not dig into the nut, and the defacement is only slight.



A gadget for loosening awkward nuts.

FASCINATING EXPERIMENTS IN CHEMISTRY



SIMPLE AND SAFE, AND CONDUCTED WITHOUT EXPENSIVE APPARATUS

By H. WELTON

CHEMICAL experiments appear to have a fascination peculiarly their own—the manner of the reactions involved, their variety and unexpectedness almost spells magic, while the utter lack of finality to any experiment provokes hours of speculation The organic chemist may spend all the years of his life in building up new compounds, splitting them, adding to them, and then realise that he has only partly explored a very tiny avenue in one small branch of the science, so vast is its extent. The story of the production of a modern synthetic sounds almost like Hans Andersen—an evil-smelling black mass of coal tar after treatment yields us a white powder 500 times sweeter than cane sugar—saccharin. The final product need not have been saccharin; by the different processes we can produce from the same black parent beautiful dyes, perfumes, high explosives. medicinal substances and a multitude of others in everyday use. Such efforts are beyond the scope of the home experimenter unless his laboratory is very highly equipped, but he can be equally as spectacular, if not quite so far reaching, in experiments with a few common chemicals on the kitchen table.

EXPERIMENTS WITH POTASSIUM PERMANGANATE

This common household disinfectant and antiseptic seems a somewhat uninteresting starting point for an evening's experiments until we realise its powerful oxidising properties. Lay a piece of paper on a metal tray or saucer, and upon it make a small mound of permanganate crystals. Now allow a few drops of glycerine to fall on this mound, and stand clear. Watch the mass burst into flame with explosive violence and ignite the paper. This is a striking experiment.

Chlorine gas, formerly used in warfare until the advent of the more devastating refinements of this branch of military antagonism, is quite easily made, but its nature demands that experiments with it must be made either out of doors or near an open window. A little strong hydrochloric acid is added to twice its bulk of water and

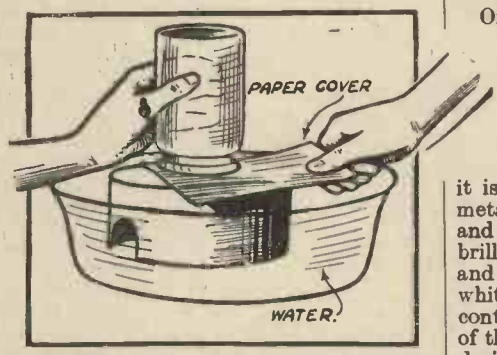


Fig. 1.—Next month we shall explain how to conduct many interesting experiments with oxygen. This illustration shows how a jam jar will be filled with oxygen.

allowed to fall by means of a pipette or a fountain-pen filler drop by drop on to a small amount of our permanganate in a glass jar. The reaction is instantaneous. A greenish-yellow gas is evolved which, providing sufficient permanganate is present, quickly fills the jar and overflows its sides. When this occurs, close the jar by laying a saucer over its mouth and put it aside until you have filled a few more jars in a similar manner. Here is interesting material for experiment.

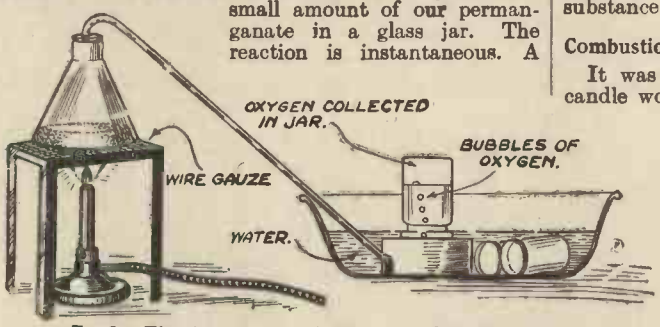


Fig. 2.—This shows the general arrangement for making oxygen.

A strip of paper soaked in turpentine and plunged into chlorine will take fire immediately.

Inflammability of Copper

One usually thinks of metals as fireproof substances. This is not always the case, however, for copper takes fire spontaneously in an atmosphere of chlorine, as you can prove. Thin copper foil or Dutch metal should be used in this experiment.

While experimenting with chlorine it is worth while obtaining a small piece of metallic sodium (Caution—stored under oil), and dropping this into a jar of gas. A brilliant reaction ensues, the sodium burning and flashing with formation of a dense white cloud, which settles on the sides of the container. If you care to scrape off a little of this white substance and taste it you will decide that it is salty. It is actually common salt. This experiment admirably illustrates that unexpectedness and extraordinary nature of chemical change . . . an unstable metal and a choking green gas combine to form a harmless household substance.

Combustion in Chlorine

It was formerly thought that where a candle would burn there also a man could breathe and live. While the converse of this may be true, there are certain conditions in which the old theory fails. An atmosphere of chlorine will destroy living organisms but will yet allow a taper to burn in it. Hold a lighted taper in the gas. It remains alight, but burns with a very dull yellow flame and gives off a prodigious amount of smoke. The explanation of this is simple. Hydrocarbon gas is burning from the wick of the taper where the wax is vaporised. The chlorine combines with some of the hydrogen in this gas to form hydrochloric acid and therefore much of the carbon present remains unconsumed and is passed off as a cloud of soot.

The Bleaching Power of Chlorine

Ordinary writing ink is readily bleached by this gas. Try this by writing a few words in ink on a sheet of paper. Damp

(*Continued on page 48.*)

Fig. 3.—Here is another interesting experiment. Iron wire is made to spark by immersion in a jar of oxygen.

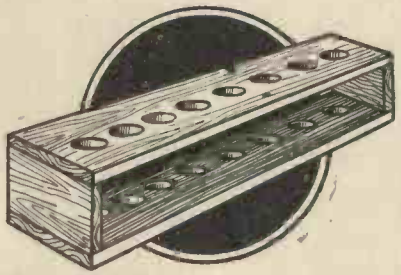


Fig. 4.—We shall from time to time describe how to make various pieces of chemistry apparatus. This shows a simple test tube holder.

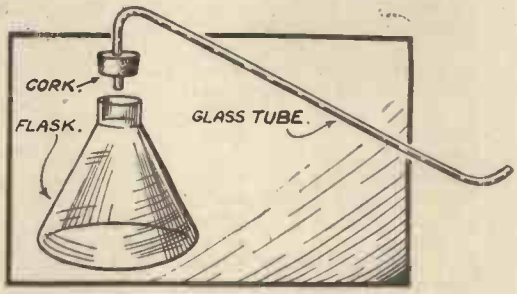


Fig. 5.—This shows how the beaker and glass tube is arranged for the oxygen-generating apparatus illustrated in Fig. 2.

SOME INTERESTING ELECTRICAL EXPERIMENTS

Scientific hook-ups that can be Performed with a Few Easily Made Pieces of Apparatus and Electricity

By W. B. RICHARDSON

THERE is no doubt that the most interesting electrical manifestations are those produced by electricity in *motion*, that is, by electric *currents*.

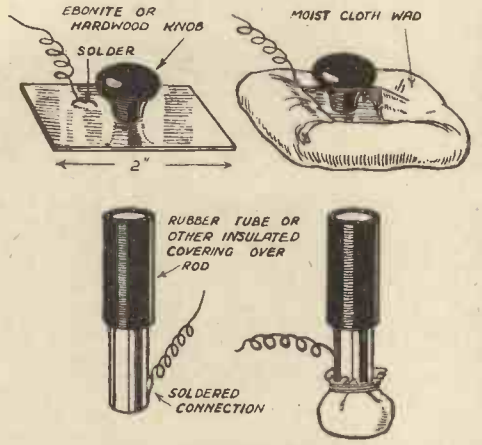


Fig. 2.—Details of the electrodes used in the muscles control experiment.

Probably the first experiments with current electricity were those made by the Italian professor, Galvani, about 1786. He noticed that some frogs' legs, which had been hung upon *iron railings* by *copper wires*, twitched convulsively every time the wind blew them against the railings. He concluded that an electrical force resided in the muscles and nerves of the frogs.

In this, of course, he was wrong, as was proved later by another Italian professor named Volta. Volta investigated the matter more thoroughly, and showed, by means of a delicate condensing electroscope, that a flow of electricity could be produced by the mere contact of two dissimilar metals, and that the frogs' legs merely served the purpose of an electroscope or galvanoscope to render the presence of the electricity visible. Actually what was happening was that the electric current produced by the contact of the metals stimulated the nerves in the frogs' legs.

Without going to the trouble of procuring legs of freshly killed frogs, we can carry out one or two experiments of a similar nature ourselves. By means of very simple apparatus we can stimulate the nerves of our own living bodies.

Stimulating the Optic Nerve

For the first experiment all that is needed is a 1½-volt cell from a flash-lamp battery or wireless grid-bias battery. A wire is connected to one terminal of the cell and the other end of the wire placed in the mouth. Another wire is joined to the other terminal of the battery and the free end of this is scraped clean and made into a small loop. This is placed lightly in the corner of the eye as in Fig. 1. Immediately the wire touches the moist eyeball a flash of light is seen. The flash may be repeated as many times as the circuit is made. That is to say, a flash will occur each time the wire is touched on the eyeball. What happens is that the current stimulates the optic nerve and produces the illusion of a flash of light. Incidentally there is no risk in this experiment so long as care is taken not to use a sharp wire or a battery of too high a voltage. Regarding the latter, from 1½ up to 4½ volts may be used with safety.

