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PRACTICAL MECHANICS

JANUARY

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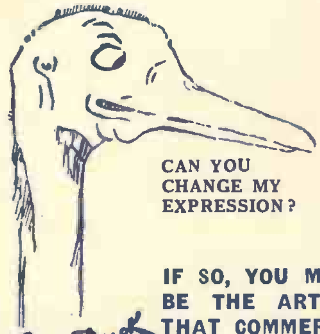

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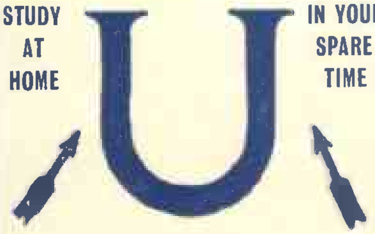

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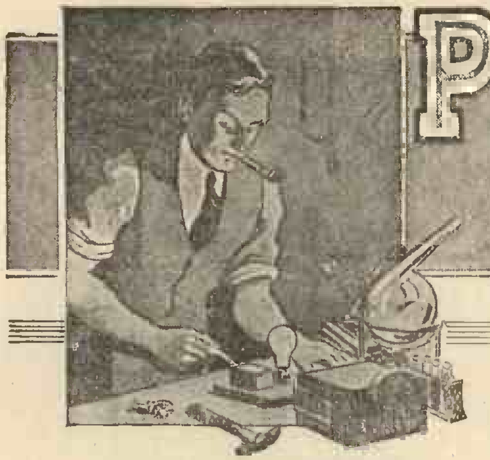

Practical Mechanics

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Edited by F. J. CAMM

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Notes, Views and News

The Return of Skilled Craftsmanship

CRAFTSMANSHIP in all branches of mechanics had developed in England thirty years ago to a point where we led the world for quality of workmanship, reliability of our products, and for native inventiveness. An apprentice in those days was one in a favoured position and envied by those forced to follow some cul-de-sac pursuit. The apprenticeship system was responsible for England providing the finest ships, the finest locomotives, the finest machinery and small tools, and certainly the finest craftsmen. It was probably a hard system. Apprentices had to work from six in the morning until six o'clock at night for 4*s.* a week during the first year of their apprenticeship, with a yearly rise of 2*s.* per week until the full period of apprenticeship (usually seven years) had expired. The apprentice having served that period would go forth as a journeyman or as an improver, and command a rate higher than the 16*s.* he would be receiving in his last year of apprenticeship, but much less than a fully-skilled man. It was usually after three years as an improver that he claimed the full rate of pay. A fairly heavy premium (about £100) was usually demanded by an employer before he would take an apprentice, who could merely claim two days' holiday a year—Good Friday and Christmas Day. The signing of the indentures was a solemn job undertaken in a solicitor's office, at which ceremony the apprentice placed his finger upon a seal and said "This is my act and deed;" but for the past twenty years fewer people have been apprenticed; the demand has been for well-paid jobs even by those of sixteen years of age, and there have been no skilled men to replace those of a past generation. The publication of PRACTICAL MECHANICS, however, indicates that the modern generation is returning to its interest in mechanical things, and readers' letters evince a lively desire for information on the use of tools and modern technical subjects. Our arrival was indeed timely!

Developments in Television

WIRELESS telephony has reached a remarkable stage of efficiency, but there is still the missing link—we cannot *see* the artistes or the announcer in the studio. The position of wireless to-day is analogous to the film industry a few years ago. We were then satisfied with silent films, but talkie picture technique is now so perfect that silent films have ceased to attract us. With the talkies we have speech and vision synchronised, and wireless cannot be considered as perfect until television and speech are similarly synchronised. Television to-day is on the brink of great developments. Many firms are experimenting with high definition television, and it would seem that *mechanical* television will not provide the solution. Television will probably be brought much nearer to perfection by means of the cathode-ray oscillograph. The problem will be solved by electrical rather than by mechanical means.

Encyclopædia of Popular Mechanics

IF you were one of the fortunate readers who reserved a copy of "The Encyclopædia of Popular Mechanics," you should claim yours by observing the simple conditions given last month, without further delay.

THE MONTH'S SCIENCE SIFTINGS

Two machines have been installed in a London hospital with the object of testing the value of wireless waves in the treatment of disease.

An American investigator, with the assistance of a British scientist and an engineer, proposes shortly to make an attempt to set up a new stratosphere altitude record by rising to a height of some 90,000 ft. Professor Piccard's record was recently beaten by two Americans, who ascended to an altitude of eleven miles.

The world's champion parachutist hopes to make a parachute descent from the "stratosphere balloon" when it reaches its greatest altitude.

The Southern Railway propose to construct a new loopline between Folkestone and Dover. To do this they propose to bore a tunnel four miles long below Dover Hill, Folkestone, to a point near Shakespeare Cliff, Dover.

Over ninety miles of tramway track in various parts of London are soon to be superseded by up-to-date trolley buses capable of carrying a larger number of passengers than the tram. Track vehicles on open roads should have been abolished years ago.

A new television scanning device, which combines a cathode-ray tube and a multiple selenium cell has recently been designed by an American scientist. The multiple cell takes the place of the normal fluorescent screen and is "scanned" by the ray in the normal manner.

The L.M.S. Railway's "Royal Scot" has recently returned from a tour of 11,194 miles in Canada and U.S.A. During the tour the locomotive was inspected by 3,021,601 sightseers.

A spring-operated clock has lately been placed on the market which is perfectly noiseless in operation (it cannot be heard even when placed close to the ear) due to the use of a new type of escapement. The clock can also be obtained fitted with a bell alarm.

A loud-speaker is now being made which is fitted with an electric clock. The clock replaces the usual fret and can be obtained in either synchronous (A.C. mains) or battery types.

Small Power Units

POWER units of the internal combustion type tend to get smaller and smaller. An 800 c.c. engine (approximately 7 h.p.) will do the same work as a 20 h.p. engine of a few years ago. The modern tendency to get the maximum amount of power from small high-speed engines is resulting in all-round economy in the upkeep costs of motor cars and other machinery. It was thought a few years ago that a successful petrol engine could not be made of smaller capacity than 30 c.c., but there are now several very successful miniature petrol engines of only 15 c.c., and one or two of only 10 c.c.

No Power in the Atom

A SCIENTIST at the recent meeting of the British Association stated that there was no latent power in the atom. Hence vanishes one of the dreams of scientific cranks and other fantastic characters who for years past have regaled the public with ungarnished tosh about propelling Atlantic liners and aircraft with the latent energy in an atom of this or that, and driving motor cars at incredible speeds with engines no larger than pins' heads. The unfortunate aspect of these scientific fantasies, especially when they emanate from those who are considered "scientists," is that schoolmasters pass them on to their students and so add to the list of things which must be "unlearned." As well, they are bruited about by large headlines in daily papers, which seldom report on a simple happening without making a mistake.

The association named could help to remedy this state of affairs by considerably tightening up the rules of membership. The mere presentation of a thesis (which may or may not be original) should not be sufficient to enable its compiler to call himself "Doctor."

Razor Blades to the North!

SOMEONE has rediscovered the "fact" that if you leave your razor with its edge disposed due north and south it retains its keenness for a longer period. This ridiculous claim has been advanced at intervals during the past fifty years. The argument is that terrestrial magnetism tensions the edge. If that be so, terrestrial magnetism would have the same effect in whichever position the razor is placed. A penny magnet would have far greater effect, and so would local electromagnetic effects. Another case of scientific moonshine!

Electric Clock

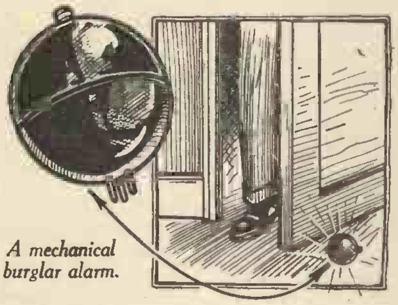
THE publication of our article on p. 140 of the December issue has convinced me that there is considerable interest in this subject. One or two readers have written to say that whilst they can get the pendulum to swing, the hands of the clock refuse to move. This is probably due to the fact that they have not made the slight but necessary alteration to the pallets which, of course, act upon the escape wheel. A short article showing this alteration will appear next month, in which many other striking articles of absorbing interest will appear.

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.

Ingenious and Cheap Burglar Alarm

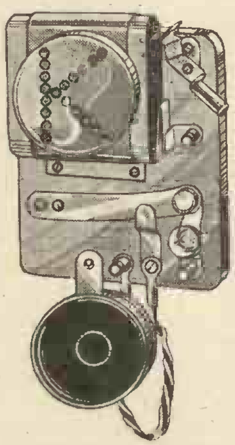
MOST burglar alarms are of the electrical make or break contact type and are expensive. Here is a device, however, of the mechanical type, costing only 5*s*. It is known as the Vesta and consists of a divided sphere, one half of which acts as a bell, the other half containing the mechanism and three legs. The device is wound up by twisting the two halves in opposite directions, and it is placed on the floor, legs downwards. The weight of the device causes the legs to recede into the body and act as a check. When placed behind the door, window, etc., opening them will cause the ball to roll. The three legs will shoot out and cause the bell to ring for several minutes. [23]



A mechanical burglar alarm.

Junior Telephone Set

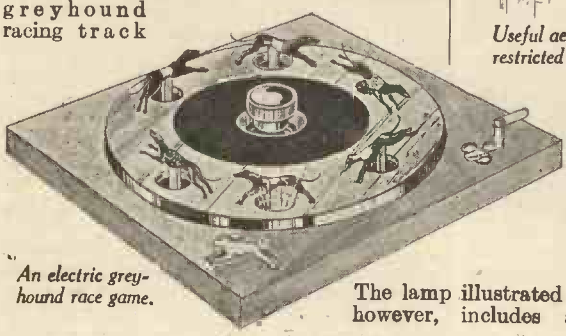
THE illustration shows an excellent little telephone set consisting of two instruments each complete with microphones, transmitters and receivers, a coil of triple wire, and two bulbs. Reception is excellent. It is operated by means of a dry battery and the set costs 12*s*. 6*d*. [24]



Junior telephone set.

An Electric Race Game

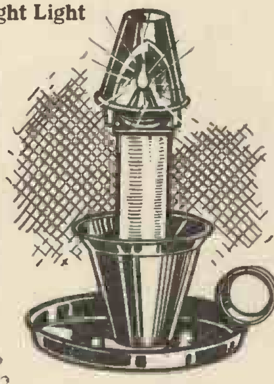
A FASCINATING race game for parties is illustrated below. It is an electric greyhound racing track with six greyhounds chasing hare. All of the colours flash up as the greyhounds reach the hare, and all doubt as to who is the winner is removed because the colour of the winner will remain illuminated at the finish. It is, of course, similar in principle to the game of roulette. It costs 10*s*. 6*d*. [25]



An electric greyhound race game.

An Ingenious Night Light

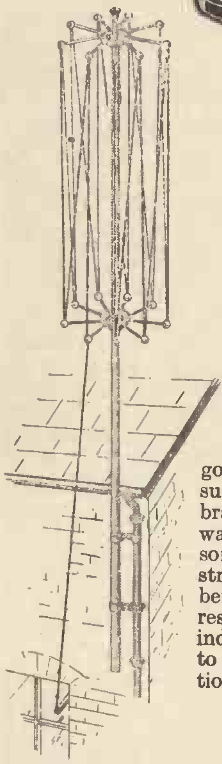
THE manufacturers claim that with the night light illustrated, which costs half a crown, you may obtain 100 hours' light for a penny. The vertical tube is stuffed with cotton wool, which soaks up the paraffin. Thus no oil is upset if the lamp is knocked over. They are finished in a variety of colours. [26]



An economical night light.

Aerial for Restricted Space

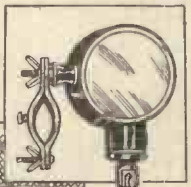
UNDER certain circumstances, where an outside aerial cannot be erected, the cage aerial illustrated will be found to give good reception. It is supplied complete with brackets for fixing to the wall. Whilst perhaps some may claim that a straight wire aerial is better, this will yield results superior to an indoor aerial owing to its elevated position. [27]

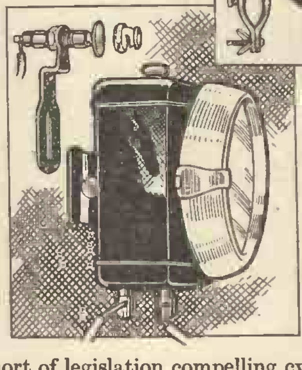


Useful aerial for restricted space.

New Cycle Light

CYCLISTS are only required by law to fit a rear reflector. Sensible cyclists fit a rear light. The lamp illustrated on this page, however, includes an automatic flashing rear lamp complete with a head lamp, the flashing rear lamp and the brackets. The price is 6*s*. 11*d*. It strikes us as being a satisfactory solution to the rear light problem, which is in a very unsatisfactory position at the moment. We suppose that nothing short of legislation compelling cyclists to fit rear lamps will solve the trouble. [28]

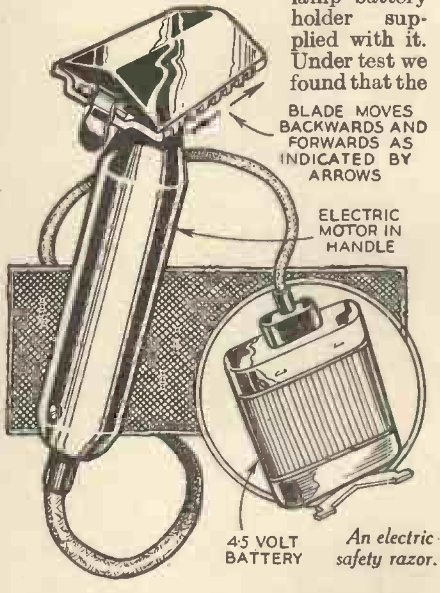




An electric cycle-lighting set with flashing rear light.

Electric Safety Razor

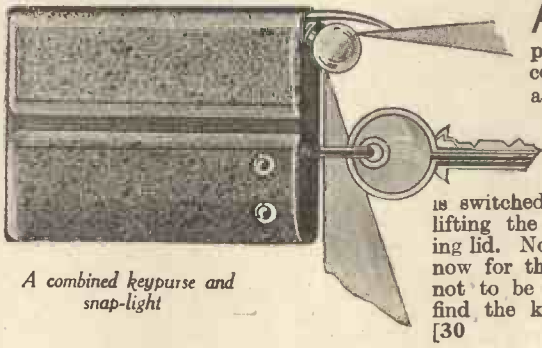
AN ingenious safety razor has a small electric motor incorporated in its handle which agitates the blade between the comb, and whilst the blade is drawn across the face thus gives it a shearing action, which will cut with ease the stiffest beard. A lead extends from the handle, and the plug at its further extremity fits into the special flashlamp battery holder supplied with it. Under test we found that the current consumed was only seven-tenths of 1 milliampere. The razor costs 25*s*. [29]



An electric safety razor.

Combined Keypurse and Flashlamp

A NEW key-purse combines also a small pocket torch, which is switched on by lifting the reflecting lid. No excuse now for the toper not to be able to find the key-hole. [30



A combined keypurse and snap-light

MAKING MAINS TRANSFORMERS FOR ALL PURPOSES

In this article the Author describes some simple methods of making at home Mains Transformers of any type

By FRANK PRESTON

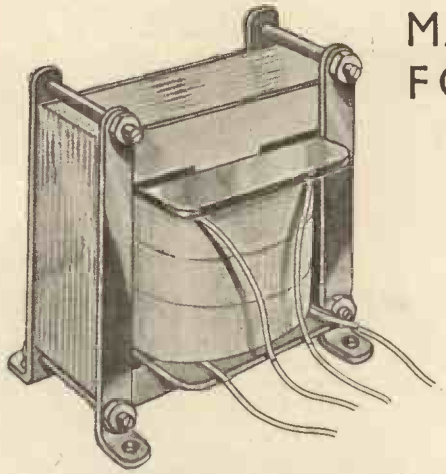
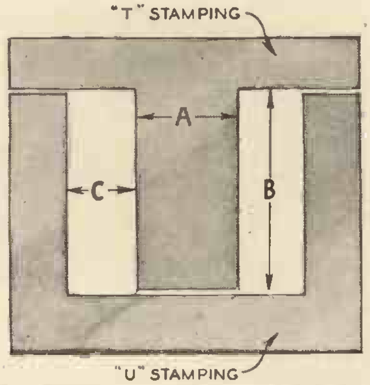


Fig. 4.—A finished mains transformer in which flexible leads are used for connecting purposes.

EVERY practical man, whether he be interested in model making, electrical experimentation, accumulator charging, chemistry or wireless, at some time or other requires a source of electrical energy. This can frequently — and expensively—be derived from batteries or generators, but the electricity mains provide a far more convenient and reliable form of supply. A.C. mains, in particular, are extremely useful to the experimenter, since the voltage from them can be changed to any required figure with the greatest of ease. All that is needed is a step-up or step-down transformer.



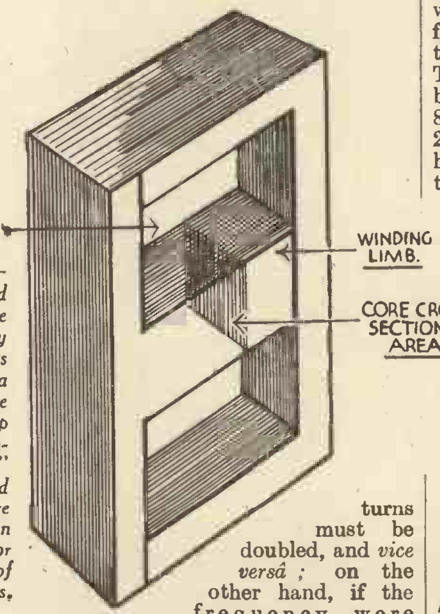


Fig. 1.—Dimensioned sketch of the stalloy stampings and also a sketch of the built-up core. Dimensions "A" "B" and "C" are given in Table I for stampings of various sizes.

Suitable transformers can very easily be constructed, whilst the work of making them is both interesting and instructive. It is fairly well known that a transformer consists essentially of an iron core upon which are placed primary and secondary windings, although most people find it very difficult to decide upon the size of core and numbers of turns required for any particular purpose. The necessary data can be obtained by making various somewhat complicated calculations, but if a few simple facts are known the arithmetic involved is not outside the scope of an intelligent schoolboy.

The relevant facts will here be given as briefly as possible, and also some tables which will remove any trace of tedium from the process of design.

Core Stampings

The type of core most frequently employed for small transformers is that consisting of a number of pairs of "U" and "T" shaped stalloy stampings of the kind shown in Fig. 1. When these are assembled they form a semi-solid core with two "windows" and a "winding limb" (see Fig. 1). Assuming that the stampings are of correct proportions (as all those on the market are) the numbers of "turns per volt" for both primary and secondary windings depend upon the cross-sectional area of the winding arm and the frequency of the mains supply. For example, if the area is 1 sq. in. and the frequency 50 cycles, eight turns should be allowed for every volt. If the area were halved the numbers of turns must be doubled, and *vice versâ*; on the other hand, if the frequency were doubled, the turns should be halved, and *vice versâ*. This rule, although so utterly simple, is invariable and forms the basis of all transformer design.

The stalloy stampings mentioned above are made in a variety of sizes, some of which are listed in Table I, where the "A," "B" and "C" dimensions are those defined in Fig. 1. In order to determine the most suitable size of stampings it is necessary to know the power, in watts, which the transformer has to handle. This is easily calculated by multiplying together the voltage and current (in amperes) of the secondary winding. For example, suppose the transformer had to supply 20 volts at 2 amperes, the wattage would be 20 × 2, or 40 watts. This assumes an efficiency of 100 per cent., but as the actual efficiency is generally about 80 per cent. the result must be increased by 25 per cent., which gives the power to be handled as 50 watts. Reference to Table I then shows that a core consisting of six dozen No. 4 stampings will be suitable.

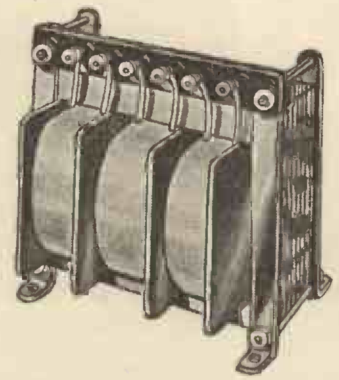


Fig. 5.—In this transformer a terminal strip is fitted and the winding spool is divided into three sections.

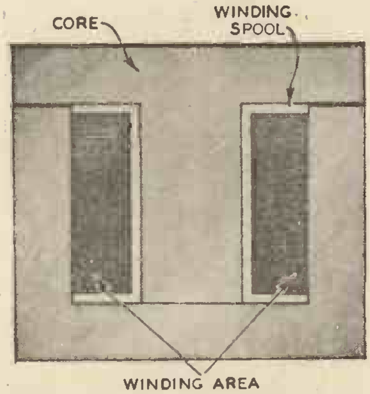
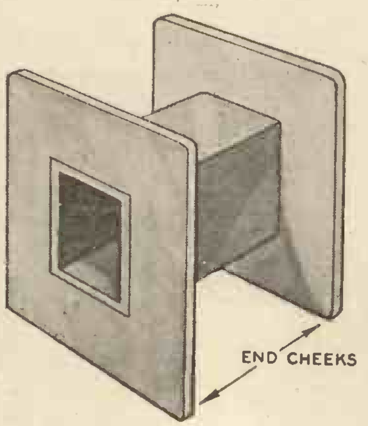


Fig. 2.—Section through a transformer showing the "winding area."

Choosing the Correct Wire Gauge

Once the core size has been determined the winding data can be compiled. Starting with the primary, which has to handle the total amount of power (50 watts), it will be seen from the Table that eight turns per volt will be required, so it only remains to decide upon the gauge of wire necessary to carry the current involved. The current is found by dividing the wattage by the voltage of the supply; for instance, supposing the voltage to be 200, the current would be 50 ÷ 200, or 0·25 ampere. The correct



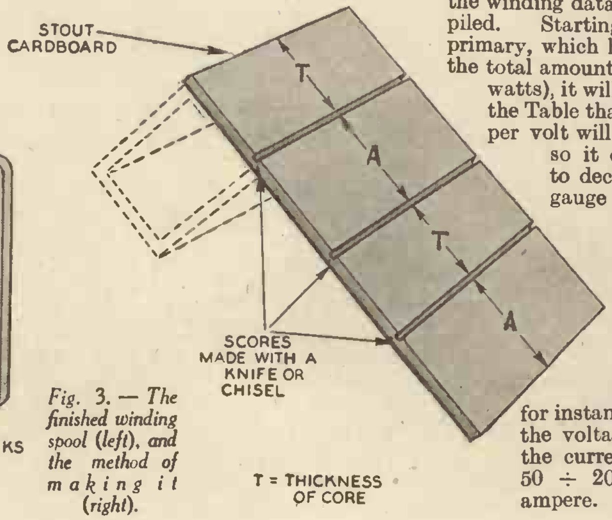


Fig. 3.—The finished winding spool (left), and the method of making it (right).

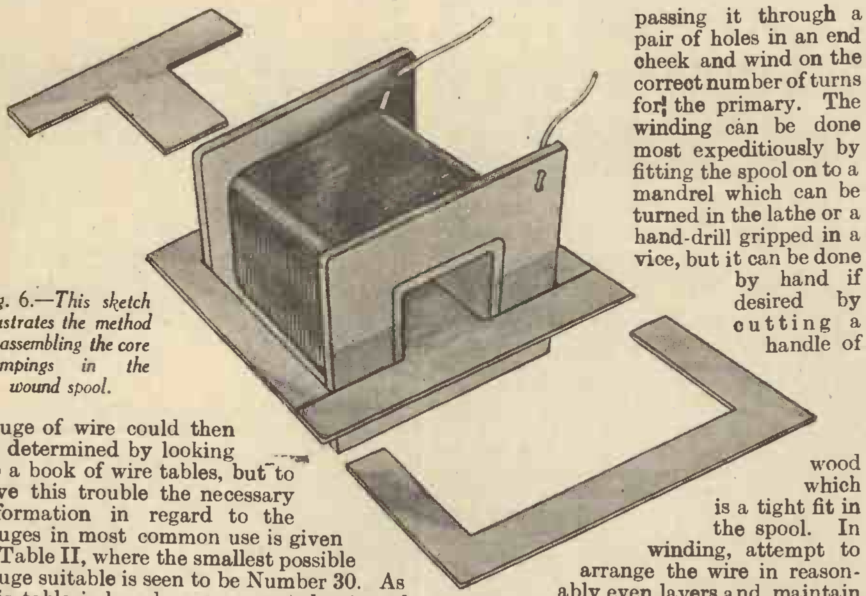


Fig. 6.—This sketch illustrates the method of assembling the core stampings in the wound spool.

gauge of wire could then be determined by looking up a book of wire tables, but to save this trouble the necessary information in regard to the gauges in most common use is given in Table II, where the smallest possible gauge suitable is seen to be Number 30. As this table is based on a current density of 2,000 amperes per square inch, however, it is slightly better, where space permits, to employ a gauge of wire one size higher than the minimum shown.

The secondary winding will consist of 8 × 20, or 160 turns, and since it has to carry 2 amperes the wire should be not less than 20 gauge.

In regard to the covering of the wire, this may conveniently be enamel in all gauges less than about 24, but for the stouter gauges it is better to use double-cotton-covered, since enamel is liable to crack and so allow turns to short-circuit.

Winding Area

The size of core was provisionally decided on in the first place, but as the winding data is now known, a check should be made by finding the actual " winding area " required (see Fig. 2). This area can easily be determined by making use of the " Winding turns per square inch " given in Table II. Taking the same example as before, we see that 28 gauge enamelled wire can be wound 3,760 turns per square inch, and therefore our 1,600 turns will occupy rather less than ½ sq. in. The secondary consists of 160 turns of 20-gauge d.c.c. wire, which can be wound 472 turns per square inch, and will therefore take up approximately ⅓ sq. in. In other words, the total winding area required is ⅚ sq. in., and as the No. 4 stampings provide 1½ sq. in. winding area they will be amply large.

The Winding Spool

We can now turn to the practical side of the question. We know what core stampings are going to be used and so we can make a spool to fit them. The simplest method of making the spool is illustrated in Fig. 3. A square-section cardboard tube is first required and can be made by scoring and bending a strip of stout card of the dimensions shown. Next, a pair of end cheeks must be made to fit tightly over the ends of the tube, and these can be cut out of stiff card or thin plywood and secured by means of strong glue. To make the bobbin more rigid it should finally be given one or two applications of thin shellac varnish and dried quickly. To cover the sharp edges of the bobbin, which might cut the wire whilst winding, a few turns of empire cloth or insulating tape should be wound on.

Winding the Primary

Now solder a short length of flex to the end of the 28-gauge wire, anchor this by passing it through a pair of holes in an end cheek and wind on the correct number of turns for the primary. The winding can be done most expeditiously by fitting the spool on to a mandrel which can be turned in the lathe or a hand-drill gripped in a vice, but it can be done by hand if desired by cutting a handle of wood which is a tight fit in the spool. In winding, attempt to arrange the wire in reasonably even layers and maintain steady tension on it to avoid slackness. After every four layers, or approximately 500 turns, it is advisable to cover the winding with a layer of empire tape, oiled silk or waxed paper to avoid the possibility of any two turns at widely differing potential getting close together. Take care that no later turns are allowed to slip past the layer of insulation.

After winding the requisite number of turns a second length of flex should be soldered to the end of the wire, taken once round the spool and anchored as before. Thoroughly insulate the primary by covering it with two or three layers of empire tape, etc., and then continue to wind the secondary, following the same procedure as with the primary. Finally cover the outer layer with insulating material to ensure that the windings cannot be damaged in any way.

Assembling the Core

The core stampings must next be fitted, and the method of fitting is clearly shown in Fig. 6. First a " T " and then a " U " are inserted from one end of the spool, after which a similar pair of stampings are inserted from the other end, this process being repeated until the spool is quite full. In order to make the core a tight fit (as it must be to prevent vibration), it might be necessary lightly to tap the last few stampings into position, but undue force must not be used or else there might be a danger of " bursting " the spool. It will be noticed that one side of each stamping is covered with a white insulating film and, to ensure that every one shall be insulated from the next, the white sides must face in the same direction.

Core Clamps

The last step is to fit suitable clamps to the core to hold the stampings tightly together and provide a simple means of mounting the complete transformer. These clamps can be made from ⅛-in. thick strip brass or steel, shaped and bent as shown in Fig. 7. They are attached by means of 1½-in. bolts and can be fitted with a terminal strip if desired, or connections can be made directly by means of the flexible leads from the windings. Both methods of finishing are shown in Figs. 4 and 5.

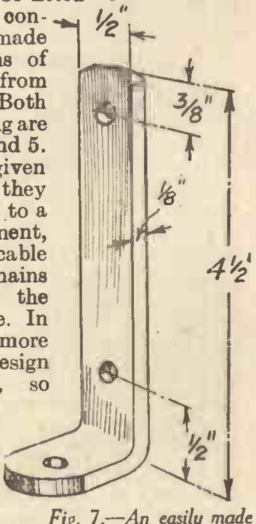


Fig. 7.—An easily made core clamp suitable for use with the stalloy stampings mentioned in the text.

All the details given above, although they have been applied to a particular component, are equally applicable to any pattern of mains transformer that the reader may require. In some cases it is more convenient to design the transformer, so that it can be used on any mains having a voltage of between, say, 200 and 250 volts. In that case the primary winding would require an additional 400 (eight 50) turns and tappings would have to be taken after winding 80, 240 and 400 turns for 240, 220 and 200 volts respectively. The tappings would be made by soldering suitable lengths of flex and passing these out through holes made in the end cheeks. To safeguard against short-circuit between the tapping points the soldered joints should be covered with a strip of insulating tape, or even with a piece of stamp edging.

When more than one secondary winding is required, such as for H.T. and L.T. supply for a wireless receiver, it is generally most convenient to divide the winding spool into three or more sections by fitting extra cheeks. The positions of these will be determined by the area required for winding in the different sections. In order to prevent mains hum it is best to place the L.T. secondary in the centre section, where it will serve as an effective screen between the primary and H.T. secondary windings. With all other kinds of " dual-secondary " transformers the primary winding should be arranged between the other two.