Fig. 1.—Stimulating the optic nerve by means of an electric current.

Muscle Control

If a small medical coil is available, quite curious effects can be obtained by removing the ordinary handles and connecting in their place two electrodes, the one consisting of a small metal plate covered with a wad of moist cloth and the other a metal rod similarly covered (see Fig. 2). The plate is placed under the wrist as in Fig. 3, the coil switched on, and the other electrode, that is the rod, is touched on the forearm near the elbow. The current will flow from one electrode to the other through the arm. This will affect the nerves controlling certain muscles in the forearm and wrist and will cause the arm to twist or the wrist to bend. Naturally, the particular muscle or muscles which are stimulated depends on the positions of the two electrodes. By moving them about some interesting effects can be obtained. For instance, by placing the plate in the palm of the hand and touching the rod on different parts of the wrist, forearm, or back of the hand, it is possible to make any finger move independently of the others, to make the wrist bend up and down, and so on.

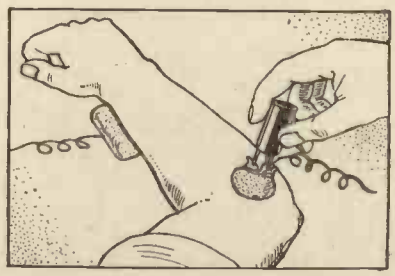


Fig. 3.—Controlling muscles of the arm by electricity.

A certain sensation of an electric shock is, of course, experienced while the current is switched on, but the current need not be so strong as to give an unpleasant shock. The speed of the trembler of the coil, and therefore the voltage of the current, may be reduced by weighting the end of the trembler with a small piece of lead. A coil with a movable core is an advantage, as the voltage can be controlled by the position of the core.

Experiments with Induction

It is well known that an electric current flowing along a wire or other conductor creates a magnetic field round it. It is also well known that if another wire is made to move about in this field that electric currents will be produced in it while it is moving. Alternatively, if the second wire is placed near the first one and the current through the first wire is switched on and off, then a momentary current will be generated in the second wire coinciding with the make and break of the current through the first one. In this case the second wire is stationary, but the magnetic field moves. It expands and collapses with the commencement and cessation of the current through the first wire. These two cases provide elementary examples of *electro-magnetic induction*. Induction takes place whenever a magnetic field and a conductor move relative to one another. It does not matter which moves. The wire may move across the field as in the first instance, or the field may move past the wire as in the second instance.

There is a very simple experiment to prove the presence of a magnetic field surrounding a wire. The wire is arranged vertically and passes through a piece of card, as in Fig. 4. A strong electric current is passed through the wire by connecting it with an accumulator and a low resistance, such as a coil of wire or a fairly high-wattage lamp. Iron filings are sprinkled on the paper, when they will be seen to arrange themselves in the formation shown, thus denoting the existence of magnetic lines of force encircling the wire.

A Wireless Telephone

A very intriguing experiment on induction may be carried out with two coils of insulated wire, a microphone button, a battery, and a pair of headphones. With this apparatus it is possible to rig up a kind of wireless telephone from one room to another in the house. The coils are wound on wooden formers after the manner of a wireless frame aerial. Double cotton-covered wire of about 28 gauge is suitable. A convenient size for the frames is 18 inches or 2 feet square. One frame is wound with about thirty turns and the other with 100 or more. The thirty-turn frame is used as the transmitter and is connected in series with a microphone button and a dry battery or small accumulator. The other frame is connected to the headphones (see Fig. 5).

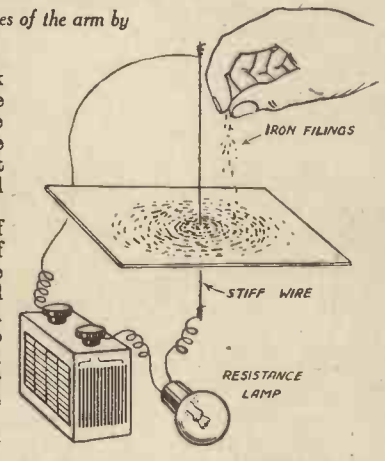


Fig. 4.—Experiment illustrating presence of a magnetic field round a conductor.

One frame is placed against the wall in one room and the other is placed opposite to it in the next room (or even in the next house in the case of attached houses). On speaking into the microphone the speech can be heard in the 'phones on the other side of the wall. The explanation is that the current which is passing through the transmitting frame is made to fluctuate by the microphone in accordance with the speech. In this way the magnetic field surrounding the frame also fluctuates, and this in turn

produces currents in the receiving frame. These currents are converted into sound by the telephones.

If desired, the receiving frame may be connected to the gramophone pick-up terminals of a radio set instead of to a pair of 'phones. The speech will then be amplified by the set. In such a case the frames may be separated by several feet if necessary, and reception will still be possible.

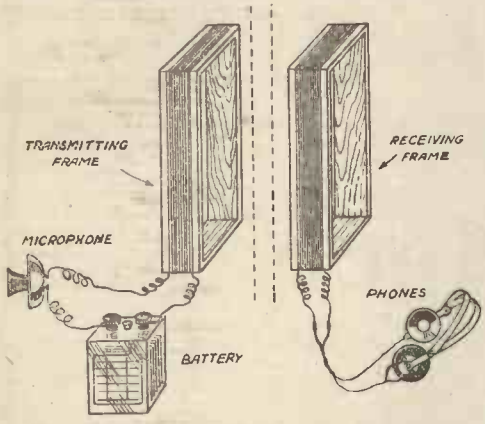


Fig. 5.—How the "wireless" telephone is arranged.

Decomposition of Water by Electricity

We are all familiar with the common applications of electricity in heating, lighting, and the production of mechanical power, etc., but its use as the agent of *chemical* changes is not perhaps quite so well known. However, it is capable of producing some remarkable results. The electrolysis of water, for instance, is a case in point. This can be carried out with the simplest of apparatus and is well worth doing. The process is the antithesis of that in operation in an electric cell or battery. Whereas the battery produces an electric current from chemical changes, in this case chemical decomposition is produced by an electric current. The apparatus is arranged as in Fig. 6. Two carbon rods (from old dry batteries) are connected to an accumulator and immersed in a bowl of water, to which has been added a little sulphuric acid (in order to make the water a conductor). Two glass test-tubes are filled with the solution by holding them under the surface and then inverting them as shown. One is held over each of the electrodes. When the current is switched on, bubbles of gas will rise from each of the electrodes. These are collected separately in the two tubes.

After a while it will be noticed that one tube is becoming filled with gas twice as fast as the other. The gas in this tube is *hydrogen*, while that in the other is *oxygen*. These are the two constituents of water. The proportions are two volumes of hydrogen to one of oxygen, hence the one tube filling twice as fast as the other. The presence of hydrogen may be detected by removing the tube when it is full. (A cork inserted in the tube while it is under water will prevent the gas escaping.) If the cork is removed and a lighted match is applied to the mouth of the tube the gas will burn with a blue flame. Oxygen can be detected by plunging a glowing splint of wood in the other tube. The splint will immediately glow with greater intensity and finally burst into flame. If a thin piece of iron wire is heated to red heat at one end and quickly lowered into the tube of oxygen it will actually *burn!* It will become white hot and consume away, giving out brilliant scintillations like a firework.

If, instead of two tubes, one large one is used and the bubbles from both electrodes collected in it by placing the carbon rods near together and directly under it, a highly explosive mixture is produced. The tube will now contain both hydrogen and oxygen in the correct proportions to form water. If a lighted match is applied to the tube a terrific explosion will result. No smoke will be produced, but simply water in the form of steam. As the explosion is accompanied by such force, a glass tube should not be used. A brass one held in the hand by means of a wad of rags while igniting the mixture is safest.

That a current heats the wire through which it is flowing can be shown by stretching 4 or 5 feet of house fuse wire between two nails driven into a wall at the same height. At the centre of the wire place a small bent wire hook and on it a piece of paper to show more clearly the effect produced. Connect the ends of the fuse wire by copper wires to a 4-volt accumulator and on completing the circuit the paper will be seen to drop an inch or so, returning to its original position when the current is discontinued. By applying a higher voltage it will be noted that the sag of the wire is more pronounced due to the heavier current being passed through it.

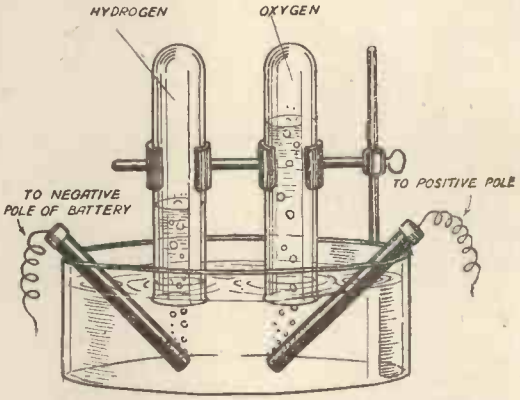


Fig. 6.—The decomposition of water by electrolysis.

once more on the disc centre, scribe another mark one division in from Y. Repeat with the next radius, and so on, making the mark one division nearer to the centre for each consecutive radius, until finally we come to No. 30 hole position. The dotted lines in the diagram will show how each hole position progresses towards the centre in a single turn spiral.

Completing the Disc

Having marked off the hole positions accurately, we must proceed to punch out the apertures. Lay the disc perfectly flat (and here let me mention that every care must be taken not to "kink" or bend the aluminium, otherwise the disc will not scan truly) on a hard wood block, for if soft wood is used the metal will be drawn down into the wood and the hole size altered. Place one edge of the punch along the radius for No. 1 hole, so that the *outer* edge of the punch is against the scribed mark. Holding the punch vertical, strike the brass holder sharply with a hammer so that a clean-sided hole is made. Repeat this operation for each hole position, so that the resultant disc is as shown partly in Fig. 5.

To enable the disc to whip out flat when revolving at its normal speed it is necessary to lighten it by cutting out five or six sections, as shown in the illustration, leaving "spokes" 1¼ inches wide and an outside rim of 2½ inches where the holes are punched. Replace the boss on the disc in its former position so that the grub screw is on the same side as all the marking operations have been effected. Now turn the disc over and give the 2½-inch rim a coat of *dead black* paint, being sure that none of the paint gets inside the holes to block them. The disc can now be placed on the motor shaft so that the blackened side faces the front, and the disc is exactly central in the baseboard slot.

It will now be possible to check and see that there is a correct alignment between the lenses and mask assembly and neon lamp, for the scanning holes of the disc should pass over the neon plate area and be observed clearly when looking into the tunnel. If any of the first or last holes are hidden, move slightly the lens box assembly or neon lamp, as the case may be, so that matters are rectified.

All is now in readiness for giving the machine a trial run. Join the 200/240-volt A.C. or D.C. mains to the terminals so marked and switch on. The disc should rotate in an anti-clockwise direction, and the speed adjusted by altering the variable resistances so that it runs at 750 revolutions per minute (I shall deal with a simple method for judging this speed next month). If there is the slightest tendency for the disc to foul any component it shows that it has not been mounted correctly, or alternatively, the motor shaft is not exactly at right angles with the front baseboard edge. If the latter, loosen the grub screw in the motor stand, twist the motor round ever so slightly and re-tighten the grub screw.

The output of the wireless receiver must now be joined to the input terminals of the "Tele-Discovisor" and the neon lamp first of all made to glow with its characteristic orange-red colour by passing a current of 25 milliamperes through it. When the television signals broadcast by the London National station are tuned in on the radio set they will modulate the glowing neon lamp, and the television images can be seen by looking through the tunnel attached to the lens assembly. It is essential that the disc is maintained at a steady running speed of 750 revolutions per minute for this to happen; that is to say, the machine must be properly synchronised, and, as this is a very important item in successful television reception, I shall have more to say about it next month.

BUILDING A TELE-DISCOVISOR

(*Continued from page 8.*)

NEXT MONTH

FURTHER DETAILS OF THE TELE-DISCOVISOR AND MANY MORE FASCINATING HOW-TO-MAKE ARTICLES

MAKING YOUR OWN ACCUMULATORS

By BATTERY ENGINEER

Although an Accumulator may seem a rather elaborate piece of apparatus, this article explains how one may easily be constructed at home

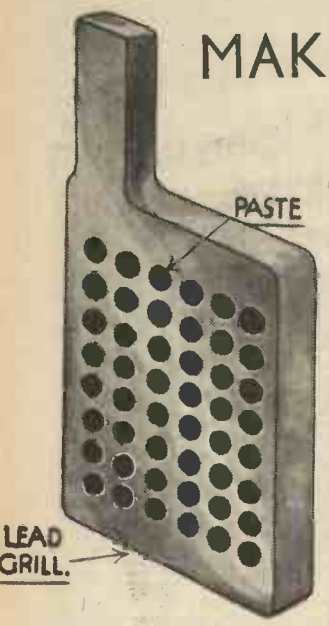


Fig. 1.—One of the plates drilled and filled.

THE construction of a really efficient home-made low-tension accumulator is not nearly such a difficult task as might at first be supposed. The necessary materials may be obtained quite cheaply, and the knowledge gained from the experiment is ample reward for the time and trouble expended. Moreover, anyone who can build and understand his own batteries is not likely to ruin the more expensive machine-made articles through ignorance or neglect.

The size and ampere-hour capacity of the cell to be constructed will, of course, be governed by the materials available and the personal requirements of the builder, but for the sake of simplicity we will consider here the construction of a cell having only three plates—one positive and two negatives.

These plates are cut from a ¼-inch sheet of lead and they must be of such a size that they will fit loosely into the glass jar which has already been set aside for the purpose. An old jam jar may, at a pinch, be utilised, but a rectangular glass box will be found easier to work with. The top edges of the plates should come about 2 inches below the top of the jar, and the plate lugs should stick up above the jar for about the same distance. One negative plate should be cut with an extra long lug, as this will be found very useful when joining the plates together (Fig. 4).

The plates have now to be perforated. This may be done by clamping them together and drilling all three at once, or by perforating each one separately with a saddler's punch. Drill as many ¼-inch holes as possible without seriously weakening the plates (Fig. 1).

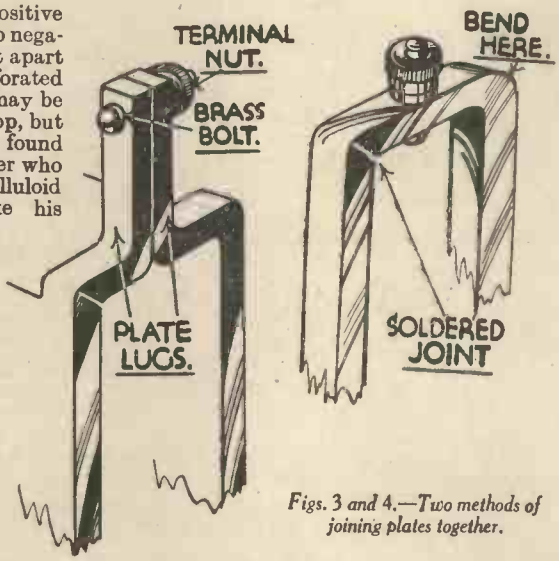
Now prepare the pastes as follows. Positive paste: a stiff mixture of red lead (4 parts), litharge (1 part) and sulphuric acid of approximately 1150 specific gravity. Negative paste: a stiff paste of litharge (5 parts) and sulphuric acid (1 part). All the above ingredients should be measured out by weight and mixed very thoroughly before using.

For pasting, the plates are laid on a smooth surface (a sheet of glass serves admirably) and the paste is forced into the holes with a flat "paddle" of clean wood. This should be done on both sides of the plate and care must be taken to force as much paste as possible into the holes until every tiny crevice is filled. The plates are then set aside for the paste to dry and harden. (Fig. 1 shows the plate drilled and pasted.)

When the plates have dried out they are ready for assembling. Each positive must be sandwiched between two negatives, and all the plates are kept apart by wooden separators. Perforated celluloid or ebonite separators may be obtained from any battery shop, but home-made separators will be found quite effective. The experimenter who happens to have some scrap celluloid or ebonite handy may make his separators from these materials; otherwise thin wooden separators should be employed. It is a good plan to groove these slightly from top to bottom down one side with a chisel. The grooved side should always be placed next to the positive plate when assembling to permit free circulation of the electrolyte (see Fig. 2).

The lugs of the negative plates should now be joined together; two methods of doing this being illustrated. In Fig. 3 the two lugs are merely bent together and fastened with a brass bolt and terminal nut. In Fig. 4 the longer plate lug is bent over at right angles and soldered on to the top of the shorter plate. The terminal is then mounted in the centre of the bus bar. If the cell is to have more than three plates it will, of course, be necessary to join the positives together in the above manner as well.

Fig. 2.—One of the wood separators.



Figs. 3 and 4.—Two methods of joining plates together.

The complete element (positives, negatives and separators) is now placed in the jar, covered with a solution of 1150 specific gravity sulphuric acid and given its first charge. The rate of charge will vary according to the size of plates to be charged, but an approximate figure may be obtained by allowing 0·2 ampere for every 10 square inches of plate area. Continue the charge until the plates gas freely and are properly formed—*i.e.*, the positive becomes a chocolate brown in colour and the negatives a slaty grey.

It is a good plan to place little bridges of ebonite or glass rod in the bottom of the jar before putting the cell into service (Fig. 5). This provides a mud-space into which any loose material can fall without shorting across the bottom of the plates.

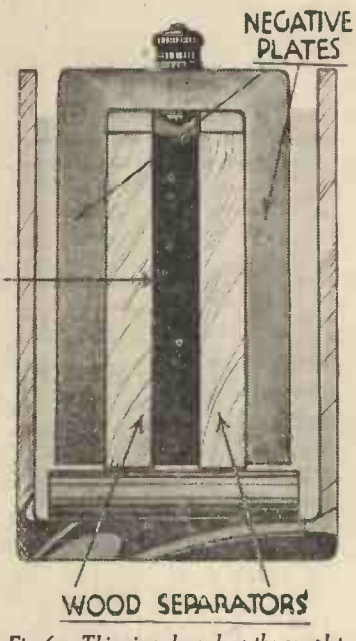


Fig. 6.—This view shows how the complete assembly is fitted together.