TABLE I

Details of Stalloy Core Stampings

Size No.	Dimensions. A.	B.	C.	Number of Stampings.	Approx. Watts.	Turns/Volt (50 cycles)	Approx. Winding Area.
	in.	in.	in.	doz. prs.			sq. in.
4	15/16	2 5/16	7/8	6	50	8	1½
5	⅝	1½	¾	6	30	12	¾
28	1¼	3	1¼	6	250	6	3
29	2	4½	1⅜	6	300	4	5¼
30	15/16	1⅛	⅞	6	45	8	¾
31	1	3½	1	6	100	8	2⅞
32	1	2¼	1	6	75	8	1¾
33	1¼	2¾	1	6	125	6	2¼
35	1½	3¾	1⅝	6	200	5	5¼

This table covers most of the commoner sizes of stampings, but some makers give different numbers to stampings of similar size.

TABLE II

Copper Wire Data

Standard Wire Gauge.	Max. Working Current (amps.)	Enamelled: Winding Turns per. sq. in.	Enamelled: Yards per lb.	Double-Cotton-Covered: Winding Turns per sq. in.	Double-Cotton-Covered: Yards per lb.
16	6·5	226	26·3	173	25·5
18	3·6	392	46·9	297	45·5
20	2·0	685	83·3	472	79·4
22	1·25	1,110	137	592	129
24	0·76	1,770	221	977	203
26	0·51	2,560	330	1,280	294
28	0·35	3,760	488	1,630	422
30	0·25	5,370	694	1,990	587
32	0·18	6,890	915	2,550	755
34	0·13	9,610	1,202	3,020	1,024
36	0·10	13,500	1,840	4,100	1,477
38	0·06	20,400	2,810	5,100	2,287

In the above table the "Max. Working Current" (in amperes) is based on a figure of 2,000 amperes per square inch.

HOW IT WORKS

THE IRIS DIAPHRAGM

This article describes, in simple language, how the Iris Diaphragm varies the amount of light allowed to pass through the lens.

By DAVID CHARLES

OF course the human eye *is* a lens, or rather a complete camera! Its transparent curved front is the lens itself, which focusses a tiny image of what is in front of it on to a sensitive film at the back, called the retina. In between the two, just as in a cine or a still camera, is the iris diaphragm, where it serves purposes practically identical with those it does in photographic apparatus.

When the light is glaring to the eye, the iris closes automatically, so reducing the amount of light passing through, and lessening the strain on the optical nerves. In similar fashion, when the light is extra bright, one closes down the iris of the little cine lens to avoid over-exposing the film by the flood of light. On the other hand, when light is poor the iris of the eye opens, to admit a bigger volume of light and enable one to see in the gloom. One does this knowingly with the lens on a camera, and automatically with that of the eye.

The Focus of the Human Eye

A cat is said to see in the dark, but actually it is only the fact that the iris of a cat's eye will open very wide indeed, so that it can pass a maximum of very dim rays, such as the human eye sees only with difficulty. The human iris opens and closes more slowly and less extensively than the cat's, and the effect is less noticeable.

The one great difference between the iris of the eye and that of a photographic lens is that the latter is often closed down to provide "depth of focus" between near and more distant detail. The iris of the eye will respond only to differences in light-volume, and although, of course, it does actually give more "depth of focus" when it closes in a strong light, the amount is neither appreciable nor noticeable. How, then, does the human eye see near and far at the same time? The answer is that it does not. Nor does it "focus," as the photographic lens does, by moving to and fro. The lens of the eye focusses by a muscular action which actually increases or decreases the curvature of its front surface; and so, without altering its distance from the retina, it changes its focal length according to the distance from it of the object looked at. The eye makes this adjustment with surprising swiftness, but it is a fact that it never sees clearly a distant object at the same time as a near one, like a camera lens with a small iris aperture does.

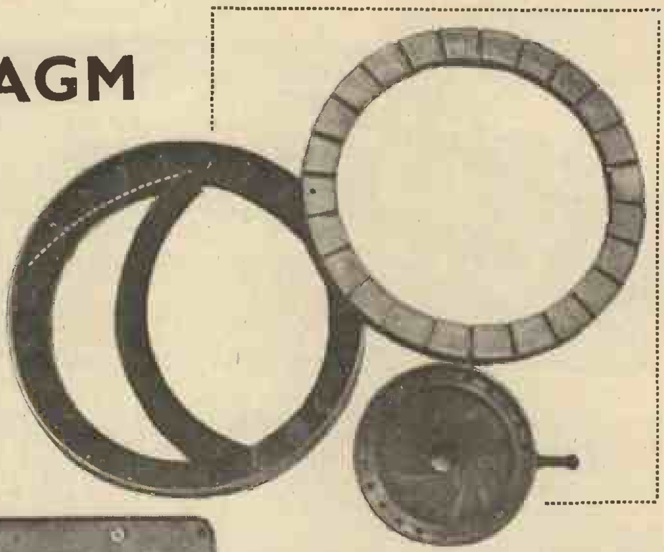


Fig. 1.—This shows the construction of a metal lens diaphragm. The dotted line shows the maximum movement of one leaf from full open to small aperture.

Fig. 4.—An uncommon form of iris used for rapid opening and closing of a large shutter.

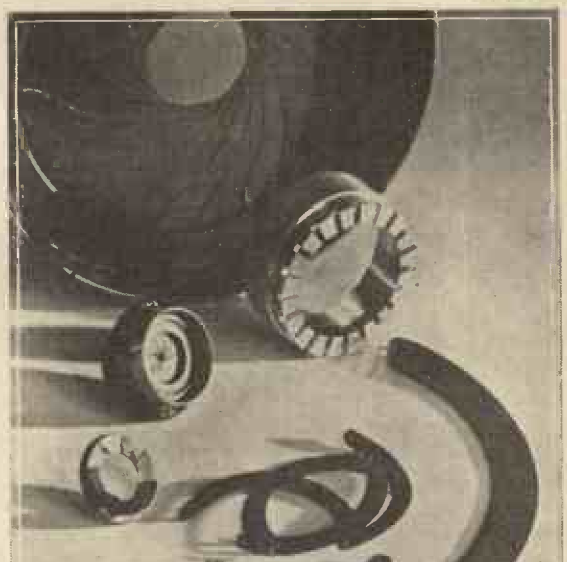


Fig. 2.—Shows the varied sizes in which irises are ordinarily made. The smallest one is less than ⅝ in. outside diameter.

A Mechanical Iris

The making of a mechanical iris which shall open and close while retaining a central circular aperture throughout the range of movement is an interesting problem. This is especially the case when it is considered that, when fully open, the parts must not materially increase the diameter of the lens-mount, to the extent of making it cumbrous.

The solution of this problem is achieved by the use of a large number of overlapping segments of extremely thin metal, of such a shape that they lie in a flat ring around the circumference of the lens-mount. See the larger iris in Fig. 1. A small pin is riveted into each end of each leaf, and on opposite sides of it. One of these pins lies in a hole, acting as a bearing, in the fixed flange of the lens-tube. The other pin is moved by means of a slotted ring which turns in the flange. The reason for slots instead of holes in this ring will be seen by the dotted line in Fig. 1, which indicates the extreme movement of a single leaf towards the centre of the aperture. When *all* the leaves move together, they overlap and form the aperture as seen in the smaller iris in the same (*Continued on page* 196).

Fig. 3.—Gauge for ensuring accurate marking of apertures.

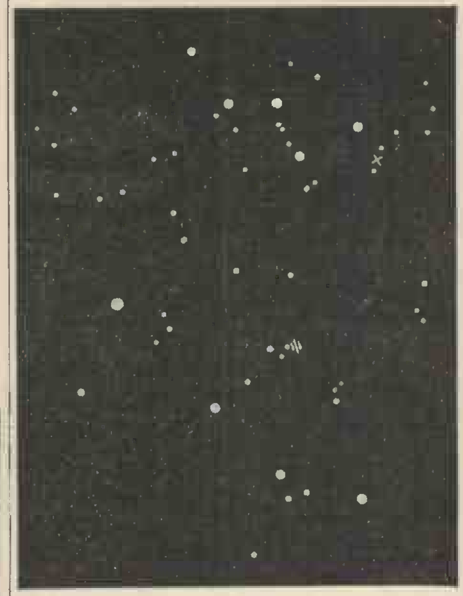
A WONDERFUL NEBULA

By N. de NULLY

THOUGH disturbances on the sun's surface continue with comparative infrequency, there are already indications that the period of sunspot minimum has been reached, if not actually passed. Groups of small spots are appearing in northern solar latitudes, presages of the commencement of another eleven-year cycle, with a maximum five or six years hence. The sun's disc should therefore be examined from time to time in case a particularly large spot be unexpectedly formed. Observations should always be made through the medium of a solar prism, dark cap or screen of smoked glass, no matter whether a telescope, binocular or naked eye be employed, otherwise there will be grave danger to sight. A 3-in. telescope, with an eyepiece magnifying 100 or 150 diameters, will show the cavity-like structure of these solar cyclones, and it will be interesting to watch their changes of form from day to day. A low power of 50 diameters or so will suffice to locate them in the first instance.

The Moon

The moon will be at last quarter on the 8th, meanwhile rising soon after sunset and getting gradually later, but remaining above the horizon throughout the night. Possessors of even the smallest telescopes will find many attractive features to inspect along the "terminator" or broken line dividing the bright from the dark portion of the disc. Full moon being passed, every eminence will now be lit up by the setting sun, whereas from new to full they are brought into relief by morning illumination. It will be new moon on the 15th and, if the western sky be clear of mist and cloud two or three evenings later (when the crescent has emerged from the glare of sunset), a magnificent chain of four ring mountains will be found lying along the southern horn. These features have been named Funerius, Petavius, Vendilinus and Langrenus (in order from the top as seen in an inverti g astronomical telescope). They are really immense walled-plains 80 to 100 miles across, and enclosed by massive broken ramparts bristling with peaks rising to heights of 11,000 ft. We are, of course, looking down into them as from an aeroplane. Below Vendilinus, towards the northern horn of the crescent, lies the comparatively smooth expanse of the Mare Crisium, an oval-shaped depression covering an extensive area bordered by lofty cliffs. This is one of those shaded patches on the moon which gave the ancients the impression of lunar seas and oceans designations which still cling, notwithstanding that they are now regarded as arid tracts.



Star map showing the positions of the Cluster in Cassiopeia (marked by a x) and the Nebula in Andromeda (indicated by three short parallel lines).

Star Cluster in the constellation Cassiopeia. (From a photograph by Dr. I. Roberts, Crowborough, taken with a reflecting telescope of 20 inches aperture. Exposure ninety minutes.)

The Planets

None of our companion worlds are favourably placed for amateur observation this month. Mercury is invisible and Venus is an early "Evening Star," setting in the south-west about 7 p.m. Jupiter does not rise until after midnight, and is therefore a "Morning Star." Mars and Saturn both set about 6 p.m., and are too deeply immersed in twilight and horizontal vapours for critical examination; they will be found close together on the 20th, not far from Venus.

The Stars

Several conspicuous constellations are now conveniently situated for viewing during the moonless evenings from the 7th to the 17th (weather permitting), and here again much can be seen with binoculars and small telescopes. For instance, Cassiopeia (the Lady in her Chair) may be easily identified by its five prominent stars arranged in an irregular W. At this time of the year this constellation is high up in the west, set against a background of part of the Milky Way. Cassiopeia contains an open star cluster of which the accompanying photograph gives a representation as it is seen through a large telescope. In a small instrument it appears as a faint cloud of minute stars, but there are rich fields to explore in the neighbourhood.

Below Cassiopeia lies the straggling constellation Andromeda (the Chained Lady), linked up, so to speak, with the adjacent group Pegasus (the Flying Horse), the latter noticeable in the form of a rectangle of stars known as the Square of Pegasus. In Andromeda is one of the largest so-called nebulæ

(*Continued on page* 200.)

The Great Nebula in the constellation Andromeda. (From a photograph by Professors Ritchey and Pease, taken with the reflecting telescope of 24 inches aperture at Yerkes Observatory, U.S.A. Exposure four hours.)

The pleasure obtained from model boats, either sailing boats or power boats, can be greatly enhanced by fitting the simple automatic steering device which is described below. It enables the boat to describe almost any predetermined course

THIS simple attachment enables you to operate the rudder of the boat as you desire while the boat is in motion. A model boat fitted with this attachment can be made to take any desired route instead of always following a straight course from one side of a pond to the other. A few seconds' thought will show you that this adds immensely to the variety of this fascinating pastime. For instance, by the use of a properly designed steering cam, a sailing boat can be made to tack against a head wind. A power boat, either steam or clockwork driven, can have the steering cam designed so that the boat will proceed from one end of the pond to the other and back again to the starting point, or perform any other evolution decided upon beforehand. Figs. 1 and 2 show the idea so clearly that very little explanation is needed.

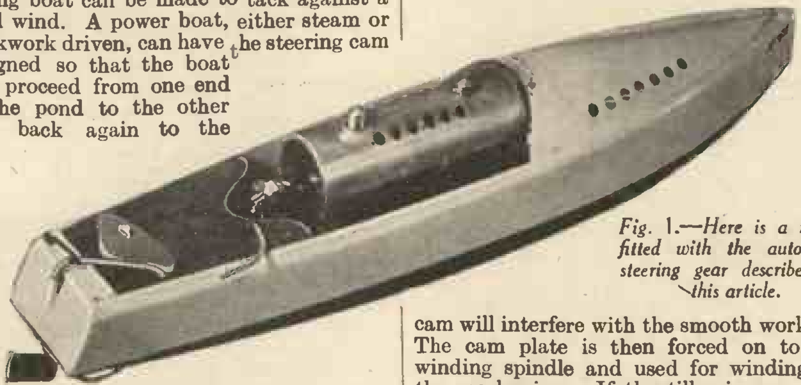


Fig. 1.—Here is a model fitted with the automatic steering gear described in this article.

A small clockwork mechanism is fixed into the stern of the boat with the winding spindle projecting from the top. On this winding spindle is fixed a suitably shaped cam, against which the tiller is lightly pressed by means of a spring. The clockwork is set in motion when the boat puts off. The cam rotates slowly, moving the tiller in the manner desired. By fitting a simple form of speed control to the clockwork mechanism and by using a number of different shaped cams a wonderful variety can be obtained. The parts required are as follow:—

(*a*) The works of a small alarm clock;

(*b*) A few pieces of plywood to form the cam plates;

(*c*) A light spring for holding the tiller against the cam surface.

Take the clock mechanism to pieces and put it together again, omitting all the dial mechanism and also the balance wheel or escape pallets and the striking mechanism. Fix a small lever to the frame so that it can engage with the escape wheel for stopping and starting the mechanism. Take the winding key and remove the loose portion. Then file the top of the barrel to a triangular section. Drill a hole through the stern cover of the boat to allow the winding spindle to project through it and fix the clockwork mechanism underneath the cover, as shown in the photograph and sketch.

Cutting the Cam Plate

A design is given for a suitable cam, but most enthusiasts will decide to experiment with several different shapes. Whatever shape is decided upon—mark the outline on a piece of three plywood, cut a small hole in the centre or "origin" of the cam and finish this to size, using a triangular file so that it is a tight fit on the top of a winding spindle. Cut out the shape with a fret-saw and afterwards go carefully round the edges with sand paper to smooth out any irregularities. This is most important, as otherwise the irregularities on the edge of the cam will interfere with the smooth working. The cam plate is then forced on to the winding spindle and used for winding up the mechanism. If the tiller is now held against the cam plate whilst the latter is rotating, it will be found that the rudder moves through an angle of about 60 degrees to the left of the centre line. In order to correct this the tiller must be bent over about 30 degrees to the right. The rotation of the cam will then cause the rudder to move about 30 degrees on each side of the central position.

Fix the retaining spring to the tiller as shown in the sketch. The starting lever is desirable, though not essential. A small piece of brass strip, about 1½ in. long by ¼ in. wide, secured to the clockwork frame by a small screw so that it can be brought up against the escapement wheel when it is desired to stop the mechanism, is all that is required for this.

The mechanism, as described above, is exceedingly simple to construct, and, using the clockwork from a small alarm clock, it will be found that the steering cam will rotate slowly for from one to two minutes.

A Simple Speed Control

Enthusiasts who wish to add a further refinement can fit a simple form of speed control on the clockwork mechanism. The simplest method is to use a very light flat steel spring to press lightly on the edge of one of the wheels in the clockwork. This will have the effect of reducing the speed at which the cam plate rotates so that the length of run may be increased up to as much as five minutes.

The cam plate shown in the sketch herewith has given very good results, but it will be found extremely interesting to try the effect of different shapes. Readers with a mathematical turn of mind may like to calculate the shapes to give any desired steering sequence, but most people will find it very much simpler to cut out a few trial cam plates and observe the results in actual practice.

In conclusion, it may be mentioned that, so far as the writer is aware, this method of automatic steering has not before been applied to model boats. It has been specially evolved for those readers of PRACTICAL MECHANICS who have not the facilities for experimenting with the more complicated methods of wireless and light control which were described in our October and November issues.

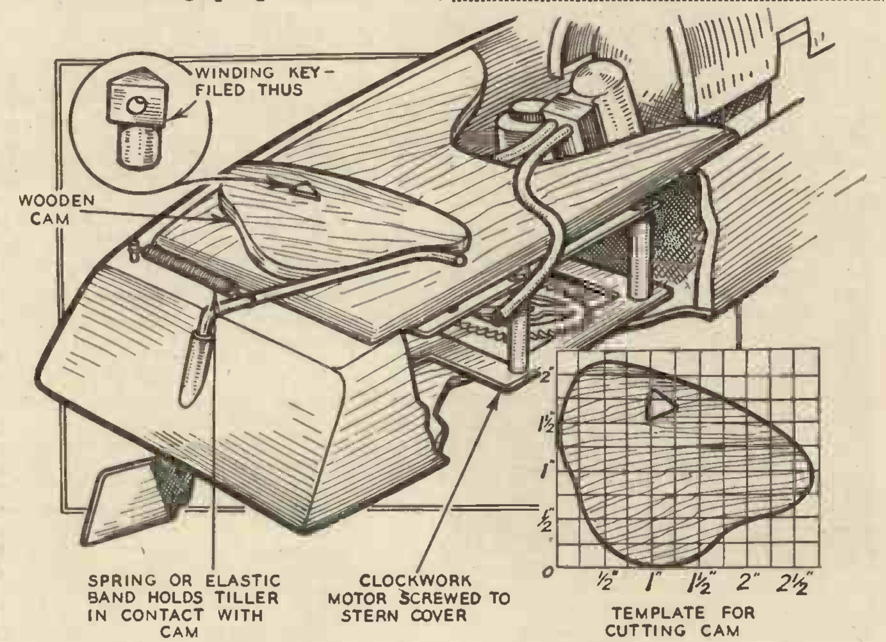
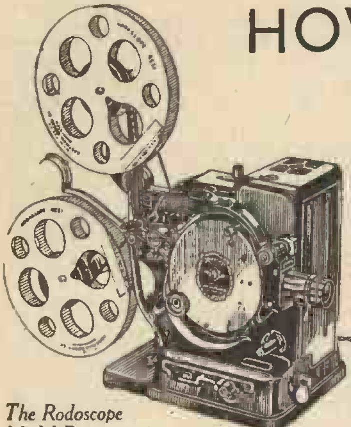


Fig. 2.—Constructional details of the automatic rudder.

HOW TO GET GOOD CINE EXPOSURES

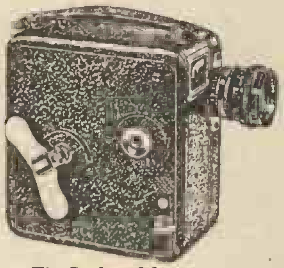
By PERCY W. HARRIS, F.A.C.I.

Editor of "Home Movies and Home Talkies."



The Rodoscope Model B projector

If you are comparing two amateur cine films, one of which is good and the other bad, photographically, the difference will nearly always be that one of the films is properly exposed and the other is not. Indeed, if you master the problem of correct exposure you will have mastered nine-tenths of the mysteries of good home movie-making.

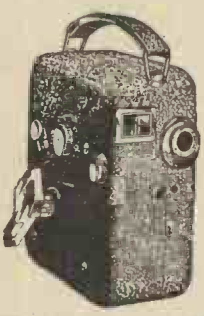


The De-luxe Moto-camera.

It is surprising how many home movie makers fail to recognise faults of exposure when they see them on the screen. Remember that nowadays there is no excuse for anyone saying, "That is very good for an amateur!" It can be said without fear of contradiction that the best amateur work is now, photographically, every bit as good as the best professional work—this was proved conclusively at the Exhibition of Prize-winning Amateur Films at the Annual Dinner of the Institute of Amateur Cinematographers this year. Leading professional producers all agreed on this point. So if you are showing your films and someone says, "They are very good for an amateur!", ask yourself in what way they fall below professional standards and then set yourself the task of rectifying the fault.

Outdoor Scenes

Take outdoor scenes for a start, as these represent the majority of amateur pictures taken. If on the screen the picture is thin, grey and "washy"; if the sky and brightly lit parts of the subject, such as white dresses, whitewashed walls, etc., are completely blank, with perhaps fuzzy edges; if objects such as tree trunks, chimneys, flagpoles, church spires and the like, which should be silhouetted against the sky, blend into it and are either lost or lack definition, then your film is *over*-exposed. If, on the other hand, your picture is very dense and dark, with excellent quality in the high lights, but nothing but sooty blackness in the less well-illuminated parts and shadows, then your picture is *under*-exposed. If your picture contains a wide range of light from, shall we say, a brilliantly lit sandy beach, on one side, with very little in the foreground, and on the other some people sitting in a deeply shaded shelter nearby, then you may get one of two effects: either your shadow details in the shelter will be perfectly rendered and your beach and distance in the sun have little detail or be practically bleached out of existence, or else your sky tones, sea, beach, etc., will be nicely rendered and your shelter will be filled with inky blackness. In such a scene as this you are asking too much even of the best modern films, for the latitude of the emulsion is such that it cannot embrace too wide a range of tone renderings at the same time. Remember, the human eye can clearly perceive an enormous range of light intensities—far greater than is possible with any plate or film on the market, and thus, while *you* may see clear shadow detail in the shelter without the brilliantly illuminated background dazzling your eyes, the camera and film are much more easily distressed. Furthermore, as you may have perceived, the human eye is fitted with an iris diaphragm which is automatically opened and closed to accommodate itself to varying intensities of light. When you are looking at a very bright subject the aperture is closed down, and when you are trying to observe in the dark it is opened wide.

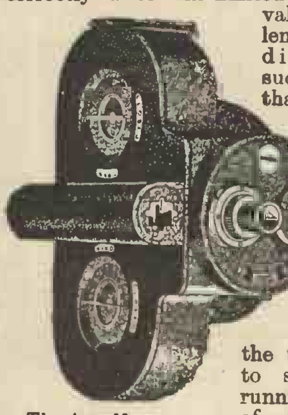


The Pathescope Moto-camera "B."

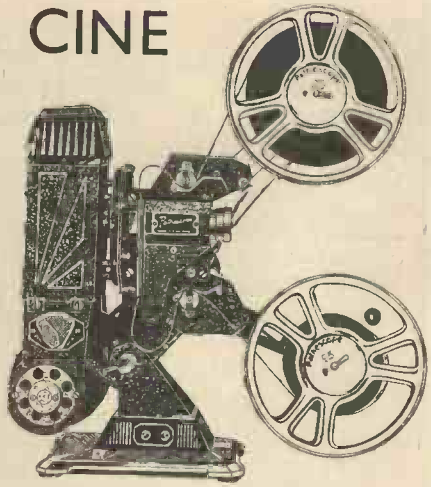
The Scenes to Choose

It is wise, then, when filming to choose scenes which do not include too great a range of light values unless you have no option, but to do so when you want a particular scene. I explained in the last article how, in controlling exposure with a cine camera, the only thing we can alter is the opening of the lens or the "F number," the shutter speed being constant. As the film itself can only register correctly a certain limited range of light values our problem is to set our diaphragm to such an opening that the light received in approximately a thirty-second of a second will give a good image of all the tones we want to show without running to the limit of the emulsion latitude. Some subjects which do not include any sky or very deep shadow have such a limited range of tones that there is plenty of room for them within the emulsion latitude. Such kinds of picture, as, for example, well-lit garden scenes with neither sky nor very white objects, will come out equally well at several different diaphragm openings, even when the largest of the several openings gives four or five times as much light as the smallest. By "coming out equally well" I mean that when you get your film back from the processing station you will not notice much difference in quality on the screen, but of course the more light which falls on the film the denser the final picture will be. But, apart from the density, the picture tones will be properly rendered, and it will simply mean that more light is required to show the denser pictures on the screen than is the case with the thinnest. However, nowadays the developing stations when processing your films adjust the density during printing, and by using several devices and methods, which are too complicated to explain here, a large degree of compensation for errors of exposure is introduced. This compensation is so good nowadays that quite a lot of movie-makers become careless, imagining that because their films come out passably well they are exposing correctly.

The Cine Kodak "8."

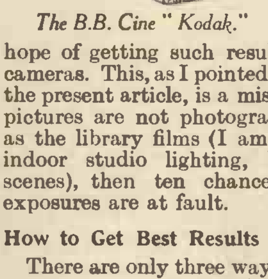


The Auto-Kinecamera.



The Pathescope "200-B" projector.

I have often observed amateurs showing library films on home apparatus and explaining to the assembled company that, of course, their own pictures are "not so good as these photographically because these are professionals," as if there were no hope of getting such results on their own cameras. This, as I pointed out quite early in the present article, is a mistake, and if your pictures are not photographically as good as the library films (I am not referring to indoor studio lighting, but to outdoor scenes), then ten chances to one your exposures are at fault.



The B.B. Cine "Kodak."

How to Get Best Results

There are only three ways. The first is to go on experimenting and exposing films by the yard, 100 ft. or mile over several years until your eye and brain have become accustomed to every conceivable lighting condition and you can "judge" by inspection of the scene and the light what stop to use. This is generally called "learning by experience," and is quite a good scheme if you are a millionaire and can wait several

(*Continued on page* 168.)

A SMALL PRECISION LATHE FOR MODEL MAKING—PART I

The simple $1\frac{3}{8}$-in. centre lathe described in this article is not, of course, intended for large work, but it will be found extremely useful for making small parts within its capacity. All of the work may be undertaken on a Drummond or any similar lathe, and when completed will be found a most useful accessory to it.

THE purpose of this article is to give a design for a lathe upon which fine and accurately turned work may be done of the kind which is called for chiefly in small, high class model making; at the same time which would be almost equally useful in other fields of high precision metal work, even that of watch and clock making and repairing. As most model makers know, the degree of accuracy required becomes greater as the scale of the model is reduced. There are many model makers to whom the greatest fascination is to be found in the really tiny model. In railways, for instance, large scales do not appeal, and such miniature gauges as that known as the 00 possesses the greatest charm. Now it is extremely difficult to turn out locomotives and rolling-stock of this small size on an ordinary, say, 3 in. or $3\frac{1}{2}$ in. lathe, and, short of a costly watchmaker's lathe, there is no other small tool on the market which meets the case.

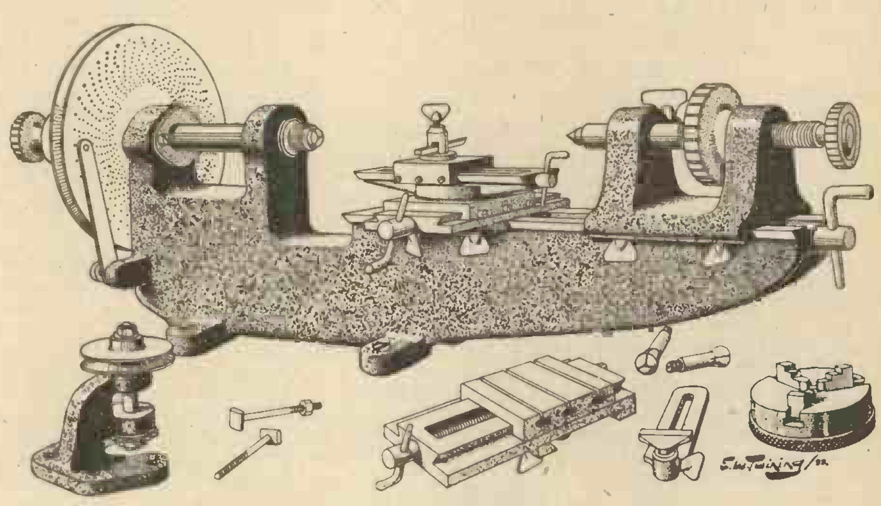
Size of Lathe

For the purpose for which it is designed a height of centres over the bed of 1 in. should be ample. This is the measurement which has been adopted, with a gap which will allow of a diameter of 3 in. being swung at the mandrel nose. The maximum length of work which can be taken between centres will be $4\frac{3}{4}$ in., the length of the bed from the gap to the end being $6\frac{3}{8}$ in.

Chief Points in Design

In a general way the lathe is of the standard engineer's type, except for the fact that it is not arranged for screw-cutting. The bed is heavy and rigid with the headstock cast as an integral part of the bed. The top slides are of the double, flat, English pattern, giving large, ample wearing surfaces. The head stock is long, giving great steadiness to the mandrel, which is hollow and runs in oppositely coned, bronze adjustable bearings, split and coned for taking up wear. The end of the mandrel is screwed $\frac{1}{2}$-in. Whitworth to take small, self-centring and independent chucks or a face plate. Besides this arrangement for holding work a draw-in spindle is fitted in the hollow mandrel and the inside of the nose is coned to take stepped chucks, or split chucks or collets. The tailstock also is hollow and fitted with a further draw-in spindle for holding similar chucks or back centres. The sliding poppet is screwed on the outside and has a milled wheel for the slow feed in drilling, etc.

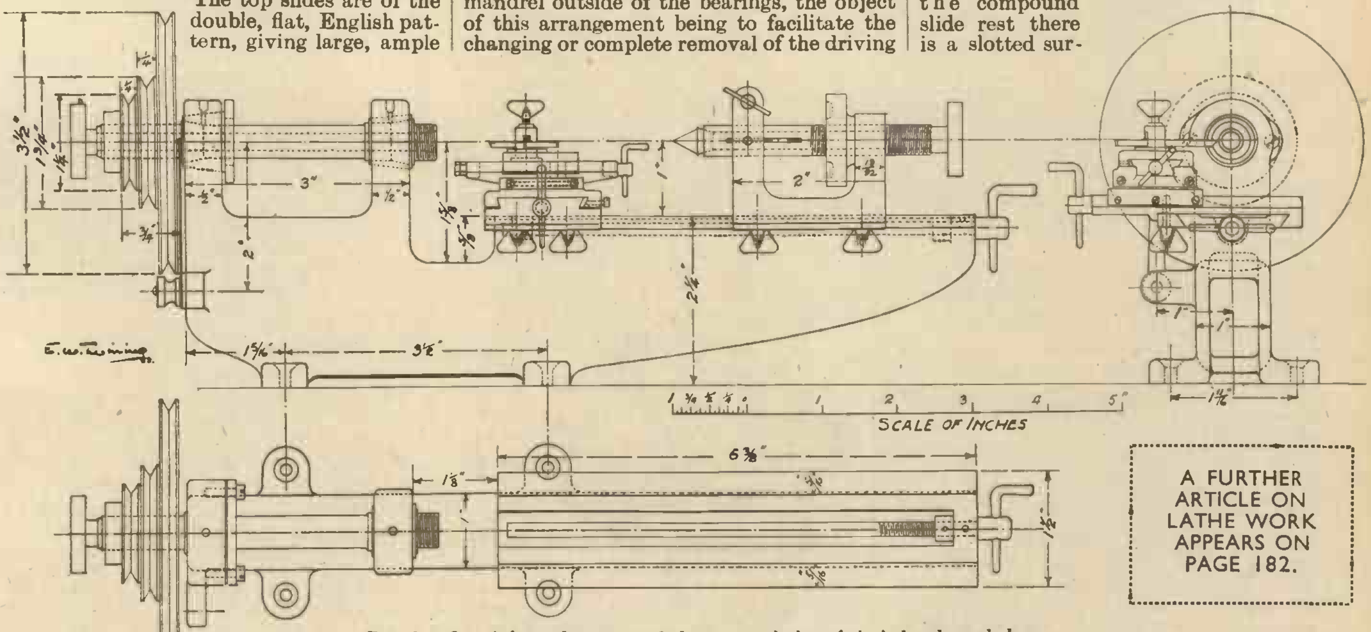
Returning to the headstock, the driving pulleys are carried on an extension of the mandrel outside of the bearings, the object of this arrangement being to facilitate the changing or complete removal of the driving belt. There are three stepped, coned pulleys, the largest being of big diameter, so as to render it equivalent, or nearly equivalent, to the back gear on a large lathe. The inner face of this wheel is perfectly flat and serves as a division plate, the index pin for which is carried on a lug projecting from the cast bed.



A view of the finished lathe.

The Slide Rest

The slide rest proper is fully compound and swivelling. The longitudinal movement of the rest, that is to say, the traverse, is controlled by a long screw driven by a handle at the tail end of the bed. The cross-feed at right angles to this is of the ordinary pattern, as is also the secondary feed for taper turning. The slide rest turning tool is held in a tool post of the American pattern with cup washer and tilting plate. Besides the compound slide rest there is a slotted surfacing table, by means of which boring and other such machining can be done. The slide rest and surface table are interchangeable by removal from the bed at the mandrel end.



Figs. 1 to 3.—A front elevation, end elevation and plan of the bed and mandrel, etc.

A FURTHER ARTICLE ON LATHE WORK APPEARS ON PAGE 182.

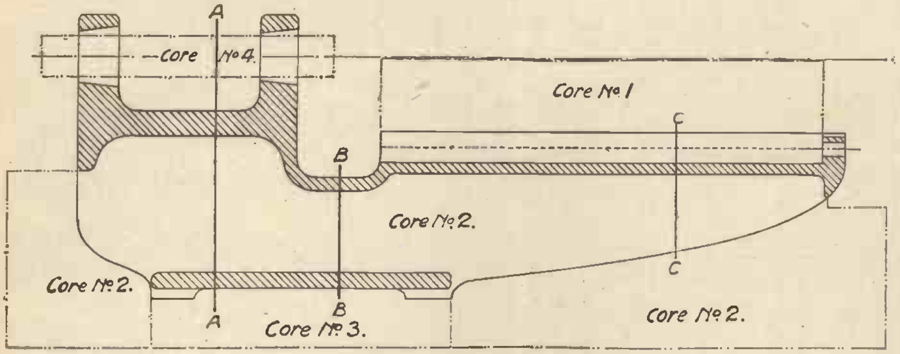


Fig. 4.—A longitudinal sectional view of the bed.

The Drawings

Fig. 1 shows a front elevation of the lathe with the slide rest and tailstock in position. Fig. 2 is a tail end elevation showing the slide rest, but with the tailstock removed. Fig. 3 is a plan showing the whole of the bed, but with the slide rest and tailstock omitted. The reader is asked to note that the great bugbear of lathe work generally, the spanner, is carefully dispensed with. Every part of this little lathe can be unclamped, moved, readjusted and re-clamped with the fingers only or, in a few cases such as the complete removal of the slide rest, by the use of a screwdriver. It may also be mentioned at this point that the scheme for the driving of this lathe is that the lathe itself would be screwed down by means of the four lugs, shown at the base of the casting, to the work bench and immediately behind it, also on the bench, would be mounted a small electric motor. The kind of motor which is eminently suitable for the work is a Klaxon, type K.M.U. 10191, Series Universal. This little machine is quite low in price and gives a considerable range of alternative speeds. Drives may be taken direct from the armature spindle or from a secondary shaft driven by worm and tangent gear. If the motor is provided with coned pulleys on both the armature and the gear shaft, and an arrangement made on the bench for quickly rotating the motor through an angle of 90 degrees, mandrel speeds on the lathe of between about 2,500 r.p.m and about 50 r.p.m. can be readily obtained.

It is proposed before completion of the drawings to give a design for an attachment for clamping to the surfacing table to enable gear cutting to be done between centres, the cutter being run on a vertical spindle carried by the attachment. In such gear cutting the division plate and index pin would be used. To drive the cutter the electric motor would be moved to a new position opposite the centre of the lathe, the belt being taken direct from the motor to the vertical spindle.

The Design of the Bed

Coming to detail design and construction, the bed will be taken in hand first. This will be best made in cast iron, although hard gunmetal may be used if preferred. Longitudinal and cross sections are shown in Fig. 4. From these it will be seen that the foundry pattern will require core boxes, suggested shapes for such core boxes, or, rather, the cores which will result from them, being indicated by dot-and-dash lines. In sending the patterns to be cast, a foundry should be selected which is known to turn out clean, fine castings in a good, soft iron of uniform texture. If this point is attended to, a considerable amount of labour will be saved in obtaining perfectly true and accurate surfaces on the bed, and there is no reason why the reader should not secure this perfection himself without machining: that is to say, work up the casting by hand, filing, draw filing and scraping. For forming the holes through the headstock a long print should be put on the patterns running the whole length or more than the distance over the two bearings. This print should have a diameter of $\frac{5}{16}$-in. and a symmetrical core will then be made by the foundry man which will leave $\frac{5}{16}$-in. holes through both the bearings. If the pattern is accurately made with the prints dead parallel with the bed, and the foundry work is accurately done, it should not be a difficult matter for the maker of the lathe to finish the tapered holes also by hand, though, of course, it would be better to put the job out unless the means are at hand of machining oneself. The point is that the two tapered holes must have their centre lines dead parallel in all directions with the top surface and edges of the bed.

The Mandrel

Fig. 4 is an enlarged detail drawing showing the mandrel, the two bronze bushes for the bearings of the headstock and the thrust ring, which provides the means of taking up wear. The mandrel itself is, of course, machined from a piece of mild steel shafting, whilst the tapered bushes are cast from foundry patterns. Bronze has been mentioned for these, but hard gunmetal, which is perhaps more easily obtained, is equally good and practically the same thing. The screws passing through the ring into the headstock are each $\frac{3}{32}$-in. Whitworth, and the cast iron is tapped out accordingly.

The Pulleys

Details of measurements and form of the driving pulleys will be obtained from Fig. 1. It is suggested, for the sake of the division plate on the face of the largest diameter, that these be cast in gunmetal in one piece, together with the collar next to the smallest diameter through which two set-screws pass to secure the pulleys to the mandrel.

(To be continued.)

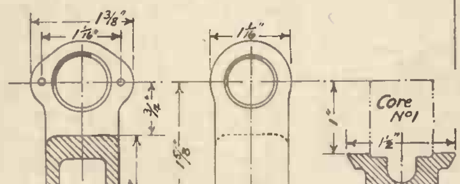


Fig. 5.—A cross section of the bed.

HOW TO GET GOOD CINE EXPOSURES

(Continued from p. 166)

years. The second method is to benefit by the exhaustive researches of experts and to use an exposure table. This is the cheapest way, for such tables are quite inexpensive and easy to use, although the results are not *always* entirely satisfactory. The third and best method is to use one of the several exposure meters now available to cine users. These range in price from about £1 up to £15 or so. All are good in their way, but some require more skill in using than others. The best of all are the completely automatic varieties based on the latest discoveries in electricity and which have only to be pointed towards the scene to be filmed, whereupon a needle on a dial moves over and gives a direct reading of the exact stops to use. These meters are almost uncanny in their operation, and depend for their working upon the fact that certain substances produce electric current when light falls upon them, the strength of the electric current being dependent on the intensity of the light. They are called "photo-electric" meters, and just recently an excellent one has been produced and marketed at four guineas. With a photo-electric meter you need not waste a single foot of film and your pictures will be marvellously uniform in quality throughout. If you are using a 16mm. camera, and your film is costing you 26s. for 100 ft. and you do much filming, you can easily save the cost of one of these meters in a season.

Automatic or Photo-electric Type

Most types are made in a tubular form, and you look through an eyepiece towards the scene to be photographed, turning a knurled ring till one of several things happens according to the type of meter. In some kinds you turn the ring until the details of the image just disappear, in others you do not see the actual scene at all, but only one or more figures, which become darker as you turn the ring until they are only just readable. At this point you stop turning and look at the indicator, which will then show you the aperture to use. Some kinds of meters may suit your eyes better than others, and it is not a bad plan to go to your nearest cine dealer and ask him to show you a few.

First of all you will use the meter on all scenes, but after a little experience you will probably use the meter only once or twice during the day's shooting, and you will be able to judge whether there has been any appreciable change in the light calling for a change of stop. Later you will use the meter only occasionally, and after a while, particularly if your filming is done in fairly uniform conditions, you *may* be able to dispense with it altogether.

Exposure Problems

Whatever your exposure problems happen to be, remember that the size of stop opening or "F number" to use depends upon the amount of light falling on the subject as well as on the subject itself. Nowadays every cine camera has an instruction book, and every one of these books contains at least some hints on exposure and generally a tabular guide. Study this carefully and get fixed in your mind some idea of the kinds of stop to use for different lights and different subjects. Furthermore, when you buy a meter and you find the speed given for a particular film by the maker of the meter is much slower than that claimed by the maker of the film, go by the exposure meter maker's number rather than the maker's claim. Then you can judge which is right from the finished films.

TELEVISION—SYNCHRONISING AND SYNCHRONISERS

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

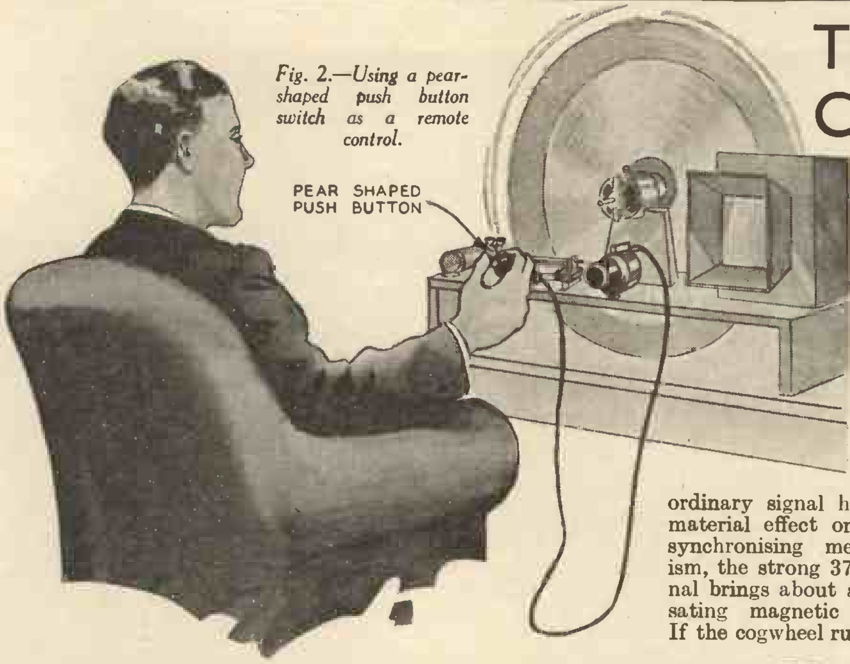


Fig. 2.—Using a pear-shaped push button switch as a remote control.

MANY of the readers who have written and expressed interest in the "Tele-Discovisor" seem to be labouring under an entirely mistaken impression as to the function of the cogged-wheel synchronising equipment. It has nothing to do with the driving of the motor which draws its electrical power from D.C. or A.C. mains or a 6-volt accumulator, as the case may be. The motor carcase serves as a convenient place for mounting the pair of field coils which, when in action, operate on the rotating cogwheel in such a manner that the speed of the motor shaft (and in consequence the disc) is maintained constant within rather narrow limits.

The secret of success for good television reception lies in keeping the motor running at its correct speed of 750 revolutions per minute, irrespective of mains voltage changes which tend to alter the speed. Hence any device which assists towards achieving this state of affairs is a definite asset.

The Action

To appreciate what is happening, remember that as the cogwheel with its thirty teeth is revolving at 750 revolutions per minute, a tooth passes a pole tip 375 times in each second. But a strong synchronising pulse or signal having a frequency of 375 is sent out from the television transmitting station superimposed upon the ordinary television signal. In addition to passing through the neon lamp, the incoming signal is fed into the two polarised field coils joined in series.

While the ordinary signal has no material effect on this synchronising mechanism, the strong 375 signal brings about a pulsating magnetic field. If the cogwheel running between the pole faces is revolving at 750 revolutions per minute, then the action of this pulsating field is neutralised. Any deviation of the motor from this correct speed, however, causes a dragging action on the teeth, that is to say, a braking effect is introduced, and this rapidly overcomes or prevents the speed change which, in the absence of this device (or something similar), would cause the image to move up or down rapidly and mar the entertainment value.

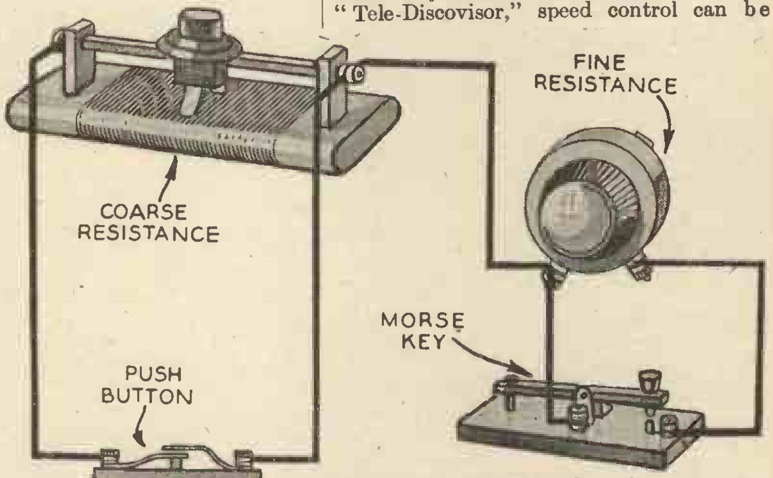


Fig. 1.—A push button is connected across the coarse resistance and a morse key across the fine resistance as shown.

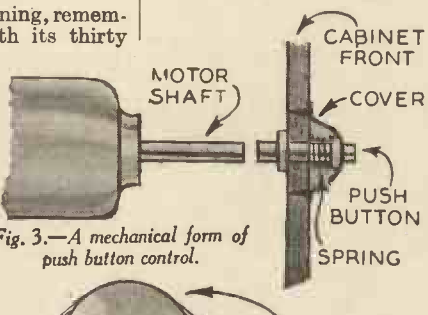


Fig. 3.—A mechanical form of push button control.

Several Forms

Now, although this cogwheel system of synchronising—a Baird patent—is capable of giving good results in the form described in the second issue, there are many variations bearing on the same principle, and the experimenter may like to try out some of these. First of all, however, what can be done by the reader who has decided that for the present he cannot afford, or does not want, to make up the synchronising apparatus detailed in No. 2 of PRACTICAL MECHANICS?

Speed control is vital, so here are the alternatives of a simple mechanical or electrical character. First of all, by using two variable resistances in series, one of coarse adjustment and one fine, as in the "Tele-Discovisor," speed control can be adjusted to quite fine limits after one has become skilled in altering the fine resistance control so as to follow any apparent vertical image movements.

Another method which has been employed with a fair measure is success is to have a coarse resistance of 30 ohms value in series with a fine resistance of 4 to 6 ohms value, both being in series with the mains feed to the motor. Across the coarse resistance connect a push button and across the fine resistance a morse key, as in Fig. 1. By a very careful adjustment of these resistances in conjunction with the main motor resistance, it is possible to maintain the motor at its isochronous speed by depressing or

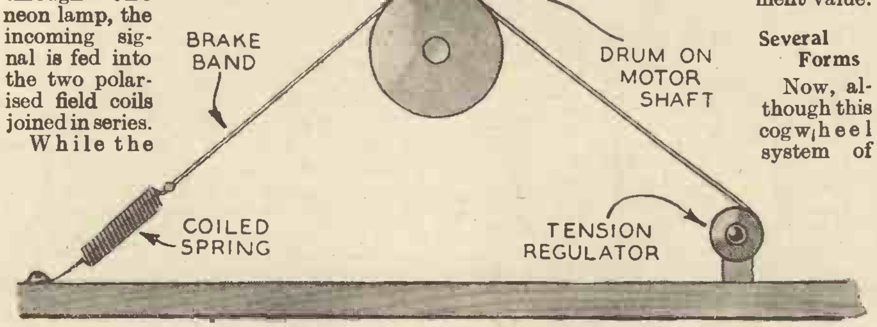


Fig. 4.—Using a break band or cord to vary the motor speed.

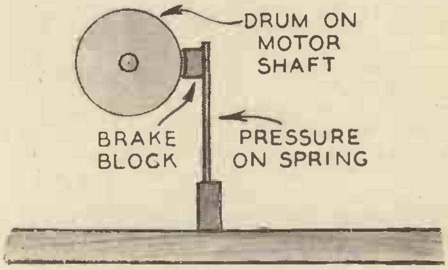


Fig. 5.—Adapting a brake block for adjusting speed.

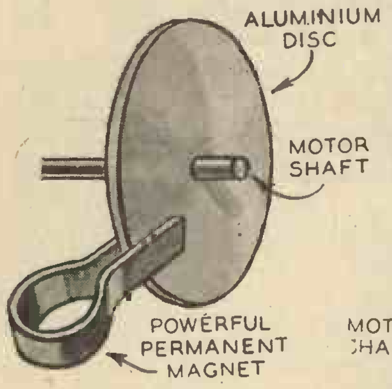


Fig. 6.—Using the familiar eddy current brake.

releasing the push button when it is desired to counteract violent fluctuations, or operating the morse key to neutralise or correct tendencies of slight image slip.

If the constructor does not favour the double scheme just suggested, he can do away with any short-circuiting device across the coarse resistance and just have a bell push in parallel with the fine resistance as in Fig. 2. The best type of switch for this purpose is one of a pear-shape, which can be held in the hand; it is connected to the resistance by a length of flex. The operator can then sit in some convenient position away from the television receiver, and with a little practice he will soon learn when to press and when not to press the button so as to effect a remote speed control.

Mechanical Control

For those who prefer an entirely mechanical control of speed, the following schemes can be tried out, although as a general rule they do not prove quite so successful as the electrical schemes. First of all, there is the straightforward push button method, as indicated in Fig. 3. Assuming the apparatus is housed in a cabinet, arrange for the motor shaft to finish about ⅜ in. from the back of the cabinet front. Now make up an ordinary bell push as shown, complete with a collar, to act as a stop at the back, and a spring to keep the push normally in an "off" position.

Then arrange for the motor to tend to run a trifle faster than its correct speed and "brake" it by pushing slightly on the button, so that there is friction between the motor shaft end and the push button rod. I have found this method quite effective in practice, the necessary skill in arranging just the right amount of finger or thumb pressure being soon acquired.

Another method is to have a small drum fitted to the motor shaft and run a brake band round this, as in Fig. 4. Attach a coiled spring to one end and anchor this to the baseboard, pass the band or cord once round the small drum, which is preferably grooved, and then attach the free end to a small cylinder mounted on a bracket which in turn is screwed to the baseboard. By turning the small cylinder the tension of the cord on the drum can be varied at will and speed control effected.

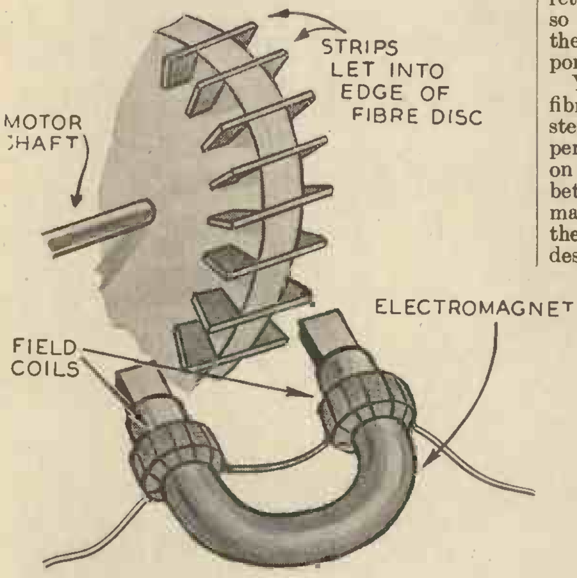


Fig. 7.—Another form of synchronising regulator working electrically.

Fig. 5 gives yet another variation, this time the adaptation of a brake block or cork pad working direct on to a drum fitted to the motor shaft. By fixing the block to a spring the motor speed is varied by direct pressure on the spring, just as in the case of a brake on an ordinary pedal bicycle.

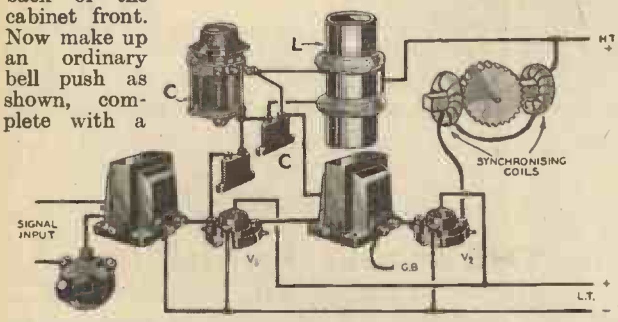


Fig. 9.—A local oscillator arranged to give a strong synchronising signal.

Other Electrical Methods

Now let me revert to wholly electrical methods which have served the purpose of functioning in lieu of the more standard synchronising device. First of all, if the constructor works in a district where mains voltage fluctuations are relatively violent or, alternatively, the motor is prone to sporadic speed changes, then an eddy current brake arrangement may be tried. An aluminium disc should be mounted on the motor spindle and allowed to run freely in the narrow gap of a powerful permanent magnet, as indicated in Fig. 6. The method of operation depends on this familiar eddy current principle, which is no doubt well known to readers and will help to check any *sudden* retardation or acceleration of the motor, and so hold the image steadier than would be the case if no form of brake was incorporated in the apparatus.

Yet another scheme is to have a disc of fibre or ebonite with thirty "teeth" of mild steel, taking the form of strips let into the periphery as in Fig. 7. This wheel, mounted on the motor shaft, is then arranged to run between the poles of a polarised electromagnet fed with the synchronising pulses in the usual manner. This will bring about the desired magnetic reluctance changes for holding the disc in step with the transmitting scanning device.

A Novel Arrangement

Readers who would like to try out something of a rather novel constructional character may be interested in the scheme illustrated in Fig. 8. A wheel some 3 in. in diameter and ½ in. thick, made from wood, ebonite or fibre, has thirty notches cut on its outside edge and corresponding holes drilled on a 1-in. radius so that iron wire of about 16 gauge can be threaded through each hole and over its notch in turn, finally twisting the wire ends together. This will replace the ordinary cogwheel and revolve between a strip of soft iron ½ in. wide and ⅛ in. thick, twisted at each end to form poles and bent as three sides of a rectangle. This field magnet has two coils, fitted as shown, connected in series to give the usual north and south polarity, being fixed to the motor carcase

(*Continued on page 176.*)

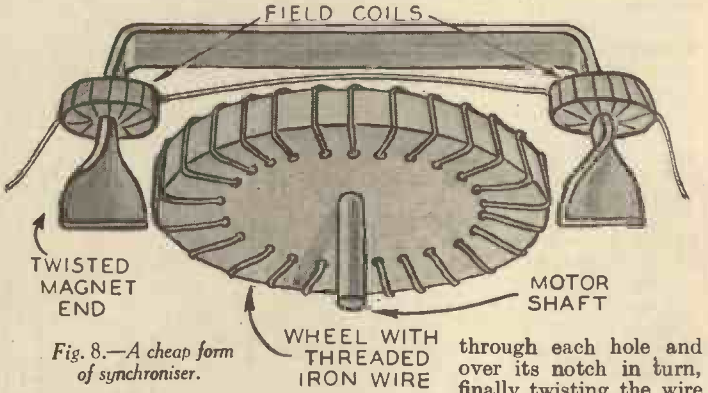


Fig. 8.—A cheap form of synchroniser.

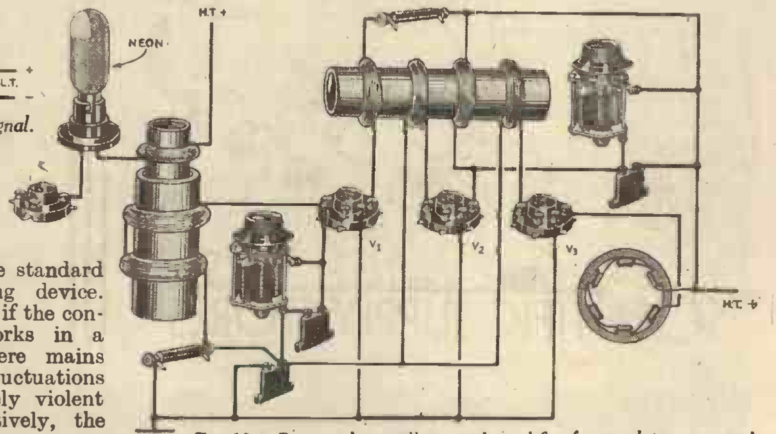


Fig. 10.—Drive valve oscillator and amplifier for supplying a control frequency to drive a phonic wheel motor.

ALL RADIO QUESTIONS ANSWERED FREE.

The PRACTICAL MECHANICS Wireless Experimenter

Every Question must be accompanied by the Coupon on page 204.

THE ALL-WAVE ECONOMY THREE

An excellent battery-operated receiver which will receive on long, medium and short waves, and which is fitted with a special H.T. current economiser device.

INTEREST in short-wave reception has been rapidly growing for the past few years, and it is by no means unlikely that in the near future there will be as many programmes sent out on the short waves as there are now on the medium and long waves. That means that in the future every instrument deserving of the name of "broadcast" receiver must be capable of bringing in stations on practically any wavelength from about 20 to 2,000 metres. At the present time it is usual to employ a special receiver for wavelengths below 200 metres or so, and though that might be the best system when maximum efficiency is called for on the shorter wavelengths, it is certainly not one that appeals to the average constructor and broadcast listener. Obviously, what is wanted is a set that can be tuned to any wavelength upon which broadcasts are made. Until recently that would have involved the use of either a very complicated circuit or a variety of plug-in coils, but there are now on the market three or four really efficient tuners which are designed to operate on all the widely-used wavebands merely by rotating a switch knob. For instance, the British General tuner, which is specified for the set to be described, will tune from 14·5 to 40 metres, 32 to 90 metres, 200 to 550 metres and from 900 to 2,000 metres. Moreover, this tuner is no more expensive than the average one intended for use on the two higher wavebands only.

It is fairly well known that reception over tremendous distances is easily possible on quite a simple short-wave receiver, and the "All-Wave Economy Three" is capable of bringing in numerous American and European, not to say Australian, stations at all hours of the day and at full loud-speaker strength. This is, of course, in addition to the twenty or more stations working on the so-called broadcasting bands that can always be relied upon to provide ample signal strength for entertainment purposes.

Circuit Refinements

It will be seen from the circuit diagram (Fig. 5) that the set, although of the popular detector-L.F. type, has a number of interesting features quite apart from the unusual tuning arrangements. The detector valve is coupled to the first L.F. on the R.C.C. principle, and in place of the customary fixed-resistance grid leak a 500,000 ohm potentiometer is employed. This latter serves as an excellent and distortionless volume control by means of which the reproduction from the loud speaker can be varied from maximum to dead silence. Also, by connecting a pair of pick-up terminals to the ends of the potentiometer, the latter serves also to control the volume of gramophone reproduction. The first L.F. valve feeds into the (really) super-power output valve through a resistance-fed L.F. transformer which gives maximum amplification and freedom from distortion. The output valve is capable of delivering a signal output of approximately 300 milliwatts, and normally it would consume something like 12 milliamps. of high tension current. So as to reduce that current to an average value of only about 5 milliamps., however, a special "economiser" device is fitted between the anode of the output valve and a grid bias supply. The device just referred to is actually the Varley "Power Puncher," an entirely new component which consists of a "Westector" high-frequency metal rectifier and a resistance-condenser network. By using this component, most of the advantages of Class B amplification are secured in a simpler and less expensive way. The "Power Puncher" regulates the H.T. current to the last valve in such a way that it increases on loud signals, and is at once reduced on signals of lower intensity. And since the volume level of any transmission is constantly varying, the anode current varies in sympathy, with a result that the average consumption is much lower than it would be if the "economiser" device were not employed, for then the current would remain at the maximum value regardless of the strength of the signals being received.

Fig. 1.—This photograph gives a good impression of the finished receiver.

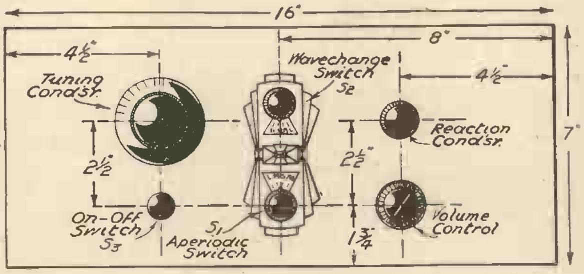


Fig. 2.—The positions of the control spindles are clearly indicated in this drawing.