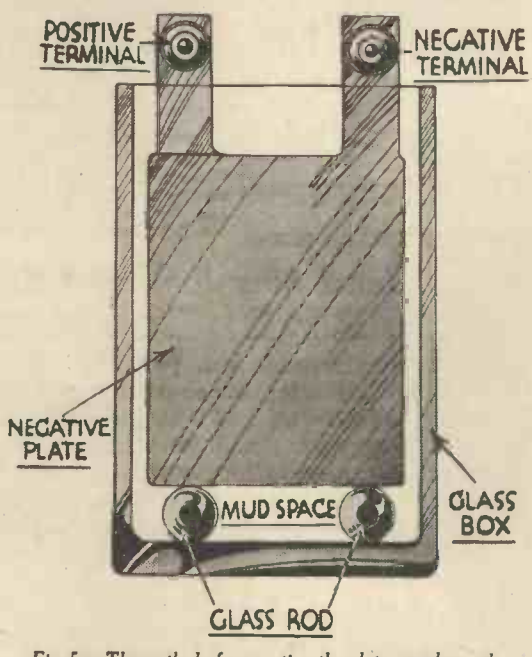


Fig. 5.—The method of supporting the plates on glass rods.

Details regarding some musical instruments which operate entirely by electronic means

By FRANK PRESTON, F.R.A.

"MUSIC from the air"—an intriguing title, without doubt—is the description given to a method of producing music entirely by means of electrical vibrations. An inventor named Theremin some little time ago designed a number of musical instruments resembling violins in appearance, but each without strings or bridges, and not requiring the use of a bow to enable them to produce music of perfect quality and timbre. Instead of strings, each "electronic violin" had inside its wooden case a rod of copper. This was connected to a valve oscillator in such a way that movement of the hand near the rod caused notes of different pitch to be emitted by a loud speaker connected to the output side of the oscillator. A good deal of skill was required to "play" the instruments, but so good was the music that a violin trio was formed to give a series of recitals on the American stage. Every performance met with a wonderful reception and the new form of electrical music at once became extremely popular. Since then the idea has been applied to various forms of musical instrument and there is no doubt that it has a great future before it. It is uncanny to see a musician play a tune without so much as touching a string or keyboard, and yet this is just what happens with the electronic device. Perfect music is produced merely by moving the hands; of course, they are not merely moved about in mid-air, as it were, but are comparatively near to a copper rod which forms an "aerial."

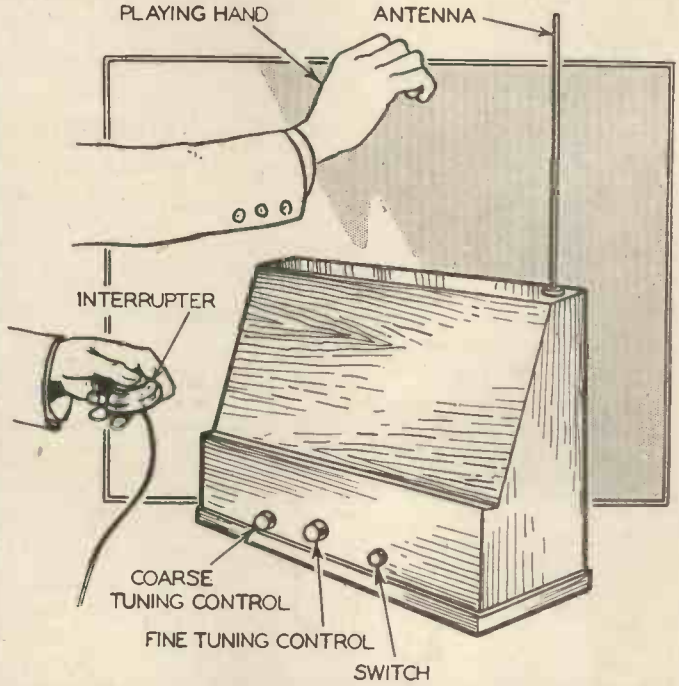
The Principles Involved

On first thoughts the whole idea of "music from the air" seems almost incredible and very wonderful indeed, but anyone who has used a critically tuned wireless set (especially one designed for short-wave reception) will find no difficulty in understanding the principles involved. Such readers know that if reaction is increased beyond a certain point a whistle is heard when the set is tuned to the wavelength of a station. Actually, this whistle is produced by the oscillations generated by the receiver "mixing" with those of the transmitter to produce a "beat note." It is the latter which is the whistle heard, and its pitch can be varied either by altering the tuning or by placing the hand near to the tuning coil or to some other component. Many readers will have noticed that very often the note of the whistle is varied even by placing the hand nearer to or further away from the tuning or reaction condenser.

It is the peculiarity just referred to which forms the basis for the production of electronic music. Instead of using a transmitting station, however, two receiving valves are used and are made to oscillate at slightly different frequencies or wavelengths. By this means a beat note is produced in the loud speaker attached, and this can be varied over a wide range of frequencies by moving the hand near to a copper rod forming a kind of aerial or antenna. The instrument is played in rather a similar manner to a violin, and moving the hand up or down the rod gives practically the same effect as "fingering."

A switch is used to obtain the necessary interval between successive notes and a foot pedal serves to vary the loudness of the music produced. Both the switch and pedal act upon the oscillator, of course, since it is this which actually produces the sounds which are heard. No "mechanical" sound whatever is made by the instrument, and the player can only hear it through the medium of a loud speaker connected to the valve oscillator. By employing a suitable amplifier (of the ordinary wireless type) the music can be reproduced at any desired intensity, and, if necessary, ordinary "violin" music could be made so loud as to be audible over tremendous distances. Moreover, it is quite possible to use the instrument for broadcasting purposes without the need for the customary microphone. The output from the oscillator would merely be connected to the transmitting valves direct.

Incidentally, it should be added that an electronic organ has now been made, and this is claimed to be even better than the simpler instrument, the violin. It has a full keyboard, and may be used to play any kind of music that is possible with an instrument of orthodox pattern.

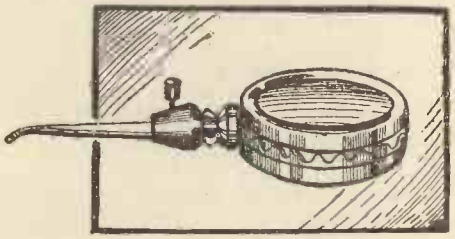


This illustration shows the Theremin Electronic Musical Apparatus which enables music literally to be extracted from the air.

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

A New Oil-can

THE K range of oil-cans continues to grow. This time it has grown in the direction of a small feeder for cycles, model engines, motor cycles, etc., here illustrated. Every reader knows the difficulty of retaining the pin cap screw used in this type of

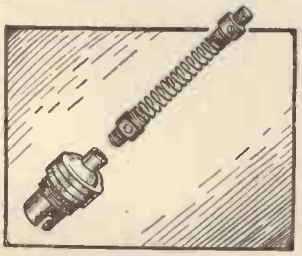


A new K oiler, with cork retainer for the cap.

oil feeder. Messrs. Kaye and Sons Ltd. have obviated the difficulty by fitting a substantial cork circlet to the base of the spout; by sticking the pin cap into the cork when the oiler is in use the cap is readily available and cannot be damaged. These cans are, of course, made with the famous serrated joint, which cannot leak or be torn apart. [1.]

A Lead Protector

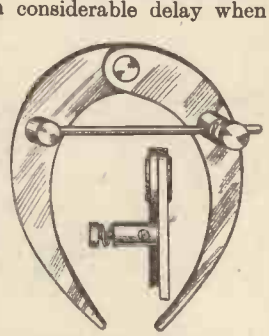
EVERYONE who uses flex leads from the mains for electric heaters, electric light, wireless sets etc., will know that these usually fray out at their point of attachment to the plug. The illustration shows a protector incorporating a spiral spring through which the flex passes. This spring acts as a protector and an antivibrator. [2.]



An electric lead protector and antivibrator.

Quick Adjusting Calipers

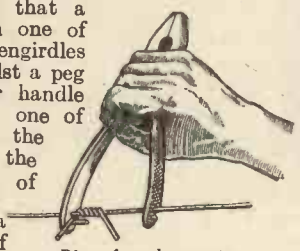
MOST amateur wood turners and lathe workers in general have encountered the difficulty caused by calipers which are so stiff jointed that it is impossible to set them accurately to size. Another drawback to the ordinary form of calipers is the fact that they cannot be quickly adjusted, which results in considerable delay when it is necessary rapidly to check a dimension. The quick adjusting calipers here shown are provided with an easy working joint and each leg is fitted with a post designed to turn. These posts have a rod attached. One is driven in and the other slides, a flat being filed on it with a slight taper towards the end. In use the calipers are opened to the approximate size and pushed over the work. The legs then slide along the rod and hold the calipers at the required setting. [3.]



Quick adjusting calipers.

Wire Splicing Pliers

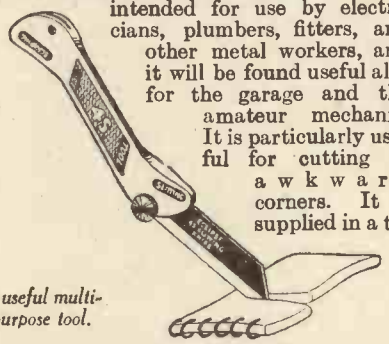
THE pliers shown are intended to be used, as indicated, to splice wire. It will be seen that a notch cut in one of the handles engirdles the wire, whilst a peg in the other handle engages with one of the ends of the wire. By the mere action of twisting the pliers round, a neat splice of spring-like formation is ensured. [4.]