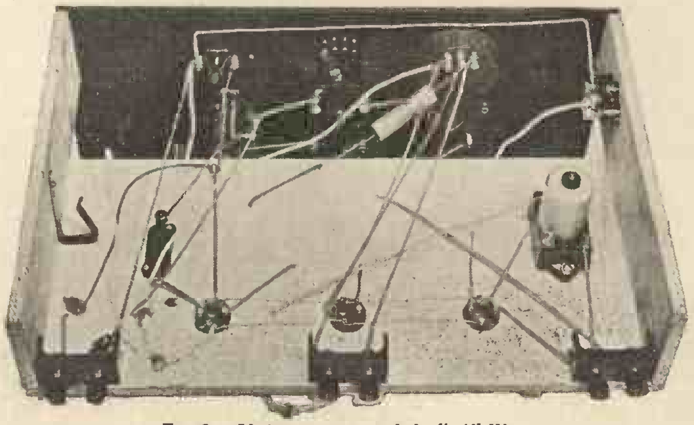


Fig. 3.—Underneath view of the "All-Wave Economy Three."

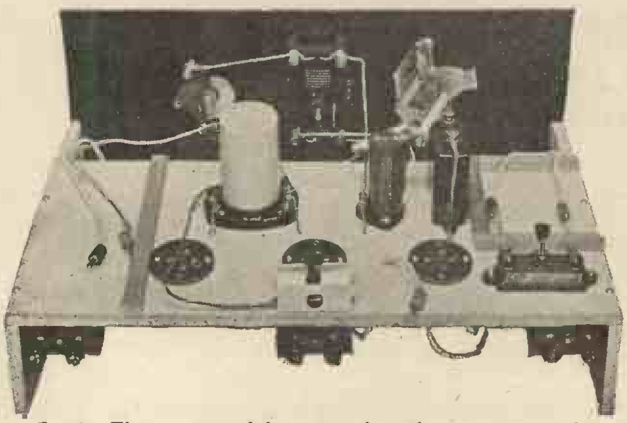


Fig. 4.—This rear view of the receiver shows that provision is made on the chassis for holding the H.T. battery and accumulator.

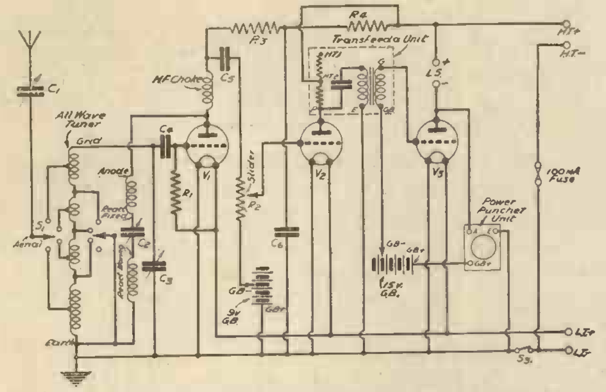


Fig. 5.—Circuit diagram of the "All-Wave Economy Three."

The H.T. Current Economiser

The method of functioning of the "Power Puncher" is briefly as follows: Normally the bias on the grid of the output valve is increased to such an extent that the anode current is reduced to only about 3 milliamps. Then, as a signal is tuned in, a portion of the low-frequency current appearing in the anode circuit of the last valve is rectified by the "Westector," and the voltage drop so obtained is used in "opposition" to the normal bias voltage. In other words, the grid bias voltage is automatically reduced and the valve therefore passes a greater amount of anode current. It will be appreciated that the value of the "opposition" voltage is entirely dependent upon the intensity of the signal currents being handled by the output valve, and thus the bias is varied in inverse proportion to the volume of reproduction being enjoyed. By this means the valve can normally be overbiased without there being any danger of introducing distortion, since the bias voltage is cut down as soon as the valve is called upon to deal with more powerful signals.

Constructional Details

The construction of the "All-Wave Economy Three" is very simple, and the set can easily be made in an evening, even by a beginner. It will be clear from the photographs that a metallised wooden chassis is employed, and this simplifies the construction, whilst also acting as an efficient screen. So that the tuner and other components could be mounted on a 7-in. panel, the chassis baseboard does not extend from end to end of the side runners, but comes only to within 3 in. of the front. This also simplifies the wiring by making it possible to take some of the leads through the opening provided. On examining the wiring plan (Fig. 6) it might appear that the chassis is somewhat longer than it need have been, because there is a certain amount of unused space at each end. Actually, this is not the case, for the space has been left deliberately to allow for the accumulator and high tension battery to be mounted on the chassis itself, thus making the leads to them as short as possible. There is another advantage of this lay-out, however, which is that the set can be tested very easily whilst it is out of its cabinet without having any straggling leads.

The chassis is supplied ready cut to size, so the first thing to do after having obtained all the components is to drill the ebonite panel in the positions clearly indicated in Fig. 2. The two holes for the tuner, as well as that for the on-off switch, are $\frac{3}{8}$ in. diameter, those for the reaction condenser and potentiometer are $\frac{5}{16}$ in. diameter, that for the tuning condenser is $\frac{1}{2}$ in. and those for the screws and dial pointer are about $\frac{1}{8}$ in.

Next mount all the parts on the panel and then bore the 1-in. diameter holes for the three four-pin valve-holders in the chassis. After that the panel can be screwed in place and the rest of the components mounted on the chassis. Notice also that a few strips of $\frac{1}{2}$-in. by $\frac{3}{4}$-in. wood are screwed to the chassis to prevent the batteries from sliding about.

The wiring is pretty straightforward and calls for very little attention. There are just one or two points that should be explained. For example, the easiest way to wire up the filament terminals on the three valve-holders is to remove the insulation from the connecting wire and then slide the wire through the holes in the respective terminals, finally tightening up the screws. One or two connections are soldered to the fixed resistances and to the tubular L.F. grid condenser, but all other connections are made by screwing the wire tightly beneath the heads of the terminals.

Battery Connections

When the wiring has been completed fit the valves in place and connect up the batteries. It will be seen that two G.B. batteries are employed, one 16-volt one for the super-power valve (in conjunction with the "Power Puncher") and one 9-volt one for the first L.F. valve. There is a "G.B. +" wanderplug for each battery, and that for the 16-volt battery is connected to the terminal of similar name on the "Power Puncher," the other being attached to a bolt passing through, and making contact with, the chassis. The wanderplug marked "G.B. – 1" should be plugged into the 14-volt socket of the 16-volt battery, and that marked "G.B. – 2" should be taken to the 3-volt tapping on the 9-volt one.

Connect the aerial and earth leads and join the two loud-speaker terminals to the centre and an outside one on the speaker unit. You are then ready for testing the set. First of all decide which waveband you are going to try first, and adjust the upper knob on the tuner accordingly; positions "S. 1" and "S. 2" give the lower and higher short-wave ranges respectively, whilst positions "M" and "L" are, of course, for medium and long waves. The lower (selectivity) switch should then be set to the appropriate position, remembering that position "A.G." is the least selective, and that "S," "M" and "L" are the normal selective positions for the various tuning ranges. It is perhaps best to try the medium waveband first so as to make certain that everything is wired up correctly and that the local station can be properly received. Use reaction sparingly and try altering the volume control to get the desired signal strength. Should it be found that tuning is not sufficiently sharp, the knob of the pre-set aerial condenser must be slacked off; on the other hand, if signal strength is not sufficiently great the capacity of the pre-set should be increased by screwing the knob down.

Short-wave Reception

To receive on the short-wave ranges the wave change switch must be set to either "S. 1" or "S. 2" and the selectivity switch turned to "S." After that, tuning will be carried out in the same manner as on the higher wavelengths, except that the tuning condenser must be operated as slowly as ever possible by means of the slow-motion (smaller) knob alone. To obtain best results it will also be found necessary to make full use of the reaction condenser, constantly adjusting this so that the set is kept "just off" the oscillation point. This state will be indicated by a faint "breathing" sound from the speaker. When first trying the set on short waves, it might be found that it will not oscillate, or that oscillation is only obtainable at certain settings of the tuning condenser. Should that be the case, the capacity of the pre-set aerial condenser should be reduced bit by bit until easy oscillation can be obtained over the entire tuning range.

Continued on page 192.

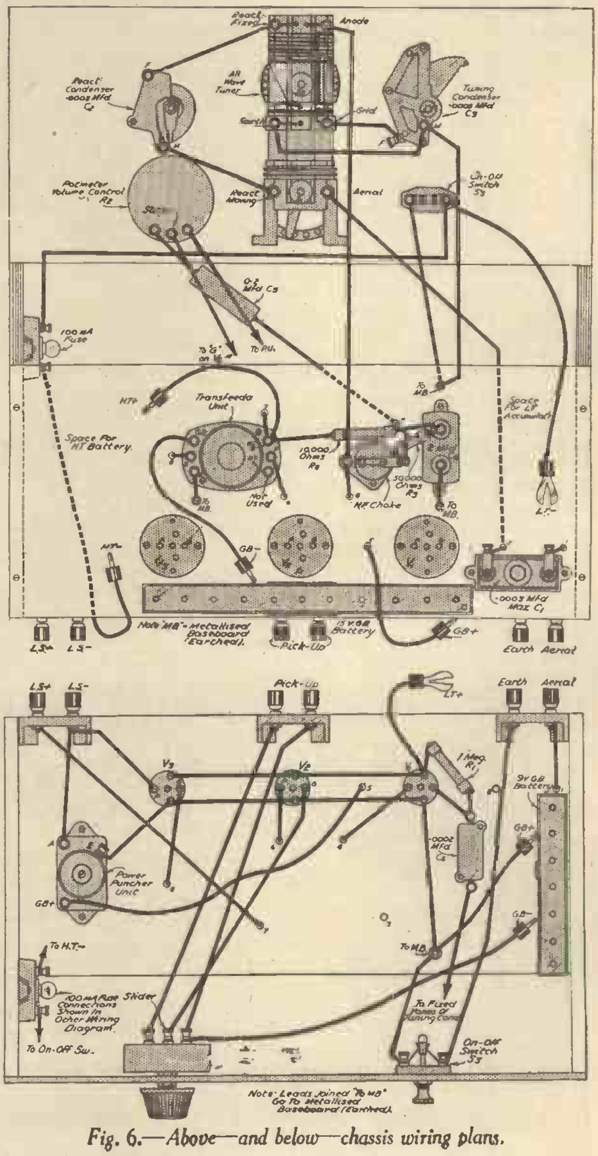


Fig. 6.—Above—and below—chassis wiring plans.

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1 ORMOND ·0005 mfd. No. 6, slow-motion condenser	6	6
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1 BULGIN dial indicator, type No. 3		2
1 "MAGNUM" 500,000 ohm potentiometer	5	0
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3 CLIX 4-pin "Air-Sprung" valve holders	3	6
3 BELLING-LEE terminal mounts	1	6
6 BELLING-LEE terminal mounts, type "R"; one each marked "A," "E," L.S.+, L.S.— and 2 marked "Pick-up"	1	6
1 GOLTONE ·0003 mfd. pre-set condenser	1	3
1 BENJAMIN "Transfeeda"	11	6
1 GOLTONE "Super" H.F. choke	4	6
1 DUBILIER 2-mfd. fixed condenser, type "BB"	3	6
1 DUBILIER ·0002 mfd. fixed condenser, type 670	1	0
1 DUBILIER ·2 mfd. tubular fixed condenser, type 4406	1	9
1 DUBILIER 2 megohm grid leak with wire ends	1	0
1 DUBILIER 50,000 ohm fixed resistance, 1 watt	1	0
1 DUBILIER 10,000 ohm fixed resistance, 1 watt	1	0
1 VARLEY "Power Puncher"	15	6
1 BULGIN fuse holder, list F5, and 100 m.a. fuse bulb	1	0
2 BULGIN G.B. battery clips, 1 type No. 2 and 1 type No. 5		6½
6 CLIX wander plugs; 2 each marked G.B.— and G.B. + and 1 each marked H.T.— and H.T.+		9
2 CLIX spade terminals		3
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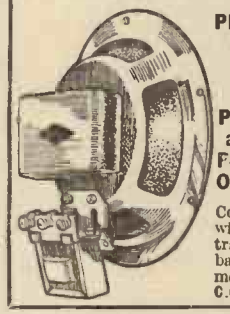

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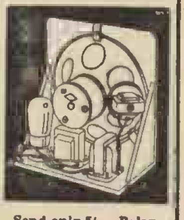

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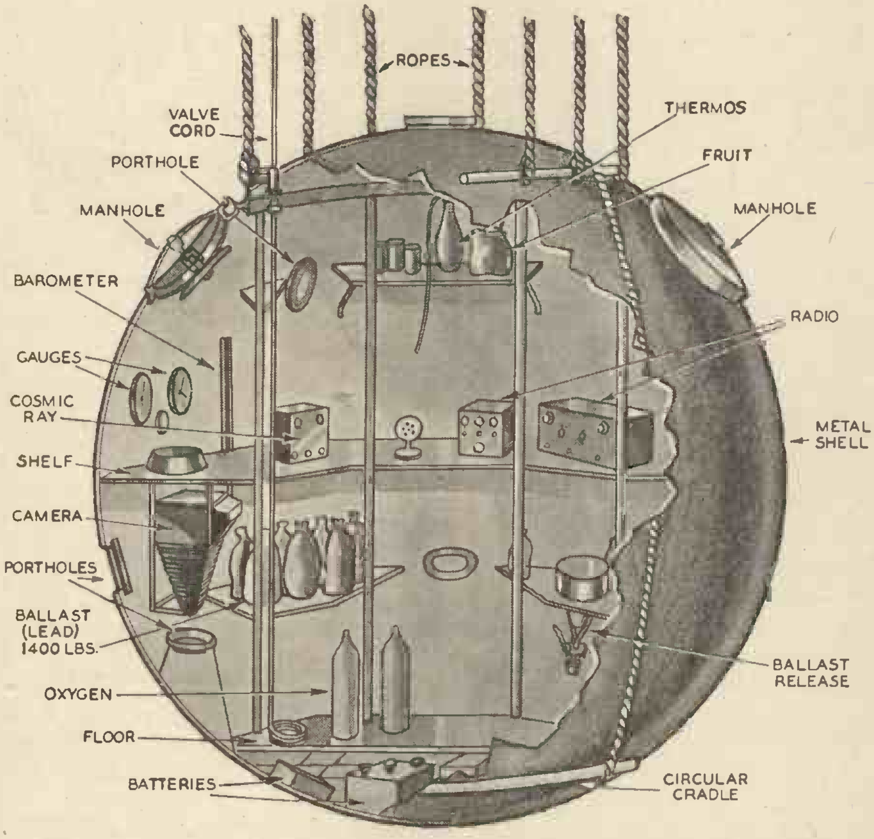
THE PICCARD GONDOLA

Interesting facts about the apparatus and instruments which will be used by Professor Piccard and Mr. Settle on their next flight into the stratosphere.

Interesting Facts about the Piccard Gondola

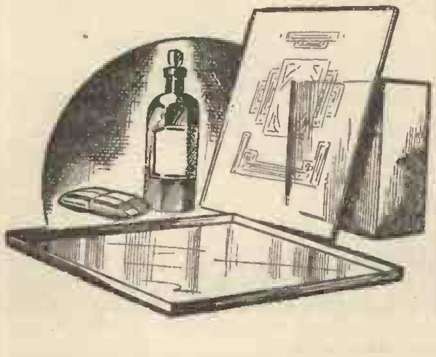
IN a recent article on "Wonders of the Stratosphere" which appeared in our October issue, we gave some interesting facts relating to Professor Piccard's world record ascent of about ten miles. The cross-sectional sketch on this page shows an interior view of the gondola of the balloon in which Professor Piccard and Mr. Settle plan their next flight into the stratosphere. In arranging the apparatus great care was necessary because of the small space allowed inside the gondola. On the left of the drawing is seen the camera, which is directed through a hole in the bottom of the sphere, whilst next to it is the ballast storage bag comprising 1,400 lb. of lead. The oxygen flasks are shown on the floor, and on the right is a very accurate ballast release device regulating the discharge of the shot. The radio receiver and transmitter can be seen on the shelf to the right, by which communication can be maintained with a ground station, whilst the instrument on the left of the shelf is that which is employed for measuring the intensity of the cosmic rays in the stratosphere. There are also barometers, gauges and other instruments for making atmospheric measurements, and also a supply of food, which is seen on the top shelf.



The sketch shows an interior view of Professor Piccard's gondola and also the compact arrangement of the necessary equipment that will be used during his next journey into the stratosphere.

Etching on Glass

TO etch on glass, one covers the selected piece of material with beeswax or melted candle ends. When the wax is cool, one then traces the desired design on to the wax with a pen tip or a needle's point, so that the glass is laid bare where the design is to appear. The prepared glass plate is then laid, design downwards, on a lead tray in which is some coarsely powdered fluor spar, covered with concentrated sulphuric acid. Apply *gentle* heat to the tray and its contents and fluorine will rise as a vapour and attack the bare glass. By this method the bare parts of the design will be completely etched out, and when the wax is removed the design will appear beautifully traced on the glass surface. It is advisable to coat both sides of the glass and trace the design on one side only. The design must be laid bare on the glass, through the wax, or a part of the design will not be etched. —J. M. (Northumberland).



TELEVISION—SYNCHRONISING AND SYNCHRONISERS

(*Continued from page* 170.)

by a magnetically-insulated bush such as brass. If the synchronising signals are now fed to this device, the disc will be held quite well at its proper speed.

Using a Local Oscillator

One method is shown in Fig. 9, and consists of a two-valve generator. The first valve is the oscillator, while the second valve acts as a combined "detector" and amplifier, having a high negative grid bias. The coil L must have a large inductance and be of the air core type, so that when it is tuned it has a frequency of 375. The tuning is effected by a fixed and variable condenser in parallel. The input L.F. transformer has the normal synchronising pulses passed to it from the radio set, and these control the oscillations in the circuit LC, so that when they are brought into tune a very strong signal is finally fed to the field coils of the synchroniser from the valve V_2. In passing, it is as well to note that "phasing" (see last month's article) can be carried out readily by bringing the local oscillator slightly off tune so as to allow the image to drift.

A Motor Drive

By using motors specially adapted for the purpose it is possible to make the synchronising signal drive the disc without any other source of power.

It is intriguing to see how this scheme of synchronising can be put into practice, and in consequence Fig. 10 becomes particularly interesting. V_2 is the oscillating valve which generates the necessary power for driving the disc after having been passed to the third valve in the anode circuit of which is the stator winding of the synchronous motor. As the frequency of the oscillating valve must correspond exactly to the strip frequency of the transmitted image (that is 375 for our present case), it must be controlled, and that is the function of the valve V_1.

An oscillatory circuit tuned to 375 cycles, and having low damping, is connected to the grid of V_1, and to this is coupled a coil in series with the neon lamp and through which must pass the synchronising pulse. This arrangement acts as a drive for the oscillating valve V_2, having an anode circuit tuned to 375 and back-coupled to a coil (receiving the driver pulse) in the grid circuit of the same valve. The complete amplifier and oscillator, as well as the output valve of the radio set, derives its high tension supply from a mains eliminator, automatic biassing being included.

The apparatus is so adjusted that the variable condenser (coarse and fine tuning) of the generator circuit of V_2 corresponds as nearly as possible to the 375 strip frequency. Then the coupling coil, which is variable with the grid circuit of the controlling valve V_1, is adjusted and the fine tuning regulated. It is essential to have all the adjustments made carefully so that the "drive" does not bring about a variable synchronising pulse in the generator circuit. The synchronous motor is of the phonic wheel type, having a rotor without a winding, but possessing thirty teeth, the air gap between the teeth and pole faces being larger than is possible with the ordinary toothed-wheel synchroniser. As the motor is not self-starting, it must be brought up to synchronous speed before it can transmit power. This may be effected by means of a friction wheel or small auxiliary motor.

Fascinating Experiments in CHEMISTRY

THE CHEMISTRY OF PLANT LIFE

In the opening paragraph of our chemistry article in the October issue, mention was made of modern chemical marvels in the production of complex synthetics from crude by-products. Now, although man's conquest of knowledge has carried him far in realms of chemistry, there can be no doubt that as yet little more than the fringe of the subject has been explored.

We may wander round a modern laboratory and marvel at the bewildering array of elaborate apparatus and the involved processes in which they are used, but all this becomes very insignificant if we pause to consider how in the commonest of living plants there are still stranger reactions taking place, many of which, unostentatious as they are, we cannot explain, much less duplicate, in our man-made laboratory.

In order that the experimenter may acquire a more intimate knowledge of this branch of chemistry, it is proposed to describe a series of experiments, to be performed with common plants, demonstrating the nature and object of some of the chemical reactions taking place which are necessary not only for their existence, but also for our own.

Fig. 4.—Oxygen is again liberated when a little carbon dioxide is added to the water.

Photo-Synthesis

Everybody knows that a green plant will wither and die if deprived of light, and most people are also aware that a plant growing in a room will turn its leaves towards the windows in order to obtain the maximum amount of light available. Clearly then, light plays a most important part in the development and nourishment of a plant, and it is with the nature of one of the effects of light that the first experiment deals.

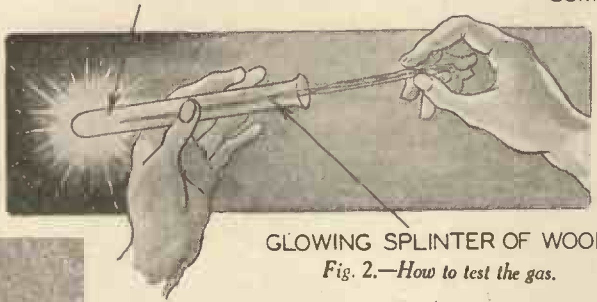


Fig. 2.—How to test the gas.

Liberation of Oxygen from a Living Plant

The apparatus required for this experiment is of an elementary nature, and the arrangement is indicated in Fig. 1. The glass bowl contains water and a little common water weed. The latter is imprisoned beneath the inverted glass funnel, upon which rides a test tube previously filled with water. When this arrangement is completed, the bowl and contents are placed in a good light (sunlight is best for rapid results, although daylight or strong artificial light may be used) and allowed to remain there for an hour or two.

Observations should be made during this period of the bubbles of gas rising from the weed and collecting in the test tube. This evolution is continuous and the experiment may be concluded when sufficient has accumulated to fill the tube and displace the water it contains. When this stage is reached the open end of the tube should be closed with the forefinger while still under water. By this means the tube still retains its contents on removal from the bowl. Alternatively, if the investigation of the gas is not to take place immediately, the tube may be corked under water and placed on one side until an opportunity presents itself.

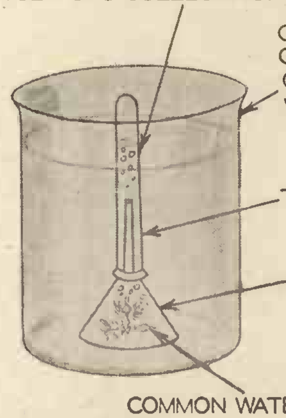


Fig. 1.—The weed liberates oxygen under the influence of light.

One simple test only need be performed on the gas. Holding the test tube in a horizontal position, remove either the forefinger or the stopper from its mouth, and plunge therein a glowing splinter of wood. You will observe that it immediately relights and burns away rapidly with a brilliant flame—the characteristic behaviour of a combustible in oxygen.

Having proved this "plant gas" to be oxygen, its origin must be investigated, but before starting upon the next experiment, which deals with this, it is interesting to sidetrack for a while and repeat the last experiment, on this occasion, however, conducting it in complete darkness. *No gas will be evolved.*

Origin of the Oxygen

Observations made during the progress of the first experiment show that the bubbles of oxygen are actually liberated from the surface of the weed. The first explanation of this phenomenon which probably comes to mind is that some kind of electro-chemical reaction is in progress there and that the water is being slowly electrolysed. This is not the case, however, as a moment's consideration will show, for if the water were being electrolytically decomposed, hydrogen would also be liberated and the collected gas, instead of harmlessly relighting the glowing splinter, would have exploded to re-form water.

The true explanation is readily arrived at by the same procedure and with the same apparatus as before, but in this experiment the bowl contains, not ordinary water

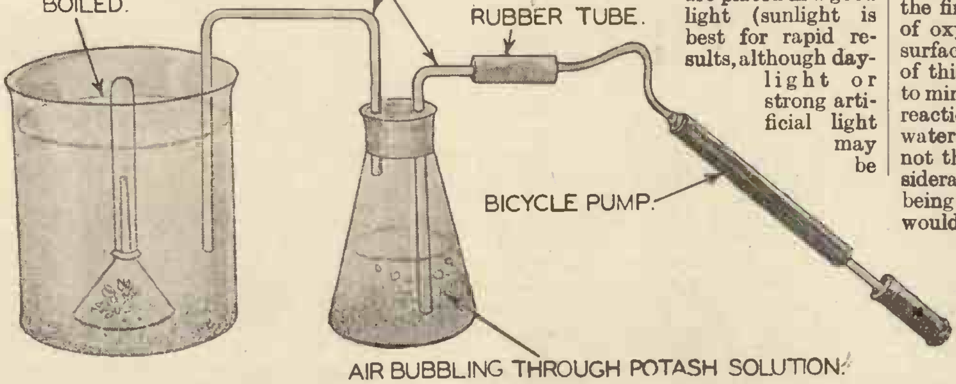


Fig. 3.—No oxygen is liberated when water which has been boiled is used. Air deprived of carbon dioxide and passed through it has no effect.

but water which has been boiled and allowed to cool, being therefore deprived of the air which all water normally holds in solution. No matter how great the light intensity under these conditions, no oxygen will be liberated by the plant.

We must conclude therefore that such a green, living plant extracts something from air and in turn gives out oxygen. Now atmospheric air is a mixture of nitrogen, oxygen, carbon dioxide, and a few of the rarer gases, including helium and neon. Of this group the only oxygen-containing gases are oxygen itself and carbon dioxide, and since it is extremely unlikely that a plant would absorb oxygen to liberate it unchanged, the field of investigation is narrowed down to carbon dioxide. This must be proved by the following experiments carried out in light with the existing apparatus, to which is added an aspirating flask containing caustic potash solution, and a bicycle pump. The bowl again contains cold water, previously boiled, and in consequence no bubbles of oxygen are evolved. A few strokes are made with the pump, and air bubbles through this water, which, as the carbon dioxide has been absorbed from the air in its passage through the caustic potash, contains now a little nitrogen and oxygen. In spite of this æration the water weed remains inert and will continue so until supplied with carbon dioxide, which is just as essential for its existence as it is undesirable for ours. This vital plant gas should now be added to the water either by bubbling one's breath (containing a high percentage of CO_2) through it or adding a little soda water from a siphon. In either case oxygen will soon collect as in the first experiment.

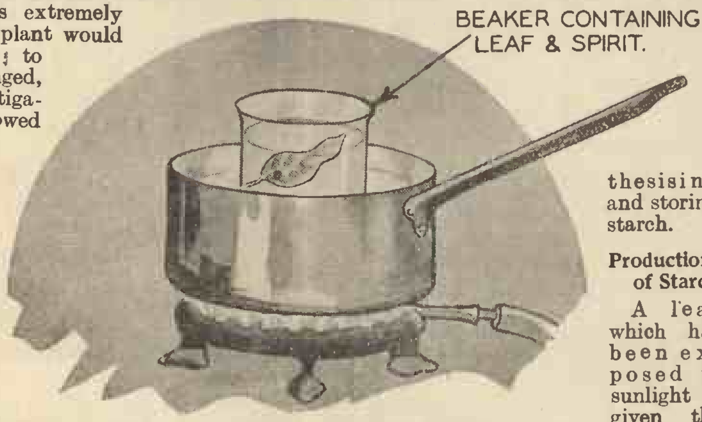


Fig. 5.—A water bath is used to warm the spirit.

Plants under the Action of Light

Reviewing these experiments it is evident that under the action of light a green living plant absorbs from the air carbon dioxide gas and liberates oxygen. This is a happy provision of Nature, for if such were not the case mankind would perish. Each time we breathe, oxygen is removed from the air and carbon dioxide exhaled. If the proportion of oxygen in atmospheric air were to fall below about 10 per cent. animal life could no longer continue. Fortunately there is no fear of this eventuality while green plant life abounds.

As carbon dioxide is a compound of carbon and oxygen it is apparent that in some manner a plant decomposes the gas into these two elements, retaining one and liberating the other. Before investigating the fate of the absorbed carbon atom, which is the subject of the next experiment, some explanation of the chemical structure of a plant is necessary. In the last issue it was stated that the walls of the cells forming a plant structure are composed of cellulose. These cells contain in various parts of the plant stores of starch and sugars—substances like cellulose, built up of carbon, hydrogen and oxygen. Also present are smaller amounts of sulphur, iron, nitrogen, potassium, and phosphorus. By means of its vascular system a plant obtains the last four elements from the medium in which it grows, while the carbon, as we have seen, is drawn from the atmosphere. Evidently this carbon is utilised in some way to form starch, cellulose and sugars. In order to substantiate this statement it is necessary to devise an experiment in which it can be shown that a green plant absorbing carbon dioxide in sunlight is actually synthesising and storing starch.

Production of Starch

A leaf which has been exposed to sunlight is given the starch-iodide test, a very delicate reaction which occurs when iodine and starch are brought together. A coloration ranging from blue to blue-black, according to the amount of starch present, appears. In order to apply this test to a leaf it is necessary first to remove the chlorophyll or green colouring matter from its tissues as the presence of this would mask the iodine reaction.

For the first experiment the leaf, as previously mentioned, must have been well exposed to sunlight. Place it in boiling water and allow it to stay there for about ten minutes or until all air has been expelled and the tissues softened. Transfer it to a glass containing warm methylated spirit and allow it to soak until all its colour has gone into solution in the spirit. (This part of the experiment should be performed over a water bath. Naked flames are dangerous near spirit.)

Fig. 6.—A photograph printed on a leaf.

When this stage is reached and the leaf is colourless it should be placed on a flat dish or plate and flooded with a solution made by diluting ordinary tincture of iodine with about an equal bulk of water. The leaf will blacken all over, thus giving a very positive reaction for starch.

The next experiment shows that leaves which have been deprived of light contain no starch. To obtain a good result with this experiment a plant should be stored in the dark for a few days. A leaf may then be tested for starch as before, but it will be found that no black colour appears. There is, in fact, no starch present.

The water weed used in the first experiment should be placed in darkness for a few days; at the end of this period one of its leaves should be tested for starch. If any appears to be present, storage in darkness should continue until the starch iodide test on a leaf is negative. When this stage is reached the plant should be divided into two portions. One is placed in a dish containing cold *boiled* water, the other in a dish of ordinary water. Both are allowed to remain in the light for some hours and then a leaf of each is tested for starch. Both portions have undergone the same amount of light treatment, yet the starch test will show that the sample taken from the boiled water still remains devoid of starch, while its neighbour in ordinary air-containing water has acquired a considerable amount.

Photographic Prints on Leaves

These experiments suggest a method of making photographic prints on plant leaves. A smooth-surfaced leaf should be selected and clamped beneath a negative. The time of exposure is not critical—about two hours in bright sunlight should be sufficient, after which the leaf print should be "developed" by the iodine method. The spirituous solution of green colouring matter obtained in these tests should not be discarded, but should be put aside for later consideration.

By the preceding experiments it has been demonstrated that under the influence of light, a living green plant absorbs from the air carbon dioxide, decomposes it into oxygen and carbon, liberates the oxygen for man's benefit, and converts the carbon assimilated into starch for its own nourishment and growth. This is certainly more than any chemist has yet achieved and the term "photo-synthesis" is applied to the process, a knowledge of which incidentally helps us to understand better the source of the energy which does our work. Sunlight causes a plant to give us oxygen, wood and coal in return for carbon dioxide and water. When we burn these combustibles the carbon dioxide, water and original energy (due to original chemical reaction and light value) as heat are returned to us, thus completing the cycle.

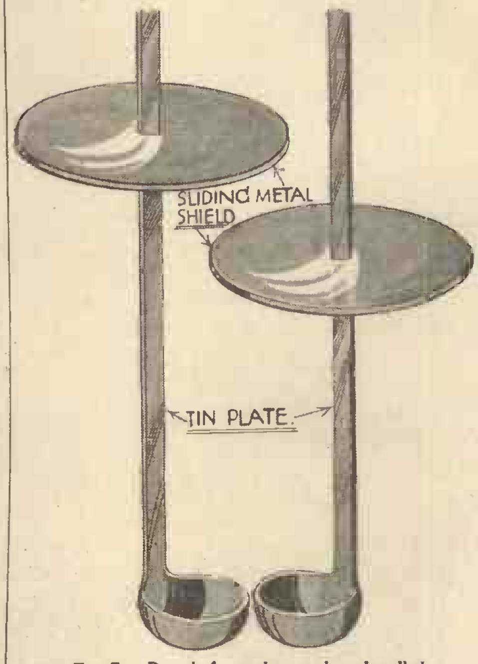
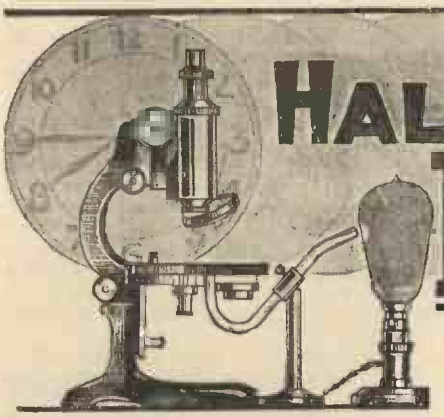


Fig. 7.—Details for making a long-handled tinplate spoon for carrying out numerous experiments with jars full of oxygen.



HALF HOURS with the MICROSCOPE

STARTING A COLLECTION

By W. J. DELANEY

How to Preserve and Mount Specimens for Storage and Examination

I HAVE only described the collection and examination of the more common objects in previous articles in order to assist beginners in the hobby of microscopy, and before going on to more detailed operations, such as dissection or high-powered examination, it will no doubt be worth while to know how to mount those items which you find offer most interesting inspection, as well as to commence a collection which you may in later years look back on with interest as relating to your first attempts at microscopic study. There are three different methods of mounting a specimen on a slide, and these are shown in Fig. 1. On the right is a solid body, such as a seed from some particular flower, and this is mounted in a small chamber, or cell, formed by cutting a ring of fairly thick paper (varying in thickness according to the actual size of the specimen), and this is stuck on to a standard slide with the cover glass stuck on top of the paper ring and just pressing against the seed to hold it in position. In the second method the specimen, say an insect body, is cemented in a balsam solution, with the cover glass held in place by adhesion to the balsam. The third example is only used for opaque objects such as foraminifera, diatoms, etc., and a disc of black paper or a layer of black cement is first placed on the slide and the objects are held in position with small dabs of adhesive. A cover glass keeps out dust, but is not otherwise essential.

Articles Needed

For specimen mounting you require a bottle of balsam; a stock of standard slides; a packet or box of cover glasses; a tin of good black enamel, or special cement; and a turntable. If you intend to prepare vegetable specimens, or insect bodies, you will also require a small low-powered dissecting microscope (or, alternatively, a magnifying glass mounted on a stand to leave your hands free), and some needles and scapels, but these I will deal with later. The turntable may be purchased or made up in the following manner: A piece of hard-wood, 2 in. wide, 1 in. thick and 3 in. long, is sand-papered smooth, and about a ¼ in. from one end a line is scribed across the block. The centre of this line is then marked and drilled to accommodate a fine screw. A disc of brass, or similar metal, is then obtained, having a diameter of 3½ in., and the centre accurately marked and drilled. The screw, preferably a No. 3 wood screw (countersunk head), is then passed through the brass disc and soldered into position from the underside, the top surface being smoothed off if necessary with a file to leave a dead flat surface. Two small pieces of watch-spring are then cut and bent to the shape shown in Fig. 3, and these are riveted so that the curved portion is on a line passing across the diameter of the disc. One or two washers of metal are then obtained and placed over the screw, which is turned into the wooden block by the simple procedure of rotating the disc. If sufficient mechanical skill is possessed by the reader, the disc may be fitted with a machine screw or bolt and a clearance socket fitted to the block, so that the disc will not rise and fall as it is rotated first one way and then the other. I prefer the former method, as it enables the thickness of the cell to be adjusted when once the manipulation has been understood.

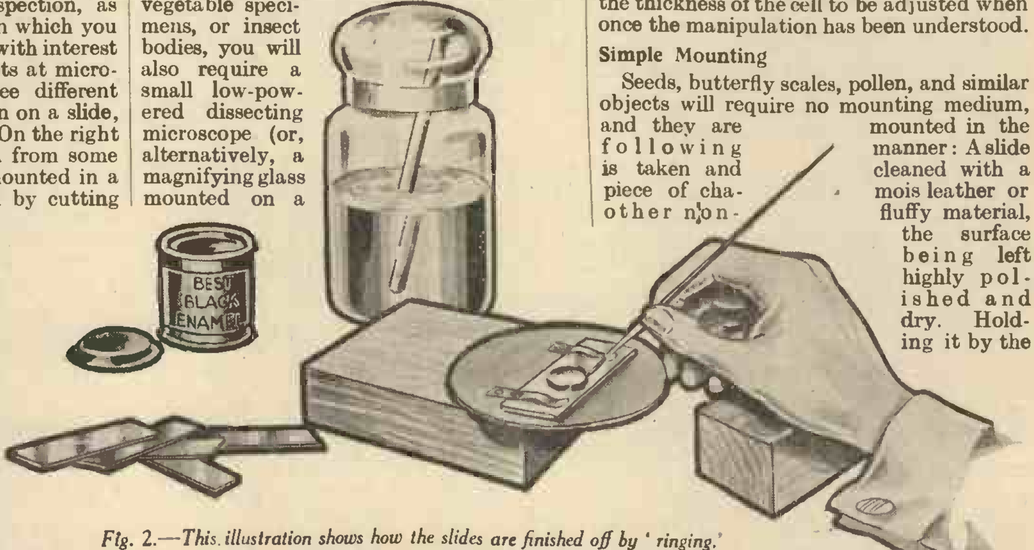


Fig. 2.—This illustration shows how the slides are finished off by 'ringing.'

Simple Mounting

Seeds, butterfly scales, pollen, and similar objects will require no mounting medium, and they are mounted in the following manner: A slide is taken and cleaned with a piece of chamois leather or other non-fluffy material, the surface being left highly polished and dry. Holding it by the extreme edges it is inserted under the clips on the turntable with the centre of the slide over the centre of the disc. A fine camel-hair brush is now dipped in good quality varnish or best bicycle enamel (black), and, holding this just in contact with the slide, at a distance of about a ¼ in. from the centre, the disc is rotated with the other hand, thus transferring the enamel to the slide in the form of a perfect ring. After one or two attempts, it will be found quite simple to place on a thin ring of enamel with a fairly rapid motion. When dry, a further ring may be added on top if it is found that the resultant cell is too shallow. When built up to the required height, the specimen is taken up with forceps or a dry brush and is carefully deposited in the centre of the cell. If the object is thick enough, the cover glass will just bear heavy enough to hold it in position, but where the object is too thin or small for this method of mounting some good gum arabic should be diluted with warm water until it is extremely thin and the faintest trace should be deposited in the centre of the cell, the object being dropped upon it before it has a chance to dry. The next point is vital to the success of the mounting. Still leaving the slide on the turntable, the complete arrangement should be stood near a fire or other warm *dry* position until all possibility of moisture remaining has been removed, when another trace of ename

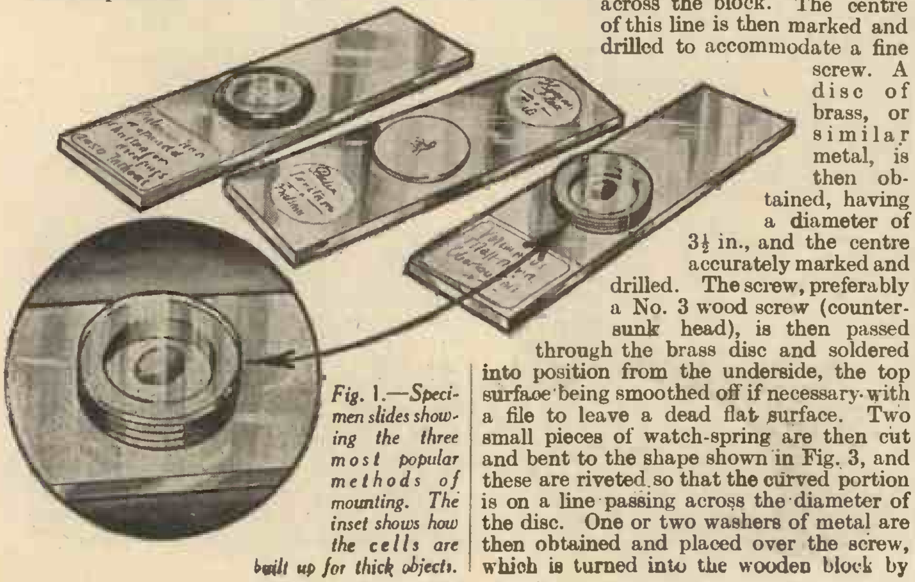


Fig. 1.—Specimen slides showing the three most popular methods of mounting. The inset shows how the cells are built up for thick objects.

should be run round the top of the cell and a perfectly clean cover glass dropped on top where it will adhere and dry in position. A final ring of enamel round the edge of the cover glass will make a neat job and ensure that moisture cannot enter. Glycerine added to the mounting gum will prevent cracking, whilst a trace of oil of cloves added to the liquid when diluting the gum will remove the possibility of mildew should the object be required to last for many years.

Balsam Mounts

Insect specimens, vegetable sections and similar perishable objects must be mounted in balsam, and this is a slightly more complicated operation, but may be carried out quite quickly in the following manner: The slide, cleaned as before, is placed on the turntable, and the specimen placed ready at hand, together with a prepared bottle of mountant or a home-made preparation made up as follows: Obtain some Canada balsam and place this in a saucer, which is stood in a larger saucer or plate in which boiling water is poured. If this is now stood over the top of a saucepan containing water, and the whole stood on a fire or gas ring whilst the water in the saucepan boils, the balsam will gradually harden, and, when thoroughly dry, it should be carefully dissolved in benzol until a consistency of average cream is obtained. I prefer to obtain a wide-mouthed bottle from a chemist and place about a ½ in. of benzol in this, dropping the pieces of balsam in until the desired consistency is obtained. A piece of thick glass rod will enable the solution to be taken from the bottle in a large "blob," which may be dropped upon the slide in the manner of treacle. A little practice will show the amount necessary for various thickness of cell. When dropped on the slide it will spread slightly and form a flattish globule upon which the specimen may be carefully deposited. A further small drop of mountant on top of the specimen will enclose it, and a cover glass over all will make a permanent job of the mounting, but excessive quantities of mountant should be avoided in order to prevent the mount being too thick. Excess may be removed by a brush or blotting paper, and when thoroughly dry a ring of black cement may be run round. Opaque objects are mounted as in the first description, without the use of balsam, the only point being the inclusion of a black paper disc or similar background to throw the object in relief.

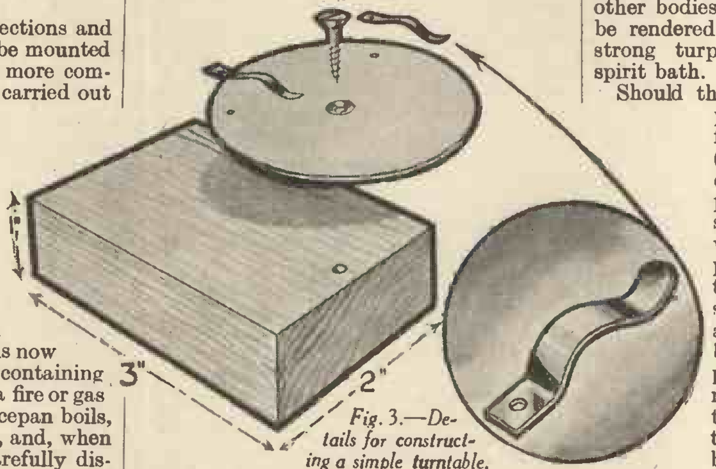


Fig. 3.—Details for constructing a simple turntable.

Miscellaneous Mounting Hints

The most important point requiring emphasis is that damp must be excluded from the mounting cell. It will readily be appreciated that warmth applied to anything damp results in the generation of steam, and no matter how small the quantity, it needs no imagination to see that steam and good visibility do not go well together. Damp also leads to mildew, so that every cell before closure should be absolutely dry. Vegetable and animal specimens may be dried out by immersing in methylated spirit or any special preparation—alcohol being used where the utmost permanency is desired. Small insects or other bodies having chitinous parts should be rendered transparent by immersing in strong turpentine after the methylated spirit bath.

Should the insect be large, or should a portion containing fat be taken for mounting, a weak solution (1 part to 10 parts water) of caustic potash should be employed for the preliminary soaking of the specimen. This will dissolve away all the fatty parts and will slightly bleach the object. The bleaching should not be carried too far, and then the specimen should be thoroughly washed and placed in the turpentine or methylated spirit bath. Vegetable specimens such as sections of stalks or leaves should be soaked in alcohol to dissolve away resinous matter, washed thoroughly to remove final traces, and finally transferred to the methylated spirit bath. Staining will bring out various portions of the section, such as veins, cells, etc., but this cannot be fully explained in the short space available. The hints given should, however, enable many permanent records to be taken, and will no doubt form the nucleus of many a good collection.

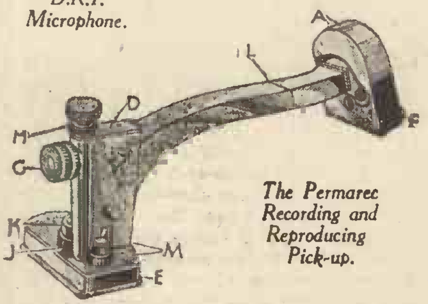
HOME RECORDING SIMPLIFIED

Details of a new and entirely satisfactory system for amateurs

THERE have been several devices for home recording placed on the market and intended for use in connection with a standard gramophone or radiogram. Few of them have been more than a qualified success, the main objections being poor reproductions with metal records, using fibre or trailing needles. The short life of metal records when used as recorded without further processes and finally in some systems, metal records have to be remade from a metal matrix pattern. This latter system is expensive and slow. Recently the writer witnessed a demonstration of a new Musikon process, who are now able to supply the Permarec flexible unbreakable permanent home recording record, which, it was obvious, had the following properties and advantages: It can be recorded and permanently hardened for use within three hours. It can be played on any standard gramophone or radiogram with steel needles; the reproduction is equal to any standard proprietary record; it has the playing life of any standard record; as the record has a metal base with pigment covering, it can be bent and dropped without fear of breakage. The record is 10 in. in diameter, and gives three minutes running time on each side, weighing 2½ oz. against 6 oz., which is the weight of a standard record. Three of these records take up the space of only one standard record. They may be used by anyone with excellent results on a radio gramophone with the small additional expense of a microphone, a groove cutter, and a recorder. It is almost impossible to damage one of these discs, and a record which we deliberately scored with a coin, when played afterwards, showed no signs of this ill-treatment. There are many applications of the Permarec record, for, apart from being able to make a permanent record of special items from the wireless programmes and the home recording of speech and music by members of the family, it may also be used for synchronising a running commentary in conjunction with a home cinematograph. They may also be used to send special greetings to friends abroad, for the recording of educational talks, etc., etc. Outfit A consisting of the Permarec recording pick-up, groove cutting attachment and records are all that the average person will require, but for cases where speech or song is recorded at home, a microphone is required which is supplied in outfits B and C. Other outfits are available for special purposes. Records can be baked at home, or through Messrs. Musikon, 17 Lisle Street, London, W.C.2, for 6*d*. each. Professional people may make records in their studios which will be processed and delivered within three hours at a cost of 10*s*. 6*d*. for each double-sided record.


The Permarec D.R.I. Microphone.

An illustration shows the Permarec D.R.I. microphone, which is of unusually good quality. It is a carbon granule microphone suspended by rubber rings in a metal ring. In the base is an output transformer with three alternative connections and also the feeding battery. On the top of the base is a control switch with an indicating light.



The Permarec Recording and Reproducing Pick-up.

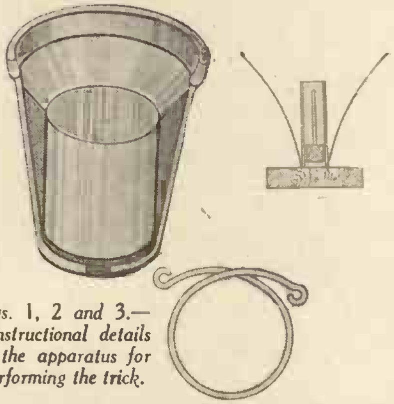
The lower illustration shows the Permarec recording and reproducing pick-up. A is the pick-up head. D is a nickel-plated pillar. E the bakelite base. F a spring nut for holding needles. H the connection screw for clamping the conveying arm of the groove cutter. M the junction contact for head phones for controlling the sound when recording. G a nut for adjusting the weight of the pick-up when recording. J an automatic electric motor stop. L the head swivel, and K a volume control. F.J.C

PRACTICAL CONJURING

Magical tricks may broadly be divided into two classes—sleight-of-hand tricks, which require a deftness only acquired by long practice, and mechanical tricks that need little beyond careful construction, a moderate gift of showmanship, and a reasonable amount of rehearsal. This article explains some mystifying mechanical tricks

A SMALL tea-chest, or similar box, containing soil, a flower pot (in duplicate), a garden trowel, a small watering can, some flowers and foliage, and a special tin container are the necessary accessories.

The basis of operation must be the flower pots, so obtain two 7-in. or 8-in. pots. Make a cylindrical tin or galvanised iron can to



Figs. 1, 2 and 3.—Constructional details of the apparatus for performing the trick.

stand inside one of these, the diameter of the bottom and an inch less in height. To the rim of this solder a flange, not cut from the flat but formed like a funnel with a narrow angle, sloping from the mouth of the can up to near the edge of the pot, to which the whole forms an inner container as shown in section in Fig. 1. The seams and joints must be watertight and the receptacle can be painted terra-cotta colour or black inside and out. Cut a disc of wood, about 1 in. thick and about ½ in. less in diameter than the inside of the can. In the centre of this erect a tin or thin-walled metal tube, also watertight, about 1 in. diameter and 6 in. high, painted green. Provide a sound bottle cork or wooden plug to move freely up and down within it. Fix a split cane spike in the centre, which may be subsequently trimmed off to a convenient height when making up the "plant." A few similar supports should be stuck into the disc, around the tube, to support foliage. They should be trimmed down to a minimum thickness and set with a tendency to bend outwards (Fig. 2). So far the structure is a permanent one and is the machinery of the effect. The growth is built up at the time of preparing for the show and is composed of such blooms and foliage as are available according to the season. Material of a light compressible nature is desirable, such as will pack into the small space available without bending and spread where free of restraint.

The Spray of Flowers

A spray is attached to the single support on the small float and larger sprays are wired with florist's wire to the side supports and around the central tube on the larger float. The small float is inserted into the tube and the large float into the container. A piece of black tissue paper is folded across the top of the latter and the same placed in a flower pot.

A cube-shaped box to contain the earth substitute, about 18 in. high, is the next item for consideration. Upon the back of this is fixed a wire bracket, designed to hold one of the flower pots. A piece of stout wire is bent into the form of Fig. 3, the large loop being of such a size as to hold the pot. It is fixed at such a height that it will clear a pot standing beneath it (Fig. 4), and as it will have to carry a considerable weight must be bolted into position. So that a pot may be lowered into the loop noiselessly it should be covered with a piece of stout rubber tubing slipped over the wire before the bolt eyes are formed, or it may be bound round with cloth or other material.

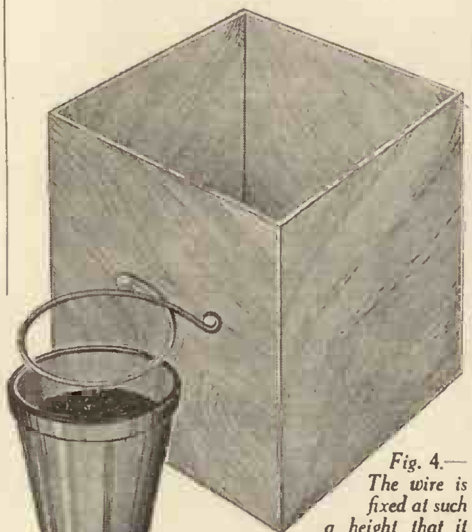


Fig. 4.—The wire is fixed at such a height that it will clear a pot standing underneath.

A Substitute for Soil

Garden soil being of an undesirable nature to handle, black sand may be used as a substitute, or, better still, dyed sawdust. The ordinary packet dyes sold at domestic stores can be used. Mix with water and pour over the sawdust in a suitable receptacle or spread upon a tray. When saturated all through spread out in the sun or before a fire to dry.

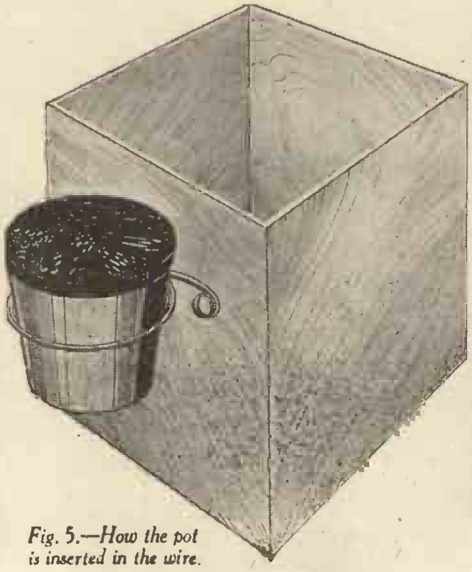


Fig. 5.—How the pot is inserted in the wire.

The watering can, if the performance takes place in the open (as, for instance, at a garden party), can be the regular garden appliance, and is singularly effective, but for indoor use the shower must be modified. Therefore stop all the perforations with beeswax (a toy can will do in this case) and make one fairly large hole on the extreme edge of the rose so that the water dribbles from it in a downward stream. If the performer excuses its erratic action by attributing the can's origin to a popular store noted for cheap supplies it will be regarded as an intentional joke. Its real purpose is to keep the available stream of water within the limit of the pot and direct it into the secret containers.

It only remains to plug the hole in the bottom of the unprepared pot with cork, sealing wax or plasticine and all is prepared. Set the loaded pot beneath the bracket, behind the box containing the "soil," with the trowel and the empty pot and the water can near by.

Performing the Trick

When ready to perform, lift the box with one hand, grasping the front rim and the other hand behind. Although it is assumed by the spectators that this hand supports the box, really it grasps the hidden flower pot, and the pot, in turn as it is lifted, raises the box by pressing against the wire bracket. The box is set down in the required position and soil scooped up with the trowel into the visible pot. When filled it is apparently put down on the table and the box of soil carried away. At this point a substitution takes place. As the pot just filled with soil is put down behind the box it is put just over the concealed pot and in position to drop into the loop of the bracket. This it does as the box is lifted and is carried off with it (Fig. 5). The pot left on the table to the eye of the spectators is the same.

The water from the can introduced in a slow, steady stream is the motive power of the growth. As the floats, big and small, rise on the surface of the accumulating water in their respective compartment the foliage appears above the surface of the covering paper, which becomes soaked and breaks away (Fig. 6). To give it a start it is desirable to puncture it in the centre, and a natural pretext for doing this is provided by "sowing" a seed. The seed is an imaginary one taken from a packet carried in the pocket, and the hole for its reception is made with a pencil or pocket knife. A few scores, judiciously placed, with a keen razor blade, when preparing the pot, will ensure its proper breaking up.

If it is found that living flowers are undesirable owing to a lengthy journey and probable fading, the well-known artificial flowers may be used instead. I recommend, however, that real blooms be employed, as they may then be broken off at the conclusion of the trick and thrown out to the audience.

It should be unnecessary to add that the whole success lies in the easy manner in which the substitution is carried out, so that this should be practised many times before presentation in public.

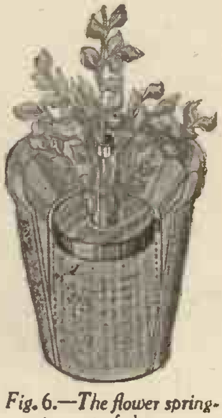
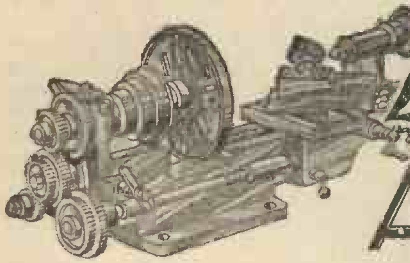


Fig. 6.—The flower springing out of the pot.



Lathe Work FOR AMATEURS

By F. J. CAMM

OF the several methods of making holes in metal those associated with the lathe are drilling and boring. Drills are extremely useful for holes of standard size, and twist drills (I shall deal with other forms of drills later) are obtainable in all sizes from one sixty-fourth upwards, progressing by sixty-fourths. A drilled hole, however, is seldom accurate. It is not of much use, for example, as a bearing, for however carefully a drill is ground it is bound to cut oversize. If a hole exactly ½ in. in diameter is required a drill of ½ in. diameter will not cut it. It will be obvious to the reader that a steel shaft exactly ½ in. in diameter will not enter a hole exactly ½ in. in diameter. So for accurate work we must drill a hole undersize and bring it to the size required by means of a standard reamer.

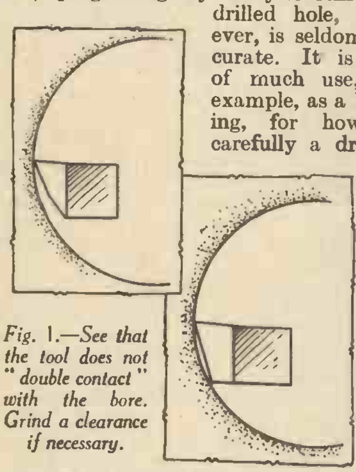


Fig. 1.—See that the tool does not "double contact" with the bore. Grind a clearance if necessary.

These methods are convenient for certain work, but when dealing with castings large holes may be required outside the capacity of drills, and such holes may appear in the casting as roughly cored openings. It is in such cases that we must resort to boring. A plain drilled hole is usually rough, but by boring, a smooth finished hole exact to any size within the capacity of the lathe can be obtained, and when a glass-like finish is required, subsequent lapping (allowing for this by boring the hole slightly undersize) by means of a brass lap and fine emery and rouge will effect a finish from which all traces of turning marks have been removed.

There are many forms of boring bars and some of them are illustrated here. A primary requirement is a stiff bar which does not spring, for a tool which is unduly flexible will cause the hole to be bell-mouthed—that is to say, have a larger diameter at the front than at the back. Unfortunately, even though the boring bar is of the most robust construction, a certain amount of spring is bound to be present. If the hole is large a strong bar of ample dimensions can be used, for it will easily pass into the hole and the amount of bell mouthing which results will be slight, and due only to the sudden application of the cutting load when the tool first meets the work.

By careful finishing cuts (a series of very light cuts) bell-mouthing can be entirely eliminated. Another cause of bell-mouthing is the heating up of the work; naturally the work heats up progressively as the tool advances, causing the metal to expand. When it cools down a bore of irregular diameter may result. The initial roughing cuts can be fairly heavy or greedy, but it is always advisable before taking finishing cuts to allow the work to cool down. An adequate supply of cutting lubricant should be directed on to the point of the tool either by means of a brush or a pump.

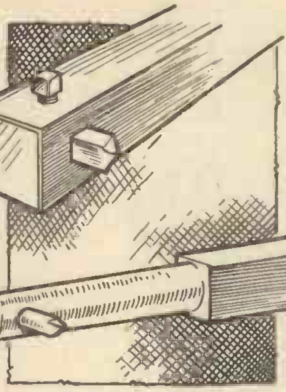


Fig. 3.—Square and round boring bars.

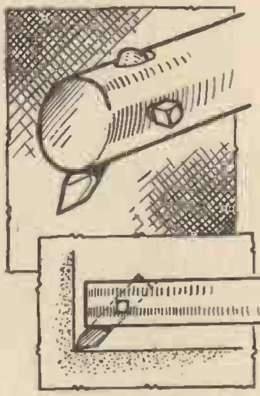


Fig. 7.—Boring bar with the cutter inclined.

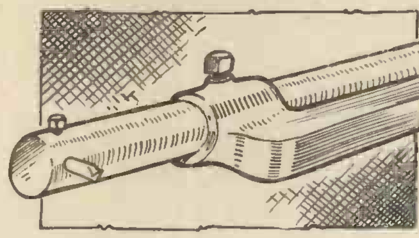


Fig. 6.—Tool-post boring tool holder.

With very small holes, however, it is necessary to use a boring bar or boring tool reduced in diameter so that it can enter the hole, and these tools usually give trouble owing to their flexibility. It is, therefore necessary to proceed cautiously with the work. The initial cut should always be a tentative one to level down the high spots in the cored hole. If the hole is not cored a hole should first be drilled and finished to size by boring. It is particularly necessary to take light cuts where ports lead into the bore, as when the tool passes these openings the load on the tool is released, and when it again starts to cut a high spot is left giving rise to an oval bore.