Pliers for splicing wire.

A Neat Combination Tool

HERE is a really efficient combination tool which may be used for slotting, sawing, scraping and slitting metals. It is intended for use by electricians, plumbers, fitters, and other metal workers, and it will be found useful also for the garage and the amateur mechanic. It is particularly useful for cutting in awkward corners. It is supplied in a tin

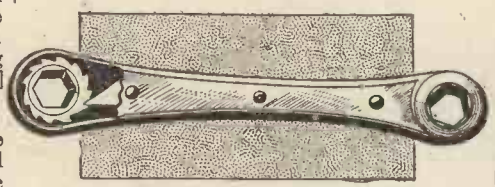


A useful multi-purpose tool.

complete with the holder, a number of 6-inch double-edged slotting blades, single-edged sawing blades, engineers' scrapers, half-round and flat, a belting and lead-slitting knife for 5*s*. [5.]

Ratchet Spanners

WHEN working in confined quarters it is somewhat difficult to use the usual type of spanner on a nut. Attempts to do so usually result in barked knuckles. It, perhaps, is not generally known that



A neat ratchet spanner.

ratchet spanners are available, which once they have engaged the nut do not need to be removed until the job is finished. A spanner of this type is shown below. They are obtainable in all sizes from a $\frac{1}{4}$ inch upwards, and to suit square nuts and hexagon nuts. They are double ended and the $\frac{1}{4} \times \frac{5}{16}$ inch cost 1*s*. 3*d*., the square pattern in the same size costing 1*s*. 6*d*. Not only does the spanner not have to be removed from the nut, but the hand does not need to be removed from the spanner. [6.]

MOVIE MAKING FOR THE BEGINNER

(*Continued from page 9.*)

much as this there is in another make a splendid outfit made up of sixty-five shillings for the camera and forty-five for the projector—five pounds ten in all. You can, of course, pay more if you want to, just as you can with still cameras, but as this argument is in the main concerned with running costs, let us adhere to them. Nine and a half millimetre film costs you two and sevenpence for a nominal thirty-foot reel (it is slightly less really), and there is another two shillings to pay for what is called processing, or preparing it ready for showing. There is no other cost whatever, no prints, no enlargements, no albums, and if you are reasonably careful very little wastage. No one has the nerve to expect a free copy of your film. Let us call it four and sevenpence for a finished reel. For the twenty-seven and tenpence you have spent on your holiday still photography you could get six finished reels, and each reel remains on the screen for about a minute and a quarter. So you see that for the same money you can have nearly eight minutes of screen time. Eight minutes of real moving pictures, big enough for all the family to watch at the same time, with real life and real movement everywhere. To make a fair comparison let us divide our films up into forty little scenes of animation to correspond with your forty still photographs. If we do this, each little animated picture will remain on the screen for ten seconds or so—quite long enough to show all kinds of interesting things. You will agree with me that there's no comparison whatever between a ten-second moving picture thrown on a screen and a little still photograph of the same scene measuring two and a quarter by three and a quarter inches."

"By Jove! I had no idea things were as cheap as that."

"Running costs can be still cheaper than this, with the new eight millimetre system," I said. "I'm not going to argue here which is the better of the two kinds—nine and a half or eight—but I would suggest you go and see both of them demonstrated for yourself. With the eight millimetre system you can have no less than twelve minutes of screen time for thirty shillings, as the film is sold in ten-shilling packets, this figure including all costs of developing and preparing ready for projection. A ten-shilling reel lasts just four minutes on the screen. The apparatus is a little more expensive than the cheapest of the nine and a half millimetre and the camera costs nine pounds seventeen and six, with the projector nine guineas. Your outlay for apparatus is thus just upon twenty pounds, but the system has the cheapest running costs of any."

"Well, you've won," said my friend, "but what is this twenty-six shilling reel I have heard about?"

"That is the cost of a hundred feet or four minutes of sixteen-millimetre film including processing," I said. "This is a larger size of film and is slightly more costly to run, but even this is not out of the way when you consider what you get for your money. With the sixteen-millimetre size and modern projectors it is possible to show pictures big enough to entertain an audience of a hundred or two if you want, while for home use you can get an intensely brilliant picture without having to darken the room too much. However, I'll tell you about sixteen-millimetres another time."

The train had stopped, and as we went out at the station we came to a tobacconist's.

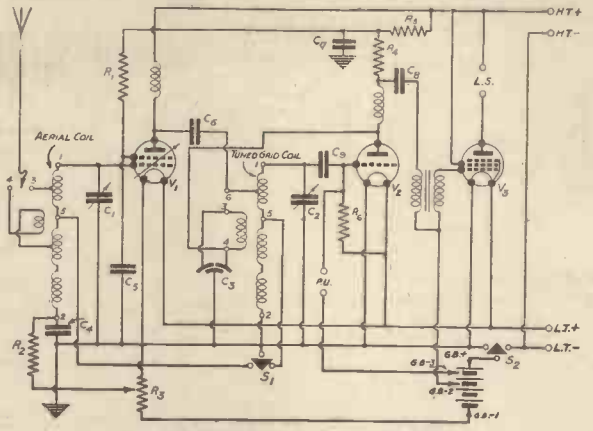
"Here's your cigarettes," said my friend. "I'm going to sell my still camera"

THE AIR KING THREE

(*Continued from page 22.*)

far as possible without allowing the set to oscillate. Even if it should oscillate no interference will be caused with other receivers, but the quality of reproduction will suffer to a marked extent. Sometimes a set is just on the border of oscillation without the operator knowing (because the usual whistle is not heard), and reproduction is poor in consequence. This can generally be checked by moving the tuning knob a little one way and then the other—if a squeak is heard on either side of the correct setting the reaction should be eased off slightly.

No mention has yet been made of using the receiver as a gramophone amplifier, but there is no difficulty whatever in doing this, for all that one has to do is to connect the pick-up leads to the terminals provided and either de-tune the set or remove the aérial lead to prevent wireless signals interfering with the gramophone music. Any type of good pick-up can be employed, but it should, for preference, be fitted with a volume control, since that fitted to the set has no effect on gramophone reproduction.

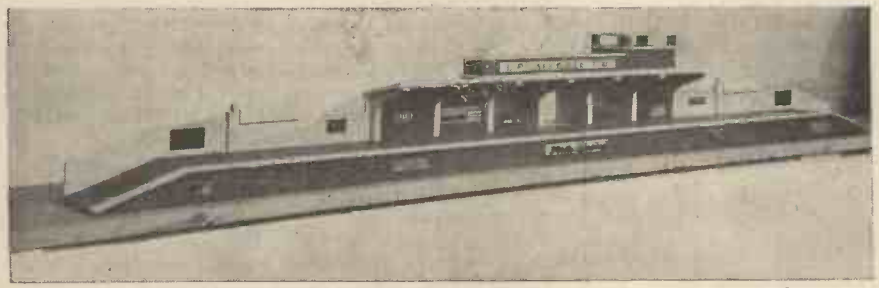


Theoretical Circuit of the Air King Three.

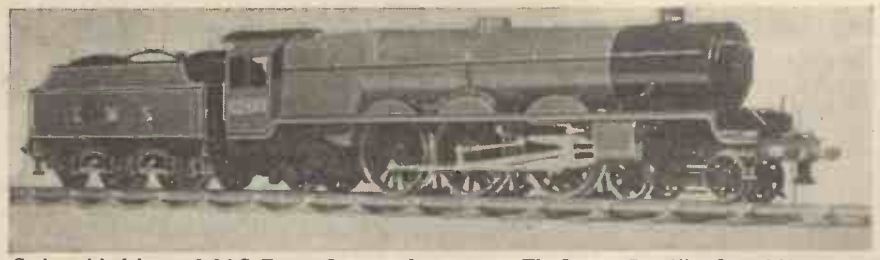
It might be added here that the set works most satisfactorily on an outdoor aerial of about 50 feet inclusive length.

REALISM IN MODELS

THE name of W. J. Bassett-Lowke Ltd. (the well-known model makers, of Northampton) is synonymous with high-grade realistic models of every description. Their two catalogues, which are reviewed on page 52, should be in the hands of every model maker; they are more than catalogues—they are text-books on making models of railways, ships, stationary engines, tractors; in fact everything to do with models and model making. The two illustrations below indicate merely two examples of the skilled realism built into their products.



New modern type gauge 0 railway station in wood, design based on the L.P.T.B. Surburban Stations on their new North London extensions.



Scale model of the new L.M.S. Express Passenger Locomotive, "The Princess Royal". It is of 2½-in. gauge employing high-pressure steam, with an internally fired water-tube boiler, and is automatically methylated-spirit fired.