It is desirable to set the tool so that only its point is in contact with the work. It may be necessary in some cases to grind clearances. Various forms of boring tools, most of which are illustrated on this page, are necessary to cope with differing varieties of work, and obviously the methods employed are decided by the work itself. The difficulties the amateur will have to contend with are cold (*Continued on page* 201.)

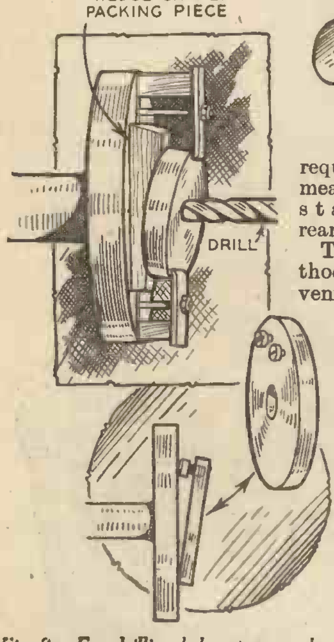


Fig. 2.—For drilling holes at an angle it may be necessary to pack the work as shown here.

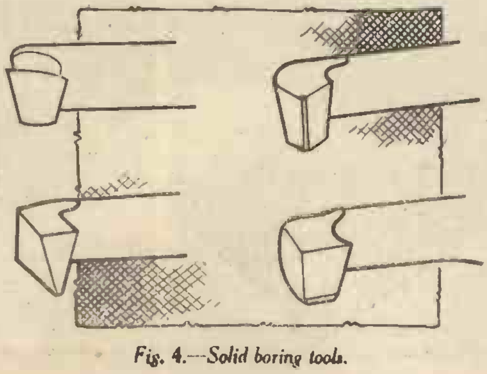
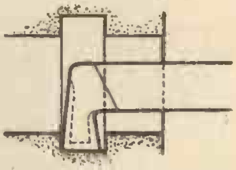


Fig. 4.—Solid boring tools.



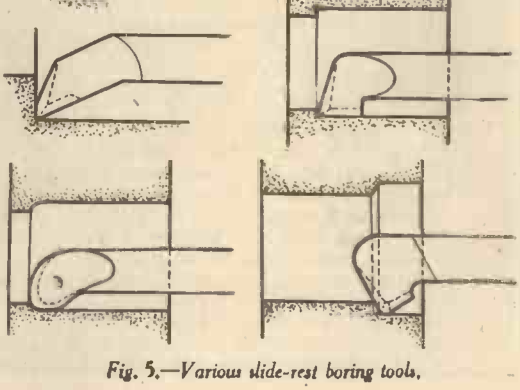
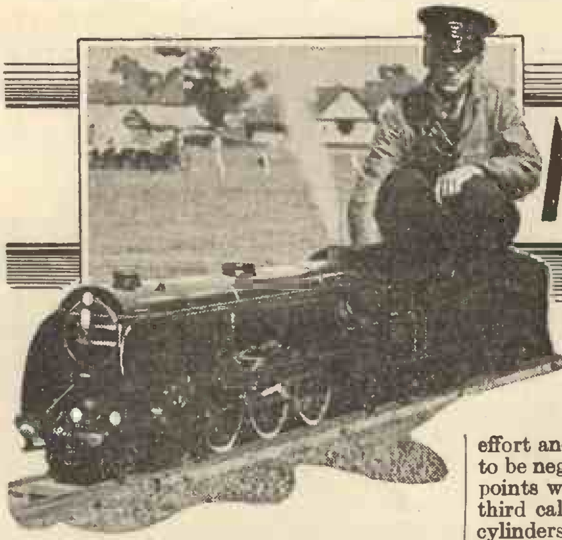


Fig. 5.—Various slide-rest boring tools.



MODEL RAILWAYS

A 4¾ IN. GAUGE GARDEN RAILWAY LOCOMOTIVE. PART I

By E. W. TWINING

IT may be wondered why, if the gauge of the track on which the locomotive is to run is 4¾ in., which is the standard width for a one-twelfth full-size model, I have not used in the title to this article the words "1 in. to the foot scale." As a matter of fact, the engine is not intended to be a 1 in. scale model and is only made to fit the width of rail mentioned, because I thought it desirable that it should run upon a model gauge which is already a standard one.

I am showing in Figs. 1 and 2, which are both side elevations, alternative boiler mountings on the same engine, and only if the second proportions for these mountings are adopted can the model be looked upon as fitting into the 1 in. scale category.

Origin of the Prototype

It may be worth while explaining the origin of the outline shown in Fig. 1. The truth is that some time ago I was asked by the managing director of one of the big locomotive building firms in the north to prepare designs for small power engines required for working an 18 in. or 20 in. gauge railway intended for carrying passengers and minerals. The chief points to be given consideration were low cost of production, simplicity, a high tractive effort and a small radius curve in the track to be negotiated with safety. The first two points went hand in hand so to speak, the third called for small driving wheels, large cylinders and a rapidly steaming boiler. The driving wheels were 20 in. in diameter, cylinders 8 in. stroke × 5 in. bore, and the boiler 20 in. in diameter, with a very large firebox and a total heating surface of 74 sq. ft. The fourth point precluded the use of more than four wheels coupled and, to carry the large boiler and particularly the firebox, a flexible wheel-base.

At the outset I abandoned all idea of making the engine a scale model, say one-quarter or one-third of the size of a standard gauge prototype. For one thing I am not a believer in making scale models of this size do the heavy work of hauling passengers and goods on public railways. Quite a number of such railways are in existence having a gauge of 15 in., but one such line in particular, which commenced work with one-quarter full-size scale models, has long since abandoned this type of motive power. The trouble is, of course, that the scale model will not stand up to the heavy work which it is called upon to do. This argument actually applies, equally well, to the small scale model on a garden railway, and it would be better for the sake of wearing qualities in the engine, when it is to be called upon to do heavy duty in passenger hauling, to abandon scale, and design the locomotive to fit its job. I have mentioned that the prototype was required for 18 in. and 20 in. gauge tracks, and when I was asked to contribute this article on an engine for working a garden railway it at once occurred to me that all the conditions were here equally applicable, and so I decided to re-draw my design to make it represent, on 4¾ in. gauge, a one-quarter full-size model of the prototype.

The Appearance of the Engine

The facts which I have stated will explain why the locomotive shown in Fig. 1 has what some people would consider an old-fashioned appearance. I omitted to mention that a minor stipulation in connection with the original was that it should have plenty of polished brass and be showy and ornamental. For this reason it had a polished brass dome and copper cap to the chimney, whilst the wheel splashers were also bright brass. As will be seen, the safety valve is mounted on the top of the dome, which dome contains the regulator, and so the bright brass casing is somewhat tall. There is, however, a very good reason for the length of the chimney. The top of this in the prototype stood 5 ft. 4 in. above the rail level. Now a great many people, when they design a model locomotive, think that it looks jolly fine to have a short, stumpy chimney. They forget that such a chimney on a big main-line passenger engine is a necessity imposed by the limits of the loading gauge. If the present day locomotive engineers could push the height of the loading gauge up to 15 ft. above the rails

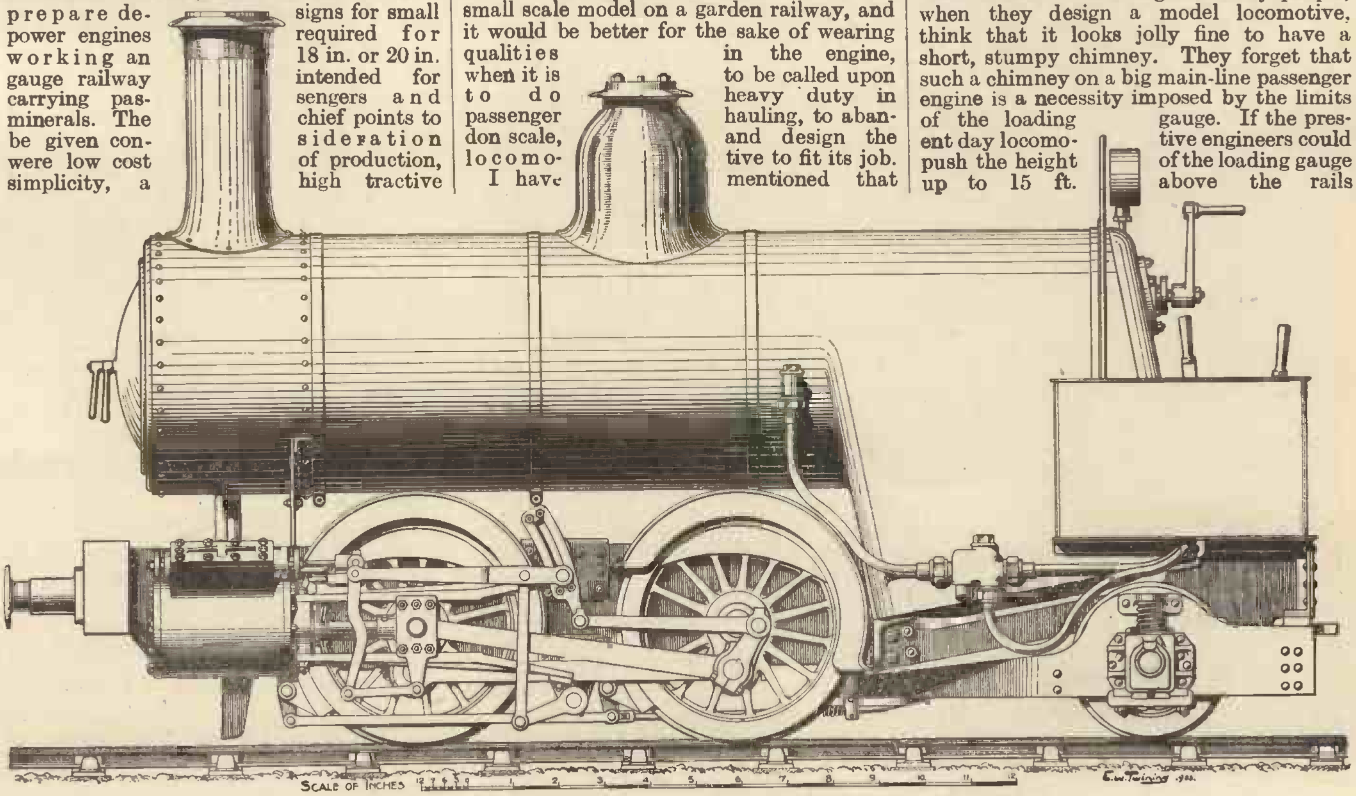


Fig. 1.—An 0-4-2 type locomotive for working an 18 in. or 20 in. gauge garden railway.

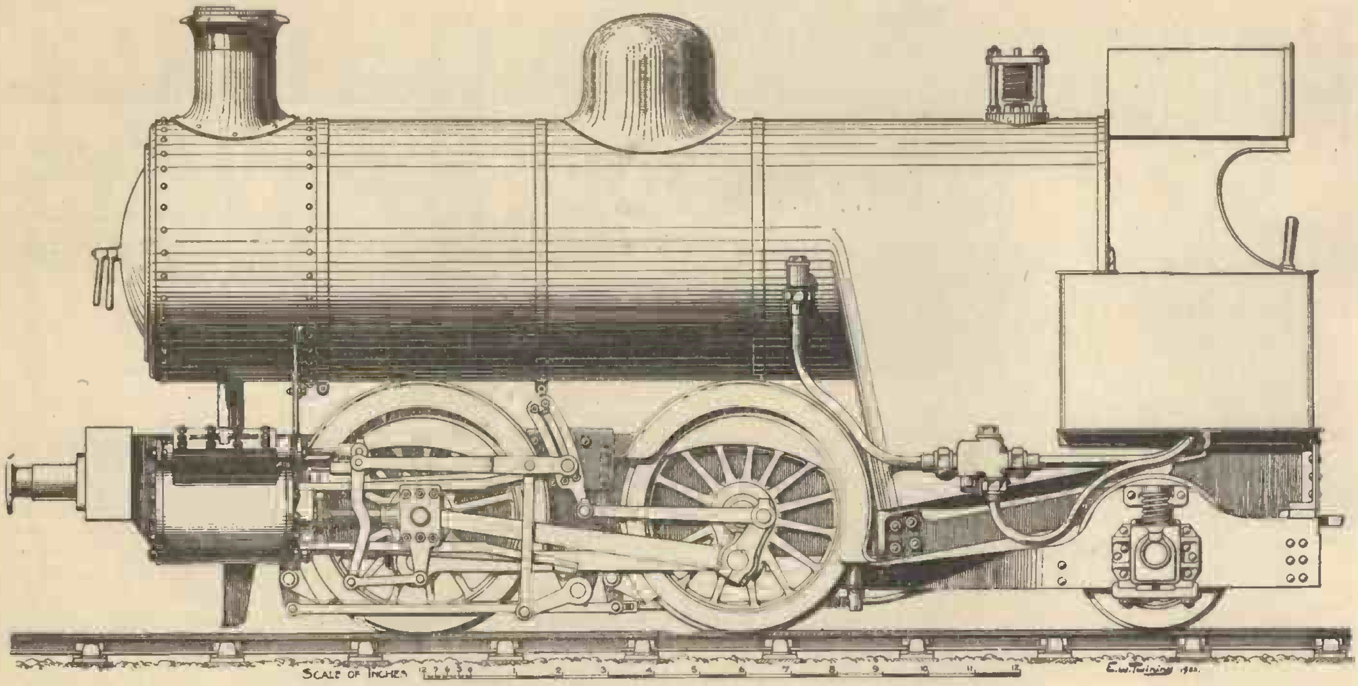


Fig. 2.—The chimney and dome shortened to come within the scale loading gauge.

they would gladly do so and let the chimneys of their engines follow suit. It was not a matter of fancy which led designers in the old days to put tall chimneys over their smoke-boxes. Everybody knows that a chimney induces a natural draught through the fire and obviates the use of the blower when the engine is standing for a considerable time. Although I give in Fig. 2 an alternative chimney and dome, the former of which is the 1 in. scale height above the rails, I do strongly advocate the design shown in Fig. 1.

Cab or no Cab?

A further difference will be seen between my two drawings. In Fig. 1 the engine has no cab, merely an ornamental weather board. In this detail the drawing does not conform to the original design, for in the 18-in. gauge engines provision was made for a very large cab with a long roof extending well back over the tender and completely sheltering the driver who sat therein. The roof of this cab was pivoted to lift upwards when the driver wished to get off the tender. In the garden railway model which we are now dealing with, the reader can please himself whether he puts a cab on or not. If he builds as in Fig. 1 I should omit the cab; if as in Fig. 2 it may very well go on, but I think the roof should be removable to gain easy access to the regulator handle.

General Description of Engine

To the reader who is familiar with locomotive work a description of the type, having the drawings before us, is perhaps superfluous, and I would merely say that the model has two simple cylinders only, measuring 2 in. stroke × 1¼ in. bore. These drive four coupled wheels 5 in. in diameter. The haulage power, therefore, should be very considerable with the projected 80 lbs. working pressure in the boiler. Such a cylinder bore is about as large as it is usual to find on any 4¾-in. gauge engine, and larger than most. The flat slide valves, which are on top of the cylinders and slightly inclined to the horizontal cross line of the engine, are actuated by full Walschærts' gear. All the links and rods, including the coupling and connecting rods, are of heavy weight with big and long wearing surfaces. The trailing wheels are mounted on a radial truck pivoted just behind the driving axle. These wheels are arranged to swing to a considerable extent to enable the engine to negotiate a curve, if necessary, as small as 15 ft. radius. The reversing gear is, of course, operated from the footplate, the reversing rod being made to pass underneath the fire-box. A hand brake is fitted and worked by a lever also on the footplate. For the present I pass over a description of the boiler and will merely say that it is to be fed by two injectors placed one on each side of the fire-box, the check valves from each being on the boiler barrel.

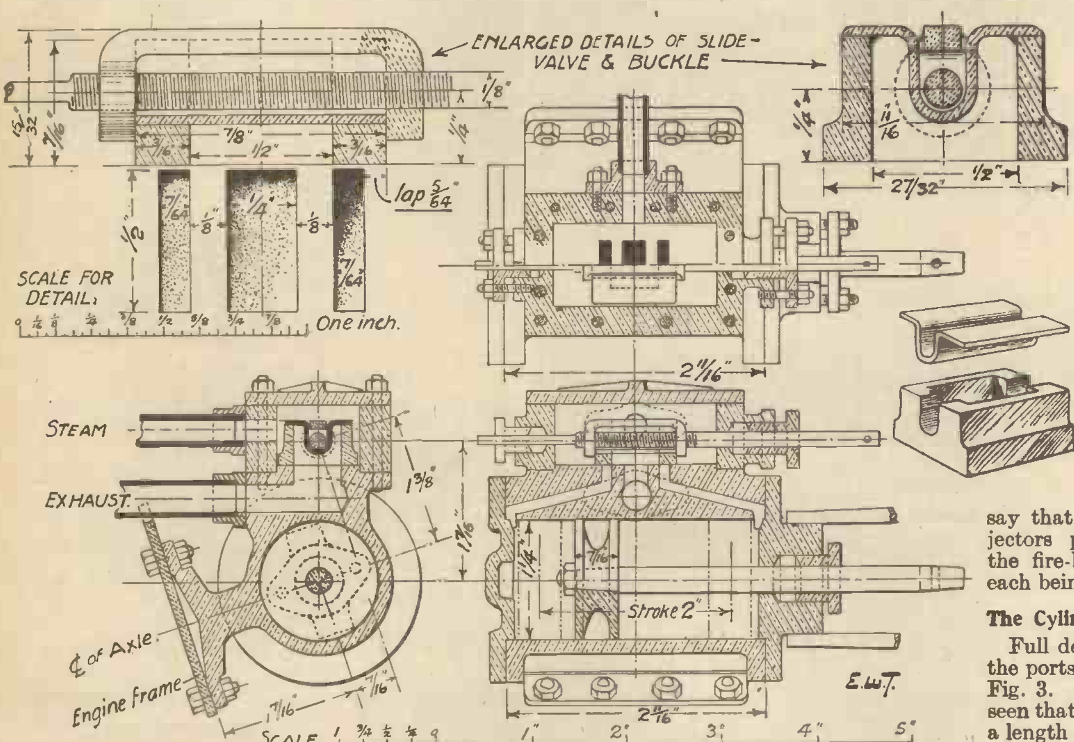


Fig. 3.—Details of construction of cylinder and slide valve.

The Cylinders

Full details of these, together with the ports and slide valve, are given in Fig. 3. From this drawing it will be seen that the valve has a lap of 5/64 in., a length of 7/8 in. and an exhaust cavity of 1/2 in.; the two steam ports are 7/64 in. long, the port bridges 1/8 in. each and the

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MODEL RAILWAYS (Continued from page 186.)

exhaust port has a length of $\frac{1}{4}$ in., the width of all the ports being $\frac{1}{2}$ in. The with their valve chests, is to be cast, is a matter of choice. It is usual in a model as large as this to make them of cast-iron, with valves of gunmetal, this being the because it is eminently suitable for outside cylinders with valves on top. In common with a number of other radial gears the lead of the valve is constant for all positions of the reversing lever. An article such as this is not the place in which to give a treatise on the design and functioning of this gear, and those readers who are not altogether familiar with it are referred to special books on the subject. For the benefit, however, of the model maker who, whether he understands the Walschærts' gear or not, will require to have an accurate setting out, or layout, for the gear as applied to his model, I have thought it necessary to give, in Fig. 4, four diagrams showing the correct proportions and movements of the various links, together with the slide valves which they move. In Diagrams 1, 2 and 3 the engine is shown in forward full gear, the die block on the end of the radius rod being at the bottom end of the expansion link. With the crank pin on the forward dead centre, as in diagram 1, the valve is then opening the front port by the predetermined amount for lead. In Diagram 2 the port is fully open, whilst in Diagram 3 the crank has reached the back dead centre and the valve is opening the back port to lead. In Diagram 4 the crank has moved to the fourth position, uncovering the back port fully, but in this sketch I have shown by two-dot-and-dash lines the effect of reversing the engine; that is to say, by lifting the radius rod to the top of the expansion link. This movement causes the valve to move backwards across the ports a distance equal to its travel and to fully uncover the forward port.

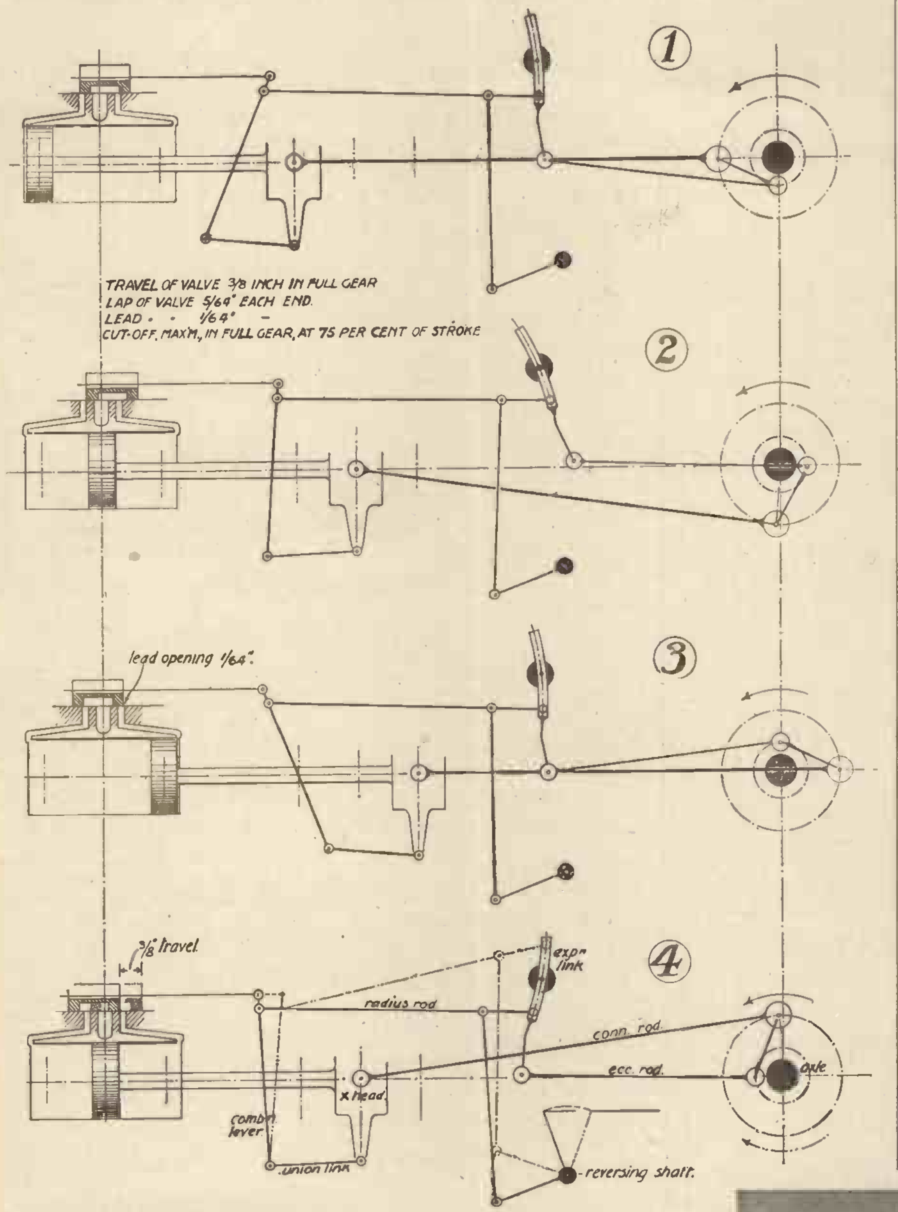


Fig. 4.—Four diagrams showing the correct proportions and movements of the various links.

method of constructing the valve is a new and original one. In order to save the trouble of chipping out the exhaust cavity it is cut or cast with an opening right through it; two slots are filed at each end and a bent brass plate is then fitted into these slots with flanges to come down on the top of the valve; the whole is then silver soldered together. The channel formed in the flanged plate top receives the valve spindle. The method of driving the valve from the spindle is also original. A double-ended buckle is bent from steel plate, tapped $\frac{1}{8}$ in. Whitworth, and the valve spindle screwed through. This buckle not only serves as a means of driving the valve, but it also provides a very nice method of setting the valve on its spindle in relation to the ports. The buckle is, of course, prevented from turning by the fact that the narrow piece connecting the circular screwed ends engages with the top of the slot in the valve.

The material in which the cylinders, same as full-size practice, but cast-iron is a source of some trouble when the engine is likely to be left unused for a long period. I have known iron cylinders to become so rusted up that it was impossible to turn the driving wheels by hand and the cylinders had to be taken down, the pistons knocked out and the bore re-lapped. I would, therefore, recommend that the castings be obtained in gunmetal, in which case the slide valves can be of brass. There can then be no fear of rusting.

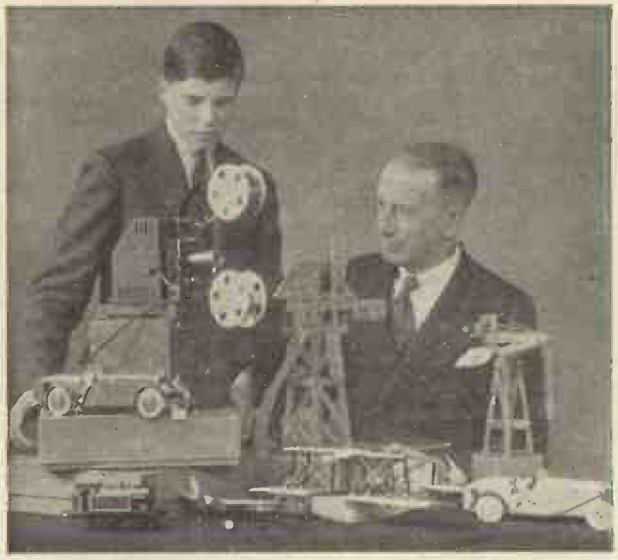
The Valve Gear

This, as previously mentioned, is of the Walschærts' type, chosen

A FINE RANGE OF MECHANICAL TOYS

READERS will be interested to know that Bassett-Lowke Ltd., the famous model-makers, have just opened a new "Plaything" Department at 112 High Holborn. This attractive range of BRITISH-MADE mechanical toys includes FROG aeroplanes, TRIX the master model-maker, Bowman steam engines, Bing British cinemas, Hornby trains, constructional, electrical and chemical sets, and each is personally selected by Mr. W. J. Bassett-Lowke. A special "Plaything" folder dealing with these toys will be sent from Northampton on request.

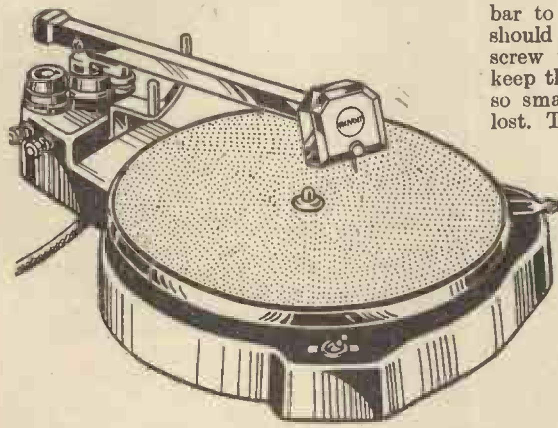
For model railway owners or would-be owners, Bassett-Lowke Ltd. have a very fine display of new productions, including a new Tank Locomotive, a new suburban station, "ASHFIELD," Colour Light Signals, models of "The Princess Royal" and the well-known and popular "ROYAL SCOT" and "FLYING SCOTSMAN" miniature gauge "0" expresses. There are also some new accessories, a new automatic coupling, and plenty to interest the Ship Model lover in motor boats, cabin cruisers, souvenir waterline models of famous ships, etc.



Mr. W. J. Bassett-Lowke with a model enthusiast at the opening of the new mechanical toy department of Bassett-Lowke Ltd.

GRAMOPHONE UPKEEP, OVERHAUL AND REPAIR

Useful Information which will help the Owners of Gramophones, Acoustic and Electrical, to obtain the best results from their Instruments.



A synchronous motor turntable showing how compact this apparatus is.

IT would not be an exaggeration to say that at least 60 per cent. of gramophone owners are not obtaining the best results from their instruments. In the majority of cases they do not realise the additional pleasure they could obtain by giving occasional attention to the components of their machines. Let us consider the parts that comprise an acoustic gramophone and a radio gramophone. The former consists basically of a soundbox, horn (of which the tone-arm is a part), and an electrical or spring motor; the latter has a pick-up with carrying arm, valve amplifier, loud speaker and motor. Both types of machines have cabinets, but providing they are fairly solidly constructed they play no part in the reproduction qualities of the instruments. If any of the component parts of the instrument are faulty or out of adjustment, the quality of reproduction will be impaired. If you have an acoustic machine, by which is meant an ordinary gramophone, in which grooves in a record are made audible by the needle in the soundbox vibrating the diaphragm, which varies a column of air in the horn and it tends to buzz on certain notes, you may be sure there is a fault in the acoustic system. It may be that the diaphragm of the soundbox is cracked.

Fixing a New Diaphragm

Remove it from the tone-arm and hold it before a strong light. When the diaphragm is made of mica and this is not perfectly clear, it will mean that a new diaphragm will have to be fitted. It is essential to purchase one of the exact size as the old one, since it is practically an impossible task for an amateur to cut this material successfully. Some soundboxes are fitted with aluminium diaphragms, and if one has been dented by the soundbox being dropped onto a record, it will be an extremely difficult task for the reader to fit a new diaphragm. Unless he has had considerable experience with soundboxes, he would be well advised to hand the job over to a professional.

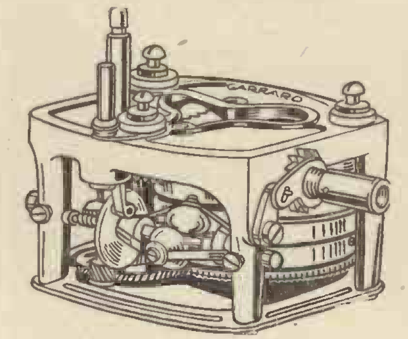
Mica—an easy Task

The fitting of a new mica one is comparatively simple. The screws securing the back of the box to the front ring should be removed. If there is any wax covering the screw which secures the end of the stylus bar to the centre of the diaphragm, it should carefully be scraped off and the screw undone. Be careful to keep this in a safe place; it is so small that it can easily be lost. The front ring should now be removed from the backplate and it will be found that the diaphragm is clamped between two lengths of rubber tubing. These are called "gaskets," and if they show any signs of perishing they should be replaced. They may have become hard, which will also prevent the diaphragm performing to its best advantage.

Accuracy is Essential

In reassembling the soundbox care should be taken to ensure that the mica is exactly in the centre of the box. It should be clamped between the rubber so that its periphery does not touch any part of the box. If this point is not watched, buzz may be introduced by the diaphragm vibrating against the wall of the box frame.

If the diaphragm has been placed in correctly, and providing that the stylus bar is not bent or out of adjustment, the threaded hole in the top of the bar should register exactly with the hole in the diaphragm, and the screw may then be turned home. If the diaphragm is out of centre, the screw should on no account be forced, as it will crack the mica.

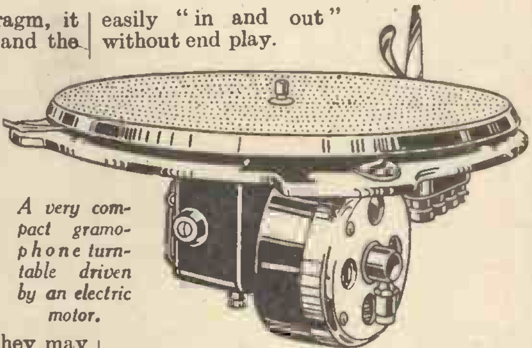


A clockwork-driven Gramophone Motor.

The stylus bar must be examined and the pivots or springs adjusted until the screw can be inserted without fouling the diaphragm. A drop of hot beeswax should carefully be dropped on the outside of the diaphragm over the juncture of the stylus bar and the centre of the mica.

Pivot Adjustment

Bad reproduction may be due to the stylus bar being loosely attached to the diaphragm or to part or all of the wax being broken away. The stylus bars of many soundboxes are mounted between pivots which are permanently fixed by a set-screw. After a soundbox of this type has been in use for some time, wear may have taken place, with the result that the stylus bar moves slightly sideways. The pivots should then be adjusted, after the set-screws have been loosened, so that the stylus bar moves easily "in and out" without end play.



A very compact gramophone turntable driven by an electric motor.

It must be remembered that a stylus bar which has been adjusted too tightly can cause serious record wear besides injuring the quality of reproduction.

Preventing Air Leaks

The soundbox should be a tight fit on the tone-arm. In the same way there should be an air-proof joint between the tone-arm and the top of the horn. It is quite a simple matter to test these joints providing you are not a non-smoker. The soundbox should be in position on the tone-arm, and a cigarette, pipe or cigar is then lit and the smoke puffed up the mouth of the horn. The joints between the horn, tone-arm and soundbox are satisfactory when no smoke is seen to exude from them.

An air leak between the horn and tone-arm can usually be remedied by undoing the screws holding down the base of the latter, and after removing it from the motor-board, a thin cardboard or paper washer which has been liberally covered with vaseline or grease should be inserted between the tone-arm and horn when they are reassembled.

Loose Needles cause Trouble

Buzz on high notes of records may be due to needles having found their way into the horn. The gramophone should be rocked gently from side to side and any loose needles will be heard rolling about inside. The silk fret or slats of wood in front of the horn should be removed, and if the machine is tilted forward the unwanted needles will probably roll out. If the horn has many sharp twists it may be necessary to procure a small magnet which should be attached to some stiff wire and then forced round the bends.

In the better makes of gramophones the horns are firmly attached to the cabinets, but should one be loose, it will vibrate against the floor or sides of the cabinet on certain notes. Similarly, loose screws or needles inside the cabinet may be touching the sides of the horn.

Finally, it can be said that very often faulty reproduction is due to the needle being insecurely held in the stylus bar. When the screw is not long enough to grip a very fine needle, either a larger needle must be used or the thread of the screw lengthened. Always remember that every part of the acoustic system of the gramophone must be free from fault if the best is to be obtained from the records.

MAKING AN INGENIOUS COMBINATION LOCK

A Novel and Simple Combination Lock which you can make and fit to Drawers, Boxes, etc.

THE combination lock described in this article is of quite simple construction, and can be made by any amateur, the only tools required being a hammer and fretsaw. It is nevertheless quite reliable, and, indeed, you can get many hours of amusement showing it to your friends and asking them to open it. The lock is made of wood, though, of course, a much smaller and stronger lock can be made of metal on the same lines. A lathe would be necessary for this. If a lathe is at hand, the wooden model can be made more accurately, though quite successful parts can be cut with a fretsaw if care is taken to get the circular parts accurate.

The lock consists of two main parts: (1) the locking device proper—the bolt (Fig. 1); (2) the releasing device, in this model consisting of three discs which, when placed in the correct combination, allow the bolt to withdraw.

The Frame of the Lock

The frame of the lock consists of a piece of wood ⅜ in. thick and 3 in. square, although these sizes can be altered to suit individual requirements, or the frame may consist of one side of a box or drawer.

To this are attached two pieces of ⅜-in. wood (X and Y in Fig. 1), size 1 × 1½ in.

Next cut three discs 1½ in. in diameter, like the one shown in Fig. 4. They should be $\frac{3}{16}$ in. thick. Two of them have a notch cut in as shown, while the third has one side of the notch cut away as shown by the dotted line. Cut another disc without any notch or central hole for the dial. The three discs are mounted on a shaft consisting of a lead pencil or skewer, and they must be a good fit on the shaft—that is, they must be able to turn individually and yet must not be at all slack. Disc No. 1 (Fig. 2) is that with one side of the notch cut away.

The Stops

The discs work together by means of small stops (Fig. 4), fixed at the same distance from the centre, so that when the stops come together disc 1 will push disc 2 round, and so on. There are two stops on disc 2 (one on each side), and one stop on each of Nos. 1 and 3, as shown in Fig. 2.

Disc 1 is joined to the dial by means of a cylinder ¾ in. diameter cut out of the frame, with a fretsaw, and indicated in Fig. 2 with a dotted line. This cylinder has a hole cut in to take the shaft, which rests in it. Glue and nail disc 1 to this cylinder, then insert the latter in the hole in the frame, then glue and nail the dial to the other end of the cylinder, placing a thin piece of card between to make it stand a little off the frame. You have now the dial and disc 1 connected and free to rotate in the frame.

Place the other two discs on the shaft, and insert the end of the shaft in disc 1 and through the cylinder, not quite as far as the dial. The end of the shaft is not, of course, fixed to the cylinder, and during the working of the lock the shaft does not turn at all. It merely serves to support the discs and to keep them from rotating when not required.

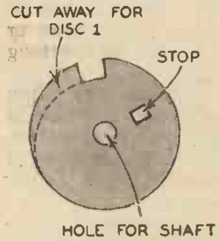


Fig. 4.—Showing one of the three discs used for the lock.

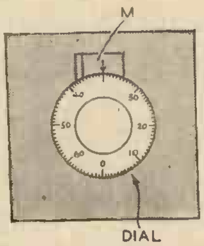
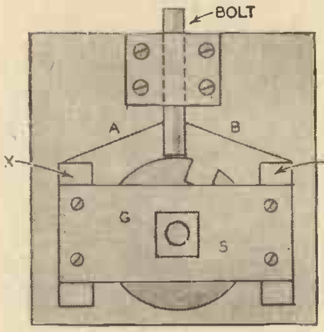
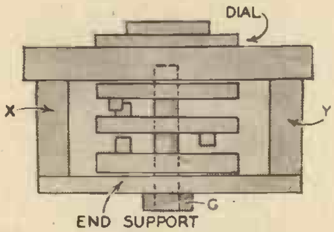
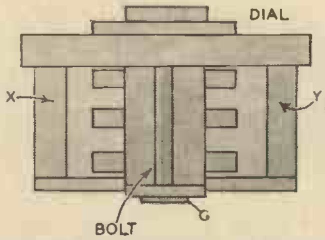


Fig. 5.—How to mark out the dial of the combination.



AB - RUBBER BAND OR SPRING





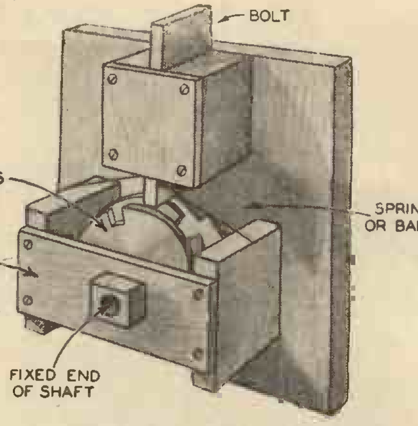
Figs. 1, 2 and 3.—A rear view, an underneath view and a top view of the lock.

The Shaft

This is fixed to the end support by the block, G, into which it is glued. The end support is $\frac{3}{16}$ in. thick and 2½ × 1 in. in size, and is fixed across the two pieces of wood already fastened to the frame. (It should be fixed after the rest of the lock is fitted together.) The other end of the shaft goes through the discs and rests in the cylinder joining disc 1 and the dial.

The bolt is a piece of $\frac{3}{16}$-in. wood, size 1½ × 1⅛ in., and slides vertically in its slot freely, and yet with as little play as possible. A hole is drilled through it, and a rubber band or spring fixed through to withdraw the bolt when the correct combination is used.

To use the lock, turn the dial round and round anti-clockwise until the stop on disc 1 hits that on disc 2, and the other on disc 2 hits disc 3. Thus all the discs are rotating with the dial. The lock is now set at "zero."



A rear view of the finished combination ock.

Turn the dial, still anti-clockwise, until the notch in disc 3 comes under the bolt. The bolt, of course, will still be held up by the other two discs. Then reverse the motion, and turn clockwise. The stop on disc 1 will not now engage with that on 2, and the former will turn one revolution before hitting disc 2 again. When this happens, turn until the notch on this disc is under the bolt. Disc 3, of course, will be unaffected, and the notch on this disc will still be under the bolt. Now turn the dial anti-clockwise again, and when the notch on disc 1 comes under the bolt, there will be a click and the bolt will fall into the notches. The lock is now released. To set the lock again, turn the dial anti-clockwise until the first disc acts as a cam and raises the bolt; when disc 2 is engaged and turns, the bolt will not fall down until released again.

The Combination

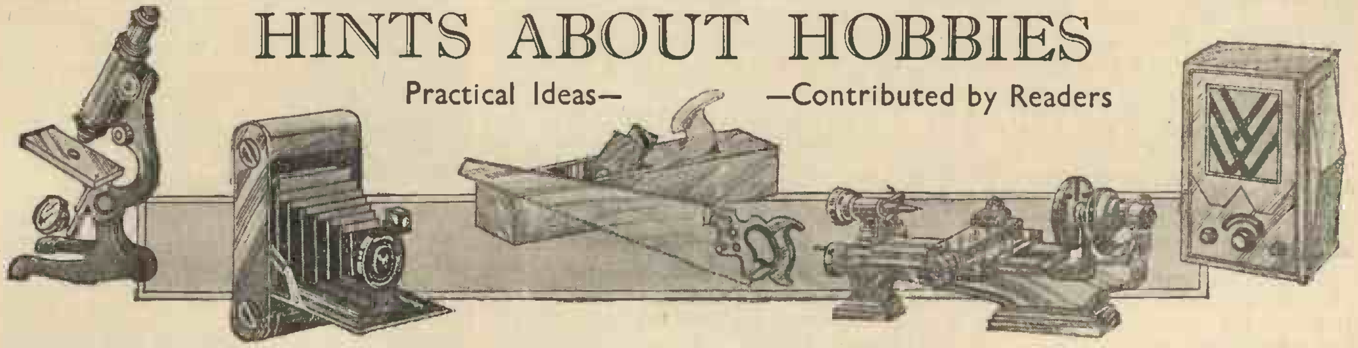
While the dial is turned as described above, make a note of the positions of the dial with respect to a mark, M (Fig. 5), on the frame. The three numbers on the dial will be the combination of the lock. When this is obtained, it will be a simple matter to open the lock by a few quick twists of the dial. Unless you know it, it is almost impossible to open the lock.

The combination may be varied by altering the positions of the stops on the discs. Take care that the discs do not interfere except when the stops touch—sandpaper them until smooth, and see that they are a good fit on the shaft.

Fix a little knob to the dial, and mark the latter with spaces and figures.

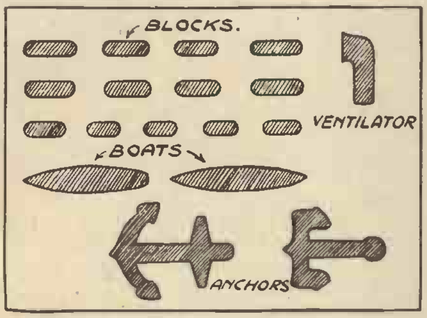
HINTS ABOUT HOBBIES

Practical Ideas— —Contributed by Readers



A Mould for making Ship Blocks

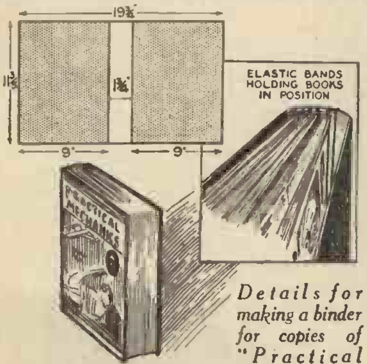
IT consists of a piece of thin wood cut out as sketch or to suit requirements, and soaked in wax, such as old candle ends. This is backed by a plain piece of wood which is also soaked.



Moulds for making various ship's accessories.

Into the moulds thus made plastic wood is pressed, which, when dry, will come out quite easily and only require smoothing up and drilling for ropes, etc.

Boats and anchors can also be made quickly and easily by using this method.



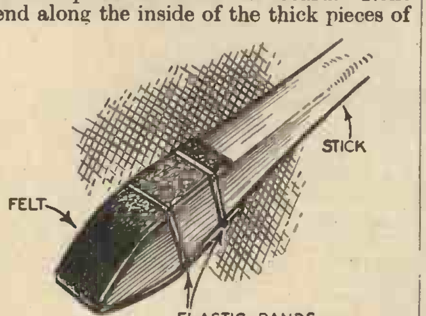
Details for making a binder for copies of "Practical Mechanics."

A Useful Binder for "Practical Mechanics"

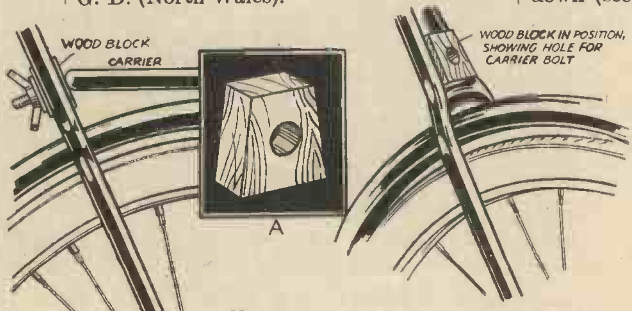
TO make this binder a piece of thin cardboard, $19\frac{3}{4} \times 11\frac{3}{8}$ in., will be needed as well as two pieces of thicker cardboard $11\frac{3}{8} \times 9$ in.; these should be securely stuck in the position shown shaded in Fig. 1. This should leave a space of $1\frac{3}{4}$ in. between the two pieces of thick cardboard. Next bend along the inside of the thick pieces of cardboard, so that the whole thing resembles a cover of a book. The front of this cover can be suitably decorated by the coloured covers of PRACTICAL MECHANICS. To strengthen and add to the appearance of the cover some passe-partout binding should be bound round the edges. To hold the issues of PRACTICAL MECHANICS together thirteen rubber bands will be needed. The method of fixing the issues is shown in the sketch.—A. C. (Upton Park).

A Brush for Poster Work

AN effective brush for hand-printed poster work may be easily made from a piece of an old felt hat and a pointed stick in the manner shown. The felt can be held in place by small tacks or by elastic bands.—G. D. (North Wales).



A useful brush for poster work.



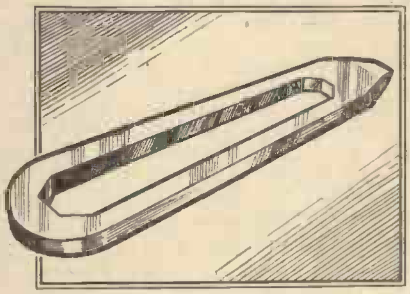
How an extra carrier support can be fitted to a bicycle.

Extra Support for the Cycle Carrier

IT is often found that the carrier is always working loose, slipping down, and rubbing off the enamel. A piece of wood shaped as in sketch A, and inserted between the back stays of the bicycle, will make an excellent support for the carrier. —J. C. (Lancashire.)

An Adjustable Spanner

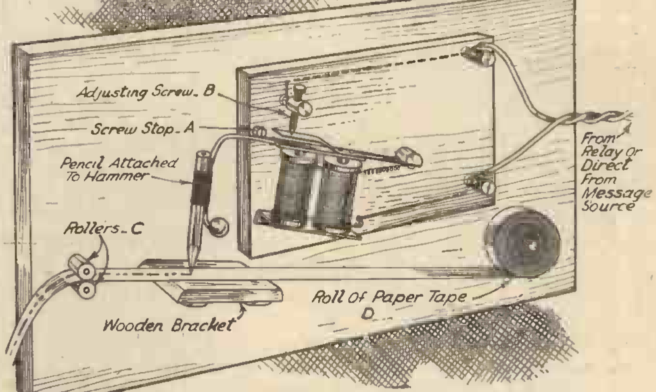
A VERY effective adjustable spanner may be made thus: Take a piece of mild steel and cut it as illustrated in the accompanying diagram. The centre cut is made to taper as required, and dimensions may be to one's own satisfaction. No more instructions are needed as the sketch is self-explanatory. This spanner will be found useful for wireless nuts and other delicate work. A screwdriver may be constructed on the other end if wanted.—A. H. (Northants).



A simple adjustable spanner.

A Morse Code Recorder

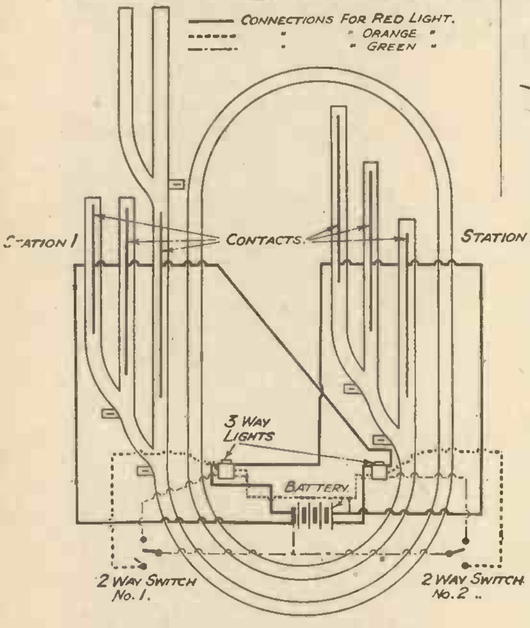
ALL that is required is (a) an old bell, (b) some pieces of planed wood and a few screws, all of which can be obtained for next to nothing. Cut off the piece of the bell that acts as the bell, and bend the hammer down (see diagram). On to this is tied a pencil, and there we have the main piece of apparatus ready for working. Adjust B so that the adjusting screw is always in contact with the contact spring, and A is a screw to prevent the spring from springing back too far. As for the rest, there is nothing to add, as the diagram supplies any further information. C and C are two rollers to draw the paper through by, and can be controlled by a handle at the back or by an electric motor if you have one handy. For paper one can use with advantage the popular streamers used at Christmas parties, which can be obtained from Woolworths. Just screw a screw in so that the roll can be rested on it (see D). —R. M. (S.W.12).



A Morse Code recording apparatus for the experimenter.

Safety Lights for a Model Railway

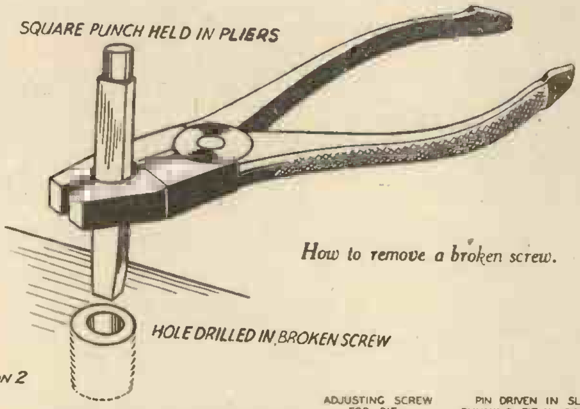
THE illustration shows a design for a model railway whereby safety lights are automatically worked by the engine. On each siding between the lines a brass contact (insulated from the track) is fixed, and the contact on the train engages with this. It is arranged so that when all three sidings on one side are filled or occupied by an engine the red light shows, if one line is clear but that station does not want an engine then by means of the two-way switch the orange light may be used. The green light will then show "all clear." Switch 1 should be near Station 2, and Switch 2 near Station 1, otherwise everything is as it should be. All the connections are clearly shown.—A. H. (Lincoln).



The layout for fitting a model railway with safety lights.

Removing a Broken Screw

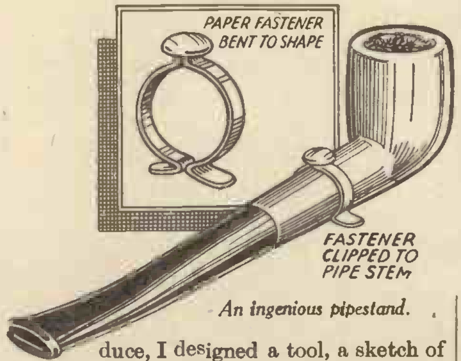
REMOVING broken bolts and screws from wood or metal often proves a tedious task, but by adopting the method shown in the sketch the difficulty is somewhat facilitated. Drill a hole in the broken half about half the diameter of the screw. Then into the hole drive a square punch and with a pair of pliers the broken screw may be unscrewed. This method will also apply to wood screws.—J. S. (New Malden).



How to remove a broken screw.

An Ingenious Pipe Stand

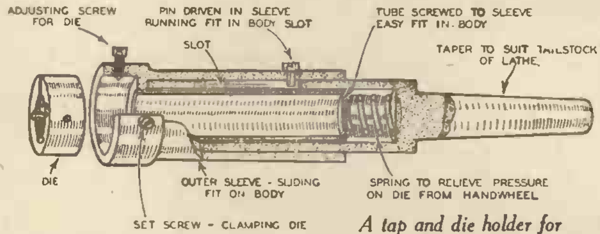
THE accompanying sketch shows a simple little device that will successfully prevent a pipe from falling on its side when placed on a table, etc., and so emptying out the burning ash. The device consists of a bent paper fastener clip round the stem of the pipe. —R. N. (Lowestoft).



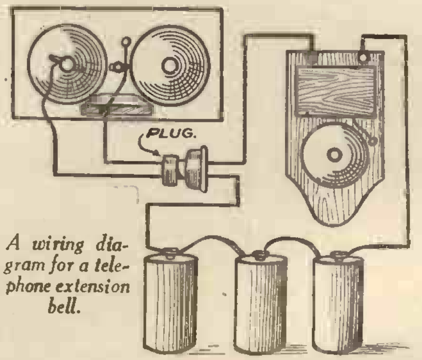
An ingenious pipestand.

A Tap and Die Holder

EVERY amateur performing lathe work is aware of the difficulty met with when using stocks and dies in trying to keep them square, so as not to produce what is known as a drunken thread. The pressure put on the dies by an amateur is also the cause of a stripped thread. Having several hundred screws to produce, I designed a tool, a sketch of which is shown, which was entirely successful in every way. The whole of the work in making the tool can be carried out on the lathe. It consists of two members. One, the outer sleeve, floating on the other, the body, which is turned with a taper on one end to suit the lathe being used. The handwheel on the tailstock feeds the die up to the work to be screwed. The spring inside the body takes up any undue pressure on the handwheel, and the die is drawn along the work, being prevented from turning by a pin which is driven into the outer sleeve, but is a running fit in a slot cut along the body. A small screw turned to a point and hardened is fitted on the end of the sleeve and the point engages in the split in the die, enabling it to be adjusted to cut the correct size. Another small screw is fitted further round the sleeve to tighten down on the die and prevent it from turning. The die hole in the sleeve should be bored large enough to allow the die to be expanded slightly, ·015 usually being sufficient. The tube is screwed a fine thread on one end to fit the outer sleeve, and is blocked at the other end to act as a stop for the spring. This tube also prevents chips from entering the moving parts.—W. R. (Bristol, 4).



A tap and die holder for the lathe.



A wiring diagram for a telephone extension bell.

THE ALL-WAVE ECONOMY THREE (*continued from page 174.*)

List of Components for the "All-Wave Economy Three" (*described on pages 173 and 174*).

- One Peto-Scott "All-Wave" Metaplex Chassis.
- One "Becol" Ebonite Panel, 16 in. by 7 in.
- One British General All-Wave Tuner.
- One Ormond ·0005 mfd. No. 6 Slow-motion Condenser.
- One "Magnum" ·0003 mfd. Reaction Condenser.
- One Bulgin Dial Indicator, type No. 3.
- One "Magnum" 500,000 ohm Potentiometer.
- One Bulgin "Junior" On-Off Switch.
- Three Clix 4-pin "Air-Sprung" Valve Holders.
- Three Belling-Lee Terminal Mounts.
- Six Belling-Lee Terminals, type "R": one each marked "A," "E," "L.S. +" and "L.S. –," and two marked "Pick-up."
- One "Goltone" ·0003 mfd. Pre-set Condenser.
- One Benjamin "Transfeeda."
- One "Goltone" "Super" H.F. Choke.
- One Dubilier 2 mfd. Fixed Condenser, type BB.
- One Dubilier ·0002 mfd. Fixed Condenser, type 670.
- One Dubilier ·2 mfd. Tubular Fixed Condenser, type 4404.
- One Dubilier 1 megohm Grid Leak, with wire ends.
- One Dubilier 50,000 ohm Fixed Resistance, 1 watt.
- One Dubilier 10,000 ohm Fixed Resistance, 1 watt.
- One Varley "Power Puncher."
- One Bulgin Fuseholder, List No. F. 5, and 100 m/A Fusebulb.
- Two Bulgin G.B. Battery Clips, one type No. 2 and one type No. 5.
- Six Clix Wanderplugs: two each marked "G.B. +" and "G.B. –," and one each marked "H.T. +" and "H.T. –."
- Two Clix Spade Terminals.
- One Coil Bulgin "Quickwyre," length flex, screws, etc.
- One Peto-Scott "All-Wave" Cabinet.
- One Peto-Scott Moving-Coil Loud Speaker Unit.
- Three Hivac Valves: one each H. 210, L. 210 and PP. 220.
- One "Lion" 120-volt High Tension Battery.
- One "Lion" 16-volt Grid Bias Battery.
- One "Lion" 9-volt Grid Bias Battery.
- One Ediswan 2-volt Accumulator, type ELM. 4.

A MODEL AEROPLANE OF THE FLYING SPAR TYPE. PART II

Concluding details, with instructions for making a twin winder

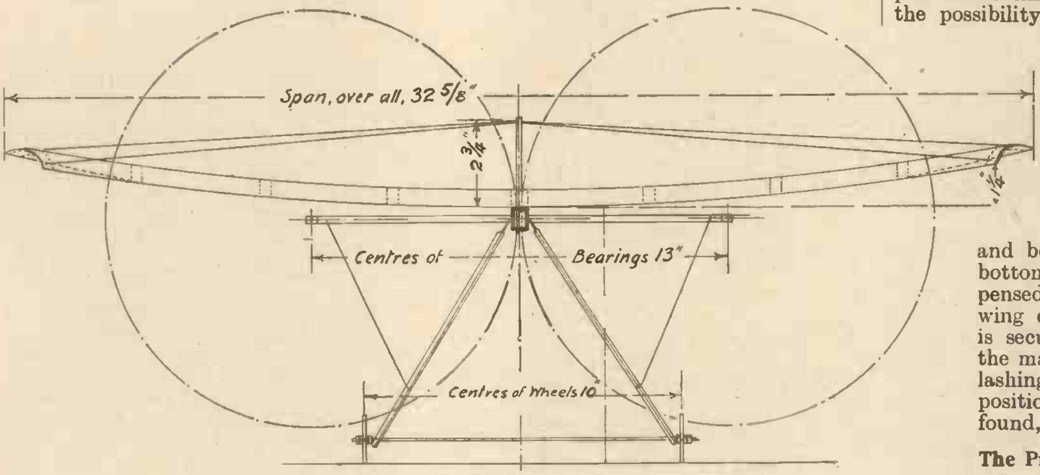


Fig. 3.—A cross-section through the centre of the spar.

FIG. 3 shows a cross-section through the centre of the machine, or approximately through the centre of gravity. This reveals the box form given to the main spar; it also indicates the details of the rear undercarriage. Both this and the front undercarriage are sprung in one direction. The side elevation, Fig. 2, shows that from each of the undercarriage struts a single strand of rubber is taken up to the spar in a forward direction. To resist the tension of this rubber strong threads, attached to the same point on the undercarriage struts, run backwards to the spar in the case of the front undercarriage and to the propeller crossbar in the case of the back one. It enables the machine to land with a cushioning effect.

Main Wing Dihedral

The cross-section, Fig. 3, shows the amount of dihedral which should be given to the main plane in order to give the model lateral stability. The amount of rise on each side of the centre at the wing tip is 1½ in. This is arranged for preferably by slightly steaming the two main spars of the wing. These spars are of spruce, and if steaming is not resorted to the wing must be built up with its ribs complete and then sprung to the dihedral by means of threads, whilst the covering, which, as mentioned, may be either of silk or paper, is put on. The threads referred to are indicated in all the general arrangement views of the model. They are not permanently secured at the ends of the spars but pass through holes. Each thread cord commences at the outrigger shown standing up from the spar in Fig. 3, passes to the end of one of the spars, say the front, across under the rib to, say, the back spar, up through another hole and terminates again at the outrigger. The second thread starts also at the outrigger and goes through holes in the spar ends on the opposite wing tip. The object of these threads, which, by the way, must be exactly of the same length on each side of the machine, is to adjust the warping of the wing. By means of them the wing can be given a slight warp, either one way or the other, or can be utilised to take out an undesired warp for straight flying.