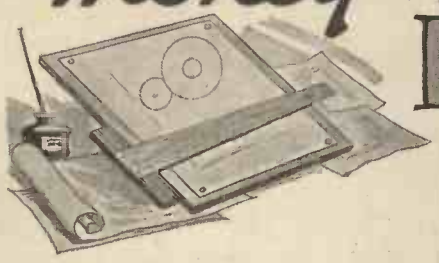
A ½-INCH SCALE MODEL G.W.R. "CASTLE" CLASS LOCOMOTIVE

(*Continued from page 32.*)

curves. It will be understood that a rubber tube connection between a rigid pipe and the engine would not stand up to the pressure of the water, since the pump is to deliver into the boiler under steam and the working pressure is 80 lbs. per square inch.

The firebox is to be fed with solid fuel. The fire is started by placing on the fire-bars a few small tufts of cotton wool saturated in petrol, then about a dozen little sticks of chopped-up wood, roughly 3 inches long and about the size of a black-lead pencil. Light the petrol and continue feeding in wood until a fair quantity of glowing material is in the box. Then introduce the coal chute into the fire-hole opening, which is shown in Fig. 11, and begin to feed in bits of coal broken up to about the size of a hazel nut.

Money Making IDEAS



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

By FREDK. JACE

Making Lead Toys

A GOOD local trade exists for those who can make lead toys in their spare time. No expensive equipment is required, and moulds only slightly larger than a pair of pliers can be obtained for a few shillings from which hundreds of thousands of replicas can be cast. You merely require some scrap lead, a source of heat, and a receptacle in which to melt it, plus some cellulose colours. Moulds are available for soldiers, railway carriages, model railway equipment, etc. The address of the supplier can be obtained on application to the Editor.

Scale Model Aircraft

REALISTIC models of military and commercial aircraft, either as radiator mascots for motor cars or as mantelshelf ornaments, always command a ready sale. Such models, whether made in wood or metal, need to be true to prototype. Until a few weeks ago the difficulty has been to obtain accurate scale drawings in this country. Now, however, it is possible to obtain scale blue-prints of almost every make of British military and commercial aircraft, and those with a flair for high-class model making will find a ready sale for models made from such drawings Local shops are usually willing to purchase.

Printing at Home

PRINTING is usually considered to be a closed profession, and if we think in terms of daily papers and weekly periodicals, it undoubtedly is; and yet thousands make a profitable sideline of printing. It is now possible to purchase for £2 or so excellent miniature hand-printing presses which will print handbills, pamphlets, brochures, posters, club magazines, tickets, etc., almost as efficiently as the real machine. If you are considering the advisability of supplementing your income, home printing will provide a lucrative sideline, if handled in a businesslike manner.

Recipe for Hair Oil

LOCAL barbers are ready customers for a good hair oil, and an excellent formula is as follows:—

Mix together 12 oz. Arahis oil, 5 oz. lime water saccharated lime solution 5 oz. Agitate this thoroughly, and then add 1 drachm oil of bergamot and 1 drachm oil of lemon. These proportions should be equally increased, according to the quantity required.

This recipe yields an excellent oil (or cream), and has a pleasant perfume.

An Excellent Paste

UPHOLSTERERS, coach trimmers and tailors use paste. The formula for an adhesive paste such as is required for sticking cloth is: to every 1 lb. of rye flour mix 2 oz. of powdered resin, stirring to a paste with warm water. When the paste is of the consistency of butter, add 1 quart of water, and gradually bring to the boil. Add 1 drachm oil of cloves to act as a preservative. Marketed in ½ lb. tins such a paste finds a ready sale.

Invisible Ink

ANOTHER recipe which, I made up and sold in small phials (obtainable from the chemist) commands a good sale among toyshops and novelty dealers is invisible ink. To make a suitable ink, dissolve 1 drachm of chloride of cobalt and 1 drachm of cobalt in an ounce of water. This is used with a pen in the ordinary way, and becomes quite invisible when dry. The writing is rendered visible by heating in front of the fire.

Earn Money with Your Cine Camera

MANY people to-day earn fairly large fees by running a local news film service in conjunction with their local cinemas. Films of fetes, gala days, sports and other local functions of purely local interest can always be sold, and provide an added "draw" in the programme. Prizes could be offered by the management to the person "marked" on the film with a cross. This could be a weekly feature, and "snatches" should be taken at the railway station in the morning, or at any other local spot where crowds congregate.

For the Model Maker

HAVE you considered the possibility of turning your skill as a model maker to account by approaching managers of local businesses, with a view to selling them models of their buildings, special machinery, etc.? Quite a respectable income can be made in this way.

Ticket Writing

TICKET writing used to be the special preserve of the skilled signwriter. Thanks to the introduction of special ticket writing outfits, containing all of the impedimenta necessary, including coloured inks and special pens, only a modest amount of practice is necessary before even the novice can turn out decent work. There is a ready market (and one which never reaches absorption point) in every district among butchers, drapers, cinemas, etc., and a profitable one at that.

Floor Polish

AN easily made floor wax is obtained by melting together 4 oz. of beeswax and 1 lb. of paraffin over a hot-water bath: that is, the container of the wax is placed in hot water, in such a way that no water comes in contact with the wax. Then add 4 oz of raw linseed oil and 1½ pints of turpentine. Stir vigorously.

Wireless as a Profitable Hobby

THOSE readers with a practical knowledge of radio might well consider developing a local business among radio shops by undertaking to repair wireless receivers sent in for servicing. Very few wireless shops employ a technician, with the result that this work is turned away. Such a sideline has the great advantage that little equipment is required, other than a pair of pliers, a soldering iron and a screwdriver.

Become a Press Photographer

EDITORS of local papers are always prepared to buy topical photographs suitable for reproduction. It is best to make an arrangement to "cover" local events beforehand. Editors of London daily papers pay good rates for exceptional "action" photographs, and photographs of any local happening of more than local interest.

Waterproofing Solution for Fabrics

A GOOD waterproofing compound for fabrics, tents, etc., which makes a good job, consists of aluminum stearate dissolved in carbon tetrachloride.

CLUB REPORTS

Club Reports for inclusion in this feature should not exceed 250 words in length, and should be received not later than the 14th of each month for inclusion in the subsequent month's issue.

THE MODEL RAILWAY CLUB

FOUNDED in 1910 with the object of bringing together all those interested in model railways, their working and construction.

Incorporated.—April 3rd, 1933.

Meetings for the reading and discussion of papers, and for running model locomotives are held at St. John's Schools, Tottenham Court Road, on the second and fourth Thursdays in each month, except August, from 7.30 to 10 p.m. The Club possesses:

1. An oval track, 66 feet round, giving a continuous run for gauges 00, 0, 1, 2 and 3.
2. A special lay-out for 0 gauge.
3. A passenger-carrying track, 54 feet long.
4. A fan-shaped lay-out for shunting competitions.

During the summer visits are paid to places of interest connected with railway work.

Subscription, 7*s.* 6*d.* per annum. (Juniors, 14–18, 2*s.* 6*d.*)

Entrance Fee, 1*s.*

Half subscriptions are payable by new members joining after August. During the Model Engineer Exhibition at the Horticultural Hall, Westminster, the Club exhibited a selection of the work of its Members on the Club Stand, which proved also a popular rendezvous.

In the week following the Easter Bank Holiday the Club holds its own Exhibition at the Central Hall, Westminster, which is proving increasingly popular. This is the popular Model Railway Festival of the year, and attracts models not only from the United Kingdom, but also from the Continent.

Fixtures for October are as follows: Thursday, October 12th, Annual Rummage Sale. Thursday, October 26th, Track Night. Hon. Secretary, J. C. Watts, 85 Wood Vale, N.10.

FASCINATING EXPERIMENTS IN CHEMISTRY (*Continued from page* 38).

the paper and plunge it into the gas. The writing fades out slowly, leaving the paper quite blank. The bleaching process may be arrested at any stage by merely withdrawing the paper from the gas. A manuscript thus partially faded will acquire the appearance of great age.

Writing restored by Chlorine

In contrast with the last experiment there is one in which chlorine gas restores an ink. The ink is, of course, specially prepared. Make it by boiling a little starch in water and add a crystal of potassium iodide. A message written with this "ink" is quite invisible when dry, but appears as a vivid blue in presence of chlorine.

Colour Changes with Permanganate

Quite an effective experiment in colour changes can be performed with a weak solution of permanganate. To a little in a beaker add a few drops of washing soda solution and follow this with a little photographic hypo. The rich purple colour gives way to green. If, instead of making the solution alkaline with soda we make it acid with a trace of sulphuric acid, on addition of the hypo no green colour forms, the solution loses all colour and appears like water.

EXPERIMENTS WITH CELLULOSE

Cellulose is a substance of which we hear a great deal nowadays. Its applications seem universal from the brilliant finish on motor-car bodies to bottle caps and ladies' stockings. There is nothing mysterious in this branch of chemistry as many people seem to imagine, although several intricate processes are involved. Artificial silk garments naturally cannot be produced in the home, but a few simple experiments with cellulose will give the worker a closer knowledge of this most interesting substance, and also an insight of the commercial processes.

Cellulose in its raw state is a constituent of the cell walls in vegetable tissue; we see it in wood and at a later stage in its career as paper; but its purest form is also the handiest for our purpose, since few households are without cotton wool.

The Mercerising Process

For our first experiment we require a beaker and a strong solution of caustic soda. A little cotton wool is placed in the beaker and covered with the alkaline solution. After a few minutes' soaking the wool will have assumed a translucent appearance and undergone a shrinkage. The same effect is noticed when strong caustic alkali is applied to paper. The contraction causes the paper to assume a crinkled appearance, which is also seen in cotton cloth after a similar treatment known as the mercerising process.

Making Parchment Paper

In this experiment we allow acid to react with cellulose. Pour strong sulphuric acid over cotton wool in a beaker, the wool is attacked and finally goes into solution. A diluted acid, on the other hand, has a toughening effect. This you can show by dipping sheets of paper in dilute sulphuric acid (2 parts acid *added slowly to* 1 part water).

After washing and drying the paper is toughened and semi-transparent; it is, of course, parchment paper.

Artificial Silk

This substance consists of fibres manufactured by treatment of wood cellulose. It has many physical properties in common with real silk, but chemically is entirely different. The handiest way to prepare this in the home laboratory is by the "Cuoxam" process. The first step is to make up a small amount of Schweizer's reagent. To a solution of copper sulphate caustic soda solution is added until precipitation is complete. The blue precipitate is collected on a filter paper, washed, and then dissolved in a little strong ammonia solution which will carry it through the filtering funnel into the collecting beaker.

This completes the preparation of Schweizer's reagent, in which cotton wool is now to be soaked. After a few minutes' soaking the wool will be observed to gelatinise and then to dissolve. If this solution of cotton is now poured into strong salt solution or alcohol, cellulose is immediately thrown down in the form of a gelatinous precipitate. Commercially the cellulose solution is forced through fine holes in a metal plate as it enters the brine, alcohol, acid, or whatever other precipitation agent is used, and the threads of fibre formed are wound on to reels. This is a very much abbreviated description of one method of making artificial silk thread, but after making a small sample in this experiment the worker will no doubt be tempted to study the process in greater detail.

AROUND THE TRADE

BRIEF ITEMS AND TOPICAL THOUGHTS CONCERNING MANUFACTURERS AND THEIR PRODUCTS

Model Aeroplane Blue-prints

SCALE Blue-prints of the leading British aircraft, of the three-view type, are obtainable at 2*s.* 6*d.* each from C. B. Elliot, of 12 Oakhill Road, Beckenham, Kent. Hitherto this type of drawing for model makers has only been obtainable from America, and no doubt they will be found extremely popular.

For Stamp Collectors

STAMP Collectors will find the Position Finder sold by Messrs. Stanley Gibbons, of 391 Strand, London, W.C.2, extremely useful for indicating the position of flaws in stamps. It is often necessary to mention the position of a flaw when writing to a brother collector or club, for instance, and this indicator enables the exact position to be perfectly located. It costs 1*s.* 2*d.*, post free.

Interesting Wireless Manual

THE Telegraph Condenser Company Ltd., of Wales Farm Road, N. Acton, London, W.3, publish a most interesting book dealing with the design and construction of radio power units. In addition to various problems regarding the choice of wireless components and the description of separate wireless terms, this book contains an ingenious Calculator which simplifies Ohm's Law. Although this book costs 6*d.*, it is worth many times its price to all who are interested in wireless.

A Cheap House Telephone

A HOUSE Telephone for every home. This is the slogan of The Kay Sports Company of Pembroke Works, Muswell Hill, London, N.10, and they supply a very efficient 'phone for 25*s.*, which consists of two super instruments with battery boxes, rests, buzzers, etc. Extra wire is obtainable at reasonable cost, and the Kay Telephone is not a toy. For the kiddies a small edition is sold at half the price. In addition some interesting Chemistry Outfits are obtainable from this firm, and will enable many interesting experiments to be carried out.

An Aid for Cyclists

A 90-FOOT beam of light from two pocket batteries. This is the result of fitting one of the new "Pifco" attachments to an ordinary pedal cycle. No need to go groping down a country lane in a dim glimmer provided by a sooty oil lamp. For 5*s.* this modern lighting device will convert night riding into a real pleasure, and will also add to your personal safety. Write to Pifco Ltd., High Street, Manchester, or 150 Charing Cross Road, London, W.C.2, for details.

Television Apparatus

THE Mervyn Sound and Vision Co. Ltd., of 4 Holborn Place, London, W.C.1, can supply all the parts for a modern television equipment. Special items are made by this company to their own design, as well as standard parts, and a visit to the showrooms or, a copy of their illustrated list, will reveal many of the lines in which this firm specialises. A Mervyn Disc is used for the instrument described in this issue.

Model Railways and Model Boats

THE name of Bassett-Lowke Ltd., of Northampton, is well known in connection with model railways, and some of the scale models manufactured by this firm may be seen at all the great exhibitions and in many large windows in our big cities. Who has not seen the large-scale models of ocean going liners? A splendid Free Booklet obtainable from this firm will give some idea of the remarkable models which are obtainable.

Help for the Amateur Chemist

EVERY device for the Chemist or Chemistry Experimenter is obtainable from A. N. Beck & Sons, of 60 High Street, Stoke Newington, London, N.16. Some interesting sets of apparatus, for standard experiments are obtainable from 10*s.* 6*d.* upwards.

A Remarkable Bargain

NOW is the opportunity to equip your workshop with a really good lathe at a remarkable price. Messrs. Gamage, of Holborn, London, are selling a complete screw-cutting lathe complete with gears for £4 19*s.* 6*d.* A smaller model with a 2½ in. plain gap bed is obtainable for 32*s.* 6*d.*

Soldering Difficulties Removed

THE proprietors of Fluxite, West Lane Works, West Lane, Rotherhithe, London, S.E.16, have a very handy book on the subject, which removes many of the difficulties which have hitherto been associated with the problem of soldering. Although it costs 9*d.* it will save its cost in a very short time in the experience which you will gain from it.

PATENT ADVICE

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

By A. MILWARD

IN order that an inventor may have the opportunity of reaping a reward for his invention it is necessary that he should obtain the grant of Letters Patent for his invention. Now Letters Patent is a monopoly granted by the Crown for a limited period in order to encourage invention, and at the expiration of the term for which the patent is granted, to enable the public to make use of the invention.

Patents are granted for a term of sixteen years, but to keep the patent alive for this period annual taxes are payable after the fourth year. A patent is only granted for a single invention and all inventions are not necessarily patentable, but, provided that a material product of a substantial character is realised or affected by the idea, it is patentable, subject to it being both useful and novel.

Inventions for which patents are granted are chiefly either vendible articles formed by mechanical or chemical operations, or machinery or processes. A mere discovery either of a natural law, a scientific principle, an abstract notion or a philosophical idea, is not patentable, but a means whereby the public may gain material advantage from the application of such a discovery is patentable.

If the invention falls within the above definition, *i.e.*, is a patentable invention, then, subject to certain formalities, a patent will be granted to the inventor or inventors either alone, or, if he or they choose, in conjunction with another person or persons. With one exception it is not possible for a patent to be granted to a corporation or a limited liability company without the actual inventor or inventors being joined in the Patent Application. The exception above referred to is in the case of an application for patent being made under the terms of an International Convention for the protection of industrial property for an invention which has been made abroad in a country which is also a member of the International Convention.

An Invention by Two or More People

When an invention has been made jointly by two or more persons, all must be parties to the Patent Application, but in the case of a person being employed to work out the details of an invention or carry it into effect, then such a person is not entitled to be regarded as the inventor or to make any claim to the invention. If, however, an employee invents anything patentable, such invention belongs to him and not to the employer.

Any person importing an invention from abroad, provided it is novel so far as this country is concerned, is entitled to the grant of a patent for such an invention, because the first importer is considered to be the inventor. An inventor abroad can communicate his invention to a person resident here and such person can validly obtain a patent in his name as a communication from the inventor.

Patents will not be granted for any inventions which are contrary to law or contrary to morality. An invention which has been commercially worked in secret cannot subsequently be validly patented if the manufacture can be determined from the product. It is also questionable whether a valid patent can ever be obtained for any invention which has been commercially worked in secret before being patented. As before stated, an invention to be capable of being validly patented must not have been known, *i.e.*, published or used in this country before the date of filing the Patent Application. Publication of an invention may be by means of a printed book, specification, pamphlet or the like in circulation in this country, whether such book be in the English or in a foreign language.

A Prior Patent

The most usual prior publication which is fatal to the validity of a patent is the specification of a prior patent, either an English or a foreign one. The prior use of an invention to invalidate a patent must be such as to constitute public use of the invention, experimental use *per se* is not sufficient to constitute a prior use.

Besides subject-matter, *i.e.*, invention and novelty, an invention must also possess utility. The amount of utility to support a patent need not, however, be great. If it can be shown that the invention is more useful than existing ones for the same purpose, either by producing a better result or lessening the cost of manufacture, the proviso as to utility will be met. Any person, which includes an infant and a lunatic and either of British or foreign nationality, may be a patentee. The first and true inventor, if resident in this country, must be one of the applicants for a patent, but others may be associated with the inventor as joint applicants. In the case of patent applications applied for in the joint name of the inventor and another person, the patent granted on such an application will be issued in the names of both applicants, and each patentee will thereby acquire a half share in the patent without further agreement, and are treated in law as joint tenants. Each is entitled to use the invention for his own profit without accounting to the other, but neither can grant a licence to a third party without the consent of the other. If either party dies, his beneficial interest in the patent becomes part of his personal estate.

The Proprietorship of an Invention

Agreements affecting the proprietorship of an invention made before a Patent Application is filed should clearly and unmistakably refer to the invention in question, and all agreements made before the issue of a patent for the invention should contain a proviso for the execution of a deed of assignment after issue of the patent. Until a patent has been sealed it cannot be assigned, and no assignment executed before the issue of a patent will be entered on the Register of Patents.

There is no such thing as a "Provisional Patent," and these words should not be used

(*Continued at foot of page* 51.)

REPLIES TO QUERIES & ENQUIRIES

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page 52. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

Recharging Flashlamp Batteries

"I have an old flashlamp battery in my possession. Can you tell me how this can be recharged?" (J. L., Exeter.)

The composition in the charging of flashlamp batteries is similar to that in other so-called dry batteries, but in flashlight batteries the charge is compressed by suitable appliances only available in a well-appointed workshop. The following are some of the compositions: (*a*) crushed carbon 2 lb., peroxide of manganese 1 lb., crushed sal-ammoniac 5 oz., 1 teaspoonful of chloride of zinc, ½ teaspoonful of glycerine, and sufficient water to make the mixture moist; (*b*) crushed carbon 75 parts, crushed peroxide of manganese 5 parts, crushed sal-ammoniac 20 parts, and sufficient water to moisten the mixture; (*c*) powdered graphite 75 parts, powdered peroxide of manganese 10 parts, dry chloride of zinc 5 parts, powdered chloride of ammonium 10 parts, glycerine 2 parts, and enough water to moisten the mixture. These mixtures must be packed in tightly around the carbon element of the battery and entirely fill the space between the carbon element and the lining of the zinc cylinder. It may be stated that all dry batteries have a limited charge of materials available for the production of electric energy, and electric lighting soon exhausts this charge.

Varnishing Photographic Films

"I am a keen photographer and would like to know the process for varnishing photographic films." (E.D., Birmingham.)

For hardening and protecting photographic films, the best plan is to varnish them by immersion bodily in any good negative varnish, then drying in a warm room. The varnish, a recipe for which is given below, should be well filtered and should not be thin enough to chill off. Dissolve 40 gr. of borax and 100 gr. of bleached shellac in 1 oz. of water in a water bath, and add 1 dr. of alcohol. The films should, of course, always be dried flat.

Softening Cast Iron

"Can you tell me a method whereby I can soften cast iron? I have tried a number of times but find I am unable to do so." (M. J., Dorking.)

A German authority says, to soften cast iron, heat the whole piece to a bright glow and gradually cool under a covering of fine coal dust, etc. Small objects are packed in quantities, in a crucible, in a furnace or open fire, under materials which when heated to a glow give out carbon to the iron. They should be heated gradually, kept at a bright heat for an hour and allowed to cool slowly. The substances recommended to be added are cast-iron turnings, sodium carbonate or raw sugar. If only raw sugar is used, the quantity should not be too small. By this process it is said that iron may be made so soft that it can almost be cut with a pocket-knife.

Facts about the Earth

"My friends and I have often discussed how many miles comprise the superficial area of the earth, also the circumference, the average velocity with which it travels round the sun and its age. I should be pleased if you can enlighten me on these details." (M. B., Bromley.)

The earth is 24,901 miles in circumference at the Equator, 7,926 miles in diameter at the Equator, and its superficial area is 196,550,000 square miles. There are 55,500,000 square miles of land and 141,050,000 square miles of water; nearly three times as much water as land. It travels round the sun at an average velocity of 18½ miles a second. The age of the earth is computed by scientists to be from 1,500 to 3,000 million years.

An Optical Illusion

"Can you tell me why wheels of carts, etc., in cinematograph pictures sometimes appear stationary, and at other times to be revolving backwards, although the vehicle is going forward?" (S. T., Cowes.)

This effect is due to an optical illusion. It is well known, of course, that the cinematograph picture is made up of a continuously appearing series, at the rate of approximately sixteen per second. In the case of a picture of a wheel, if it so happens that in the interval between two pictures a spoke has been moved exactly the same distance as that between two or more spokes, then the appearance of every spoke being alike to the eye, there is no apparent change, and the wheel appears stationary. Should the movement be a little short of one or more spoke spacings, then the wheel appears to be moving backwards. In the same way, if the movement just exceeds the spoke spacing an impression of a very slow forward movement is created.

Patent Advice—(*Continued from page* 50).

as notice to the public that the invention is the subject of a patent. The invention should either be referred to as "Provisionally Protected," or the better form, "Patent Applied For." After the acceptance of an Application for Patent, accompanied either with a Provisional Specification or a Complete Specification, the period between the date of application and the date of sealing the patent is the term of "Provisional Protection" and during such term no action for infringement can be entered. An action for infringement can only be brought after the date of sealing a patent and no damages for infringement can be obtained for any infringement committed before the date of acceptance of the Complete Specification.

The stamping of an article with the word "Patent," or the false representation that an article is patented, when no patent exists, or such is not the case, renders the person doing such thing liable for every offence on conviction to a fine not exceeding £5.

Damages in respect of an infringement will not be awarded in respect of infringement from a defendant who is able to prove he was unaware of the existence of the patent, and the use of the word "Patent," unless followed by the number of the patent, is held not to constitute notice of the existence of a patent.

A patent may be revoked on various grounds, for instance, that the invention was obtained by fraud, that the patentee was not the true inventor, or that the monopoly rights have been abused, for instance, by supplying the demand for the patented article by importation instead of by manufacture in this country, or by refusal to grant a licence to manufacture under the patent.

Two or more provisional specifications for inventions which are modifications one of the other may be included in one Complete Specification, provided that the same applicant has thereby obtained concurrent provisional protection for the said inventions.

An improvement in an invention forming the subject-matter of a patent may be protected by a Patent of Addition to the original patent. It becomes part of the original patent, and expires therewith, but requires no separate renewal fees to be paid.

If a patent be endorsed "Licences of right," whereby any person shall be entitled as of right to a licence under the patent, only one half of the usual renewal fees are payable to keep the patent in force.

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A SMALL catalogue, issued by E. Gray & Son, Ltd., of 18–20 Clerkenwell Road, London, E.C.1, contains lists of prices and details of various sections of metal rods, sheets and tubes, as well as a most complete list of such items as rivets, wire, nuts and bolts, pinion wire, washers, metal beads, chains, rubber tubing, brushes, etc., and no workshop should be without this handy reference book. It may be obtained free on application, if you mention PRACTICAL MECHANICS, and the reference is LIST MM. [1.]

Radio Components

THE Bulgin 1934 Catalogue, just issued, provides a real mine of information. A glance through this book reveals the fact that practically the only wireless apparatus which is not listed is the valve and loud speaker, but from the smallest on/off switch, which costs 1*s.*, to a gramophone pick-up at 30*s.*, there is a most interesting range of apparatus. There are eighty pages in this Catalogue, which devotes over twenty to a complete Technical Manual giving hints on receiver construction. The address of Messrs. Bulgin is Abbey Road, Barking. [2.]

Milnes H.T. Units

THOSE who are in the unfortunate position of having no electric light mains available should write to Milnes Radio Co., of Victoria Works, Church Street, Bingley, Yorks, for a copy of their booklet "This H.T. Business." A complete description of the H.T. Supply Unit which may be recharged from an ordinary accumulator is here given, and many interesting facts concerning this nickel-iron cell are dealt with. A simple switch is fitted to the H.T. Unit and this permits the accumulator to be connected to the receiver for listening, or to the cells for recharging. One is assured of a constant and unfailing H.T. supply without the necessity for repeated visits to the wireless store for new batteries. [3.]

Goltone Products

ALTHOUGH Messrs. Ward & Goldstone, of Pendleton, Manchester, are widely known as manufacturers of electrical apparatus, they also make a comprehensive range of wireless accessories. Their latest catalogue, R/130, shows a number of interesting tuning coils of the dual-range type and a metallised lead of ingenious design for connection between the aerial and receiver for the elimination of static and similar noises. Various types of instrument wire and flexibles, electric bells, meters, switches and lampholders, ebonite panels, dry batteries, chargers, fuses, etc. An inset to the Catalogue gives interesting details concerning a novel Dynamo Cycle Lighting Outfit which may be fitted to any ordinary pedal cycle and which provides, under normal riding conditions, a powerful headlight and rear light. The illumination is provided by an 8-volt bulb which gives ample light, even at walking speed. [4.]

Watkins Providers

LIST No. 303, which costs 1*s.* from Watkins Provider, Exchange Works, Bridge Street, Newport, Mon., is a complete guide to the art of picture framing, and in addition to the concise instructions many picture mouldings are illustrated with fullsize sections. Reproductions of many good pictures are included in the Catalogue, which also gives details of various sundries such as glass, mirrors, putty, transfers, hangers, stools, plywood, etc. [5.]

Novel Turkish Bath

A HANDY booklet, obtainable from The Gem Supplies Co., Ltd., 230 Borough High Street, London, S.E.1, gives details of some novel home apparatus for Turkish, Russian, Hot Air, Vapour or Perfumed Baths to be obtained in any ordinary living-room. It is not even necessary to utilise a bathroom. [6.]

Don't forget to reserve your copy of the ENCYCLOPÆDIA OF POPULAR MECHANICS, see pages 28 and 29.

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