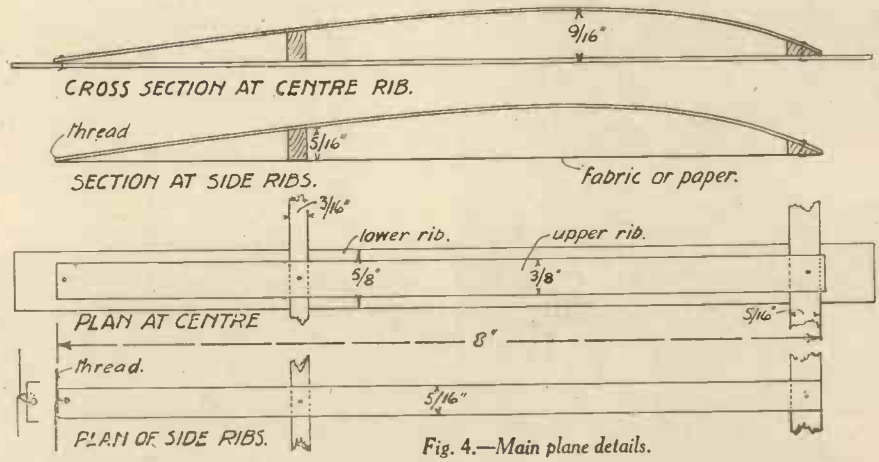


Fig. 4.—Main plane details.

It will be noticed in the side elevation that the outrigger which supports the wing bracing cords is fixed in the main spar and passes through slots in the centre rib. The object of these slots is to adjust the longitudinal position of the wing, but this permanent fixing of the outrigger precludes the possibility of removing the wing for transport. Since I made my own model recently I found that it is much more convenient to remove the wing and, although I have shown the outrigger, in the drawings, fixed, I recommend that it be made to pass through the top rib and be tenoned and glued in the bottom rib, the slots being dispensed with. This leaves the wing entirely independent, and it is secured to the spar each time the machine is flown with a simple lashing of thread. The correct position for it must, after being found, be marked upon the spar.

The Propellers

The disc swept out by the blade tips of both propellers is also indicated in Fig. 3. Although the distance between the centres is equal to the diameter of each of the screws, namely, 13 in., the angle between the shafts, due to the pull of the rubber motors, will prevent the possibility of the blade tips fouling each other. These propellers may be made by steaming and twisting flat pieces of birch wood or, better still, carving them from solid blocks of pine. Both must be made exactly alike except for the fact that they are opposite-handed: that is to say, the pitch angle at all points along all the four blades must be exactly the same. The length of the pitch is 20 in., and the angle at the blade tip is 1 in 2. The width of the blade, from a point 3 in. from the centre, is 1¾ in.: that is to say, for 3½ in. the blade is parallel.

The screws are of right- and left-handed pitch. It is immaterial on which side of the machine the right-handed

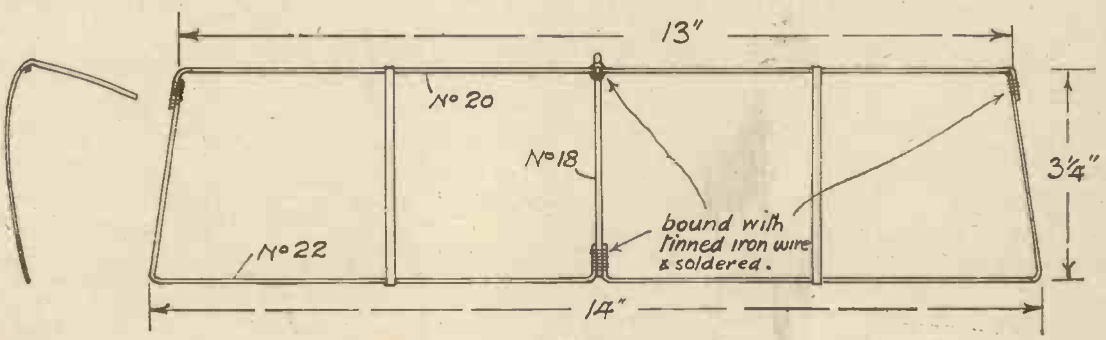


Fig. 5.—Details of the elevator.

screw is placed, except that for convenience in launching the machine by hand it will be found best for the right-hand pitch propeller to be on the right-hand side, for it is easier then to hold the inner tips of the blades under the fingers of the operator's hand, the other hand being employed in supporting the spar. When releasing the propellers for rising off

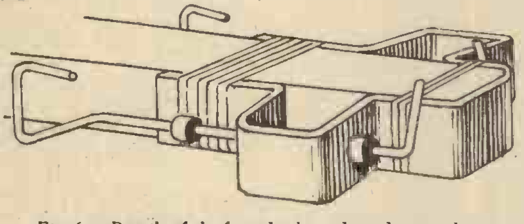


Fig. 6.—Details of the front hooks and winder attachment.

the ground both the operator's hands will naturally hold their respective propellers. There is one little point to be borne in mind when arranging the positions of the right- and left-handed screws: that is the direction in which one has to turn the handle of the double winder. If the right-handed pitch propeller is on the right hand of the machine the handle of the winder must be turned anti-clockwise unless it is revolved by the operator's left hand.

Plane Ribs

The centre rib of the main plane is double, as shown in Fig. 4, where the uppermost sketch shows the wing in cross-section. I should make the bottom rib of birch, the upper one of spruce. All the remaining ribs are single only: that is to say, there is a cambered top member without any bottom member, the fabric or paper of the underside being without any support. The trailing edge is formed by a strong thread passing right across the wing and laced through holes bored close to the end of each rib.

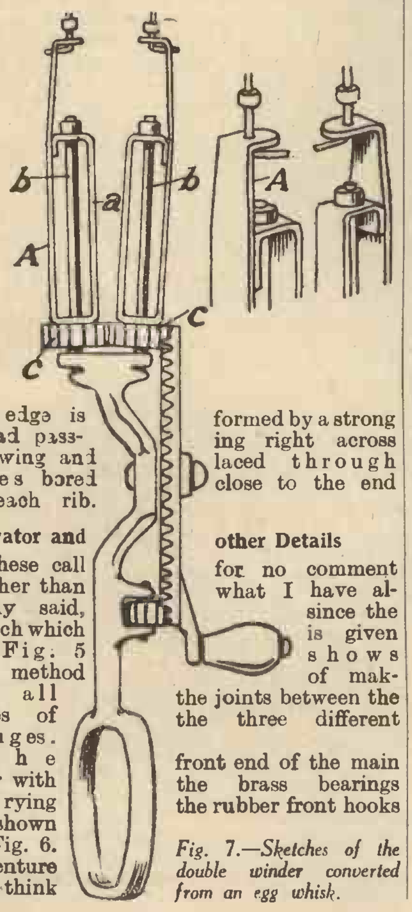


Fig. 7.—Sketches of the double winder converted from an egg whisk.

Elevator and other Details

These call for no comment further than what I have already said, since the sketch which is given in Fig. 5 shows the method of making all the joints between the wires of the three different gauges. The front end of the main spar with the brass bearings carrying the rubber front hooks is shown in Fig. 6. I venture to think that this sketch will be self-explanatory. The up-turned spindle ends previously referred to, over which the winder is slipped, are shown pressing against the nose of the spar. In soldering the collars on the spindle care should be taken to see that the two nearest to the rubber hooks are sufficiently far away from the bearing to allow the up-turned ends of the spindles to clear the nose of the machine when the spindles are drawn forward.

The Double Winder

There are, I believe, several forms of egg whisk sold by ironmongers and other dealers. I happen to know of two different patterns, and, in fact, have used them for conversion into aeroplane double winders. The principle of both, or all of them, is the same, but some are better and more accurately designed and constructed than others, and a pattern should be chosen which is not only suitable for alteration but which works smoothly and is strongly built. In Fig. 7 I have drawn a winder converted from an egg whisk with a cast-iron handle and cast-iron gear wheels. The part which is uppermost in the drawing is the portion which has been altered. When the whisk is purchased the flat metal strips A,*a*, form the large bow, and this bow, by arrangement of the gear wheels *c*,*c*, is at right angles to a similar bow on the other side of the whisk; the loops of one bow, when the handle is turned, revolve inside of the other, being carried upon the spindles *b*,*b*, which are formed of a continuous piece of stout wire. What the model maker has to do is to cut off both of the bows, leaving one side, say A, longer than the other. The end A is bent over sharply, rounded off and drilled with a hole just a little larger than the diameter of the wire, No. 18 gauge, of the rubber hook spindle. The other part of the bow, *a*, is also bent over as shown, drilled and made to revolve upon the remains of the wire loop of the whisk, the loop being cut away so as to leave about $\frac{3}{16}$ in. beyond the hole in *a*; a brass collar is then soldered upon the remains of the wire loop. This completes the job, and it will be seen that upon turning the handle of the winder the holes drilled in A, if they are accurately placed, will revolve truly and be capable, when they are passed over the spindles on the model, of revolving and winding up the rubbers.

The Rubber Motors

For normal flying the quantity of rubber, given in the table of weights, should be sufficient to give a good duration with the model, and with this weight of $1\frac{3}{4}$oz. on each side 600 turns should be possible with the rubber properly lubricated. Of course, all winders have not exactly the same gear ratio between the big and little wheels, and the reader must be careful to find out what the ratio is. On one of those which I have the ratio is 3–1; therefore 200 turns of the handle will put 600 turns on each rubber skein.

Neon Tube Practice

By W. L. Schallreuter, Dr. Phil. 132 *pages*. 10*s*. *Published by the Blandford Press, Ltd.*

THIS is an important work on a subject which is of increasing interest, for the growing popularity of neon lighting systems for publicity and other purposes makes a work of reference on the subject a necessity. This volume is a scientifically and technically accurate manual which will be of great value to the electrical engineer. It does not attempt to deal fully with the theory of gas discharges, but in a popular manner it covers the subject in a style which the reader will appreciate: and in any case the average electrical engineer would not understand the theory of the subject. The chapter headings include: The Gas as a Conductor, History, Rare Gases, Electrodes, The Positive Column, The Electrical Supply, Air Pumps and Vacuum Technique, Luminous Tubes for Sign Work, Glass Bending, Pumping and Filling, Ageing and Testing, The Practical Use of Neon, Neon Lettering, Panel and Box Signs, Striplighting, Self-contained Units, Beacons, Neon for Medical Purposes, Erecting a Neon Sign, Wriggle Tubes, Hot Cathodes, Low-tension Neon, Patent Literature, Unsolved Problems and The Future of Neon Work.

The chapter on Wriggle Tubes is particularly interesting, and the whole book makes fascinating reading.

Filmcraft

By Adrian Brumel. 238 *pages*. 3*s*. 6*d*. *Published by George Newnes, Ltd.*

AMATEUR cinematographers will welcome this brightly written work on the technique of film production, prepared chiefly as a guide for amateur film enthusiasts. It deals mainly with the production of silent pictures from the pre-scenario stage through production, editing, shooting script of a dialogue film, and includes an abbreviated glossary of the principal technical terms used in film production. Useful appendices deal with film cutting, creation, film writing, lighting and its application, act direction, production, management, etc. An excellent volume.

Film Technique

By V. I. Pudovkin. 204 *pages*. 3*s*. 6*d*. *Published by George Newnes, Ltd.*

THIS is the third edition of the translated version of Pudovkin's standard work, which entirely covers the whole subject of film production. It is a serious work designed for those engaged or interested in the complete subject of film production, and goes progressively through the various stages—the scenario, the plastic material, the film director, peculiarities of film material, the director and the scenario, the actor, the actor in the frame, the camera man, close-ups, sound films, etc., etc.

Complete Model Aircraft Manual

By Edwin T. Hamilton. 578 *pages*. *Published by Harcourt, Brace & Company, New York.*

AN American work on model aircraft, dealing chiefly with American methods of building balsa wood models and other parts of typically American models. This is by far the largest work on the subject which has as yet appeared, and the beginner should certainly possess a copy, for although it does not deal with compressed-air engines, petrol engines, nor power-driven models, it certainly covers a fair amount of elementary ground. The constructional methods adopted in America, are, of course, vastly inferior to the correct methods adopted by English model builders, for balsa and paper are the main materials used in U.S.A. The main tool, too, seems to be a pocket knife; but, nevertheless, this is an interesting volume which does credit to its author and its publishers. It is well illustrated.

Hobbies New Annual

Edited by F. J. Camm. 3*s*. 6*d*. 128 *pages*. *Published by Geo. Newnes, Ltd.*

THIS is the third year of issue of "Hobbies New Annual." Its contents are entirely devoted to practical instruction on making things, and parts for making a set of drawing instruments, a perpetual calendar, a pocket game of draughts, and a model aeroplane are given free.

The models described and illustrated include model yachts, model aeroplanes and model aeroplane engines, electric motors, model tractors, cranes, locomotive steam turbines, kites, and there are many other sections dealing with light-ray control, building a catamaran, wireless sets, weather indicators, heliographs, games, printing blocks, electroscopes, beach rafts, electro-plating, amateur theatricals, a model electric locomotive, letter balances, hot-air balloons, making a banjo, etc., etc. There are 270 illustrations.

MAKING A TWIN-SOLENOID MOTOR

By A. J. BUDD

(*Concluded from page 129 of the December issue.*)

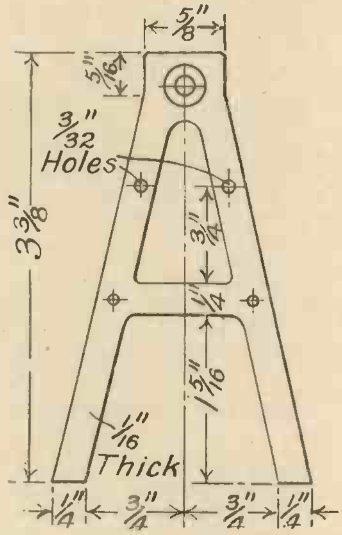


Fig. 5.—Details for one of the A-standards.

The flywheel can be fixed to the crankshaft by the usual grub-screw method.

Hard sheet brass, $\frac{1}{32}$ in. thick, can be used for the two connecting rods which can be marked out together to the dimensions given in Fig. 4. Drill the holes for the crank-pins and gudgeon pins, and, after roughly cutting out the rods with a metal piercing saw, hold each piece in a vice and file down to the scribed line. Each rod is filed down on both sides so that the metal is thinner than at the ends.

Solenoid Bobbins and Plungers

Details of the solenoid bobbins are given in Fig. 3. The central tubes, in which the plungers work, are intended to be made of thin brass tubing with an internal diameter of $\frac{5}{16}$ in. The bobbin ends or cheeks may be of sheet brass, No. 18 gauge or $\frac{3}{64}$ in. thick, the top ones being circular in shape and the bottom ones square, as indicated. Drill the centre holes in each plate so that they fit tightly on the brass tubing, after which adjust the cheeks so that they are square with the tube, and solder the joints.

It will be noticed that the bottom end of each tube is flush with the bottom face of the lower cheek, while the top end of the tube projects $\frac{3}{16}$ in. above the upper cheek. This is done to provide a guide for the plunger, which overrides the top cheek at the end of its upward stroke.

The plungers are pieces of soft iron rod, $\frac{3}{4}$ in. long and of a diameter that will allow them to slide easily within the bobbin tubes. A slot $\frac{3}{32}$ in. wide and $\frac{3}{8}$ in. deep is cut down the centre of each plunger, as indicated in Fig. 6, and a hole drilled through at right angles to the slots at a distance of $\frac{1}{4}$ in. from the ends for the gudgeon pins. These can be cut from a piece of $\frac{3}{32}$-in. diameter mild steel rod.

Contact Cam, Springs and Insulating Block

The insulating block which carries the brushes can be cut from a small piece of $\frac{1}{8}$-in. ebonite to the dimensions given in Fig. 7. File the projecting end pieces to an angle as indicated, to conform to the sloping edges of the standard to which it is to be fixed. Thin springy German silver, No. 26 gauge, may be used for the two contact springs or brushes, being cut to shape as at D, and drilled to take the fixing screws. Now place the block in position against the A-standard and mark the position of the holes where the fixing screws are to go, then drill the holes through $\frac{1}{16}$ in. diameter, and lightly tap out with a $\frac{3}{32}$-in. Whitworth tap. The $\frac{3}{32}$-in. Whitworth machine screws used for fixing the block should have the ends filed down so that they do not project more than $\frac{1}{8}$ in. into the fibre block, as indicated at E (Fig. 2), it being important that the ends of these screws do not touch the brushes.

The contact springs can now be screwed on to the block with $\frac{3}{32}$-in. Whitworth screws, which should not be more than $\frac{1}{4}$ in. long under the heads, a thin brass washer being slipped on each screw previous to screwing in. Tighten the screws up so as to hold the springs firmly, and then bend them slightly, as depicted at F (Fig. 7), so that the top parts are $\frac{1}{16}$ in. apart.

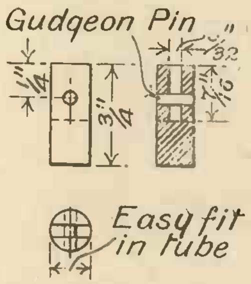


Fig. 6.—Soft iron plunger.

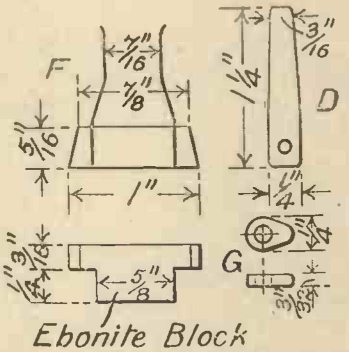


Fig. 7.—Details of ebonite block, contact cam, and springs.

To make the contact cam, take a small piece of German silver $\frac{1}{32}$ in. thick and file it to the shape shown at G, the hole being drilled $\frac{1}{8}$ in. diameter to fit the crank-axle. File away the sharp edges with a fine-cut file, leaving the cam smooth, especially at the narrow end which makes contact with the springs.

About 18 yd. of No. 26 D.C.C. copper wire will be required for each bobbin. Wind each layer on evenly, and fill the bobbin right up to the edge of the circular end, leaving about 6 in. of the starting and finishing ends free for connecting-up purposes.

After securing the last coil of wire by tying round a couple of turns of white thread, the bobbin can be given two coats of shellac varnish and then put by to dry.

The other parts of the motor can now be assembled, and taking the crankshaft first, with the flywheel in position, slip on the contact cam and also two brass washers, as shown in Fig. 2. Next pass the ends of the crankshaft through the bearings in the A-standards, and then, having screwed the two inner nuts on to the stay rods C, C place these in position and screw on the outer nuts. The inner nuts must be adjusted so as to maintain the inside faces of the standards at $1\frac{1}{16}$ in. apart, when the outer or clamping nuts may be screwed up tightly. Now rivet the base plates on to the angle pieces at the bottom of the standards, keeping the latter quite parallel. If found more convenient, $\frac{3}{32}$-in. bolts and nuts may be used instead of the rivets.

The standards may now be screwed down on the baseboard by means of $\frac{3}{8}$ in. round-headed wood screws. This being done satisfactorily, proceed to screw the crank webs on to the ends of the shaft, and after adjusting them so that they are at an angle of 180 degrees to each other, solder lightly to the shaft. The two washers H, H can also be soldered in place so as to allow just a slight lateral movement of the crankshaft in the bearings.

Place the solenoids in position and carefully mark the holes in the baseboard to take the fixing screws, first of all making sure that the axis of each plunger tube is "plumb" with the centre of the crankshaft. The centre of each tube should also be $\frac{1}{16}$ in. from the outside face of the A-standard. Having screwed the solenoid down, the connecting rods can be coupled up to the plungers by passing the gudgeon pins through, and the "big ends" may then be connected to the cranks by screwing in the crankpins, leaving about $\frac{1}{32}$ in. for side play, as indicated in Fig. 2.

After screwing on the insulating block which holds the brushes, fix two terminals near the front corners of the baseboard, as shown in Figs. 1 and 2. A diagram of the connections is given in Fig. 8. It will be seen that one wire from each coil is connected to terminal T2, and each of the other ends is connected to a contact spring. The terminal T1 can be connected up with one of the screws at the foot of the adjacent standard. The wires from the two solenoids to terminal T2 can be passed through small holes made in the baseboard, and connected up on the underside, while the other connecting wires will have to remain "above board." The final adjustment to the cam can now be made so that it makes contact with the brushes at the proper moment. Give the flywheel a slight turn till the cranks are in a horizontal position, then move the cam round till it is also horizontal, and pressing against one of the contact springs, after which it can be lightly soldered to the shaft.

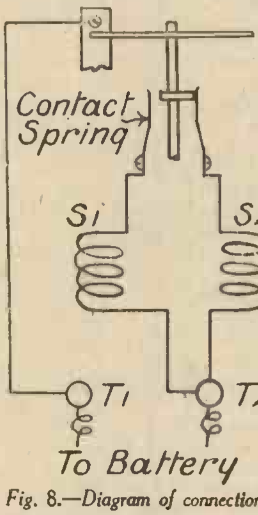


Fig. 8.—Diagram of connections.

WONDERS *of the* POLARISCOPE

By CHARLES EARLE

[This article concludes the articles on Polarised Light with a description of the third, and probably most efficient, type of Polariscope, in which the general principles of the two other types are amalgamated.]

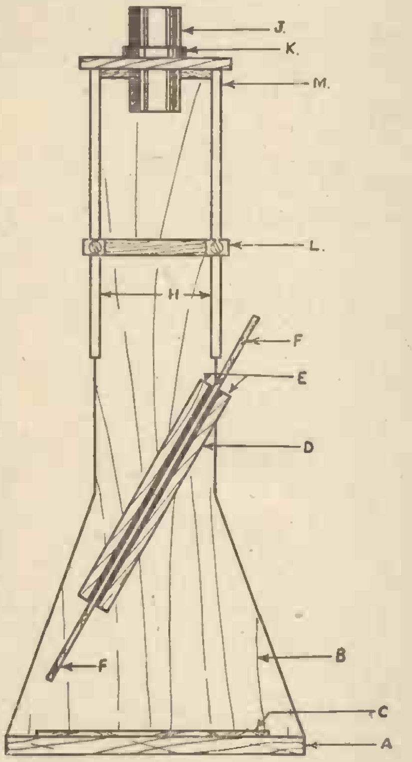


Fig. 1.—A vertical highly efficient Polariscope.

THE apparatus described here is designed to stand upright, somewhat after the style of a microscope, but has no magnifier, as it is designed for handling medium- and large-sized specimens. A lens may, however, be fitted if desired, in fact, the lens-carrying stage from the model previous can be slipped on to the rails of this model quite easily. Looking at Fig. 1, you will see that much of the construction is similar to that of the horizontal Micro-Polariscope described in detail in our Nov. issue. The upper part of the vertical support is practically identical with the polarising end of that instrument, except that the rails to carry the clamping screws of the subject-stage are 6 in. long instead of 7½ in.

Where the rails terminate the support (B), which here takes the place of the baseboard in the previous model, spreads out from 2½ in. to 6 in., and to this wider end is affixed, at right angles, the baseboard proper (A) and the two steadying supports (N) which help to keep the whole thing firm and upright. The "prism" on the top stage in this instrument is the analyser, while the light reflected from the baseboard mirror (C) is polarised in its passage through the adjustable glass-plate (F), and thus a second "prism" is unnecessary. The inclinable glass-plate (F) acts in a similar manner to the bundle of negative glasses we used in our first and simplest apparatus. One point should be noted here, the mirror now under discussion is to be of ordinary silvered plate glass and *not* black glass as in the earlier model. The arrangement of the polarising end of this instrument is really quite simple, and will be obvious to almost any reader.

The Frame for the Glass-plate

"D" is a piece of wood, 3 in. long by

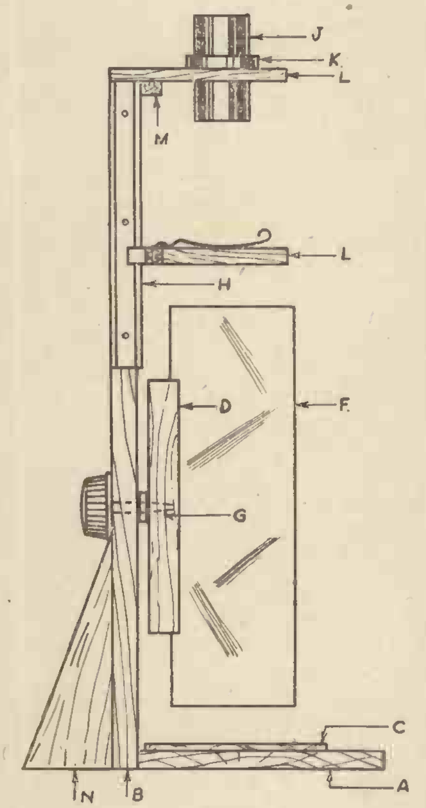
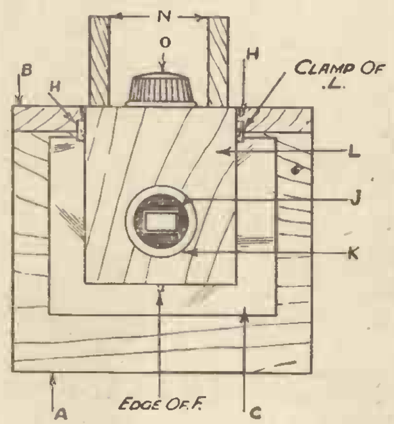


Fig. 2.—A side view and (below) plan view of Fig. 1.
A. Baseboard, 6 × 5 × ½ in. B. Upright, 14 in. long, ½ in. thick. C. Mirror, 5 × 4 in. D. Grooved wood strip, 3 × ¾ × ¾ in. E. Rubber or cement in groove. F. Plain glass, 8 × 2 in. G. Wood screw with ¼-in. shank. H. Brass rails, 6 in. long. J. Prism mounted in tube. K. Stop collar. L. Block, 3 × 2½ × ⅜ in., to hold J. and K. M. Strengthener for L. N. Struts of ½-in. wood. O. Radio knob to turn G. and D.

¾ in. square in section, and has a groove ploughed along one side, about ⅜ in. deep and of a width to accommodate the glass-plate (F) already referred to. On the other side of this wood piece is a stout wood screw



with a ¼-in. shank projecting, as shown at "G." When firmly screwed in, the head of this screw must be cut off so that the shank will pass through a hole in the middle of the upright (B), and 4½ in. from where this joins the baseboard. See that the shank is a fairly tight fit in this hole, so that, when turned in it, it will stay "put."

Fixing the Glass

The sheet of glass (F) is ordinary window glass 8 in. long by 2 in. wide, and of a suitable thickness to fit well in the groove of the wooden carrier (D). Rubber packing, cement or putty may be used to make all firm here. An ordinary radio knob, such as is used for a reaction condenser or rheostat, is affixed to the screw shank, as shown at "O," and, if pushed well down into contact with the surface of the upright (B), will materially help to retain the glass-plate (F) at the desired angle when the knob is rotated.

In practical use the light is reflected from the mirror (C) and the glass-plate (F) rotated until the angle is correct, when the polarised beam is seen in the analyser (J), having passed meanwhile through the specimen under observation. This apparatus will be found to be very easy to handle once the knack of getting the angle has been acquired.

Examining Large Objects

Where large objects are to be examined, they are simply stood on the baseboard mirror (C), while small ones are mounted on the subject stage (I). In the former case the glass-plate is, of course, rotated to its approximate angle before standing the specimen underneath. Large objects may be made up, such as stars, crescents, flowers, wheels, etc., from mica, cellophane, transparent or translucent papers and fabrics, and viewed in this manner. If these objects are hung on thread, or mounted on pin-point pivots, so that they revolve slowly while under observation, the effect is much enhanced and really gorgeous colour effects can be obtained.

Subjects

It would be futile to attempt to give any list of subjects, for there is hardly a single pinch of common dust that will not yield the experimenter infinite pleasure, while those who are fortunate enough to have access to a collection of classified minerals or crystals will acquire much real knowledge. In conclusion, don't overlook the possibilities offered by the really beautiful crystals and "stones" which make up most of the cheap imitation jewellery and fancy necklaces which are to be found in profusion for a few pence.

THE IRIS DIAPHRAGM

(*Continued from page 163.*)

photograph. Fig. 2 shows an assortment of sizes, including another form of slotted ring, and a couple of the smallest irises made which are within ⅝ in. external diameter and which close almost to a pinhole.

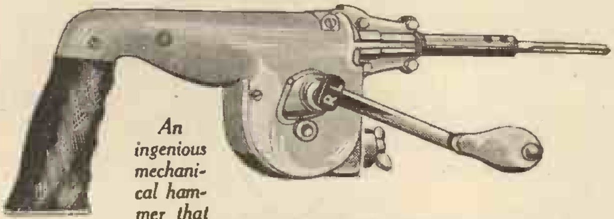
The Relative Apertures

In order to define, on the lens-mount, the relative apertures for any individual lens, which must be done with precision, a brass gauge is made, as in Fig. 3, to the predetermined diameters of the apertures required. This is inserted in the iris, which is closed down to each step in turn, and the mount is engraved against the pointer on the turning ring, or *vice versâ*, according to the design. Irises are used in photography for shutters as well as for lens apertures. Fig. 4 shows a rather uncommon form, in which three blades of unusual shape, which open instantly to maximum aperture, and which close again as instantly on expiration of the required exposure.

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 Mechanical Hammer

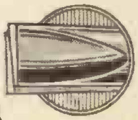
THE first illustration on this page is of a mechanical hammer. It is of light construction, but it delivers a severe blow. The mechanism consists of two four-throw cams. The cams take their drive from the shafts close to the main bearings—an ideal position. The drill carrier positively rotates the drill or hammer bit, and the tool may thus be used for two purposes. At an average turning speed of 120 r.p.m. 480 blows per minute are delivered. It costs 30*s.* [21]



An ingenious mechanical hammer that delivers a number of severe blows in rapid succession by simply turning the handle at the side.

An Ingenious Screwdriver

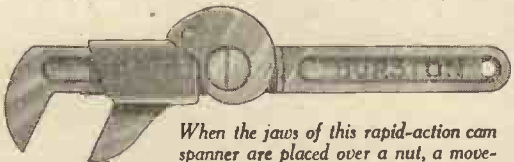
EVERYONE is acquainted with the difficulty of inserting screws in awkward places. Here is shown a screwdriver whose blade consists of two parts, each having an inclined face in contact. The blade is inserted in the slot of the screw and by sliding the ferrule down the blade, the ends tightly grip the screw. Only one hand is therefore necessary to insert it. [22]



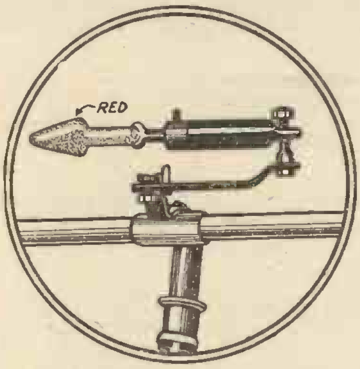
A screwdriver that grips the screw, so making it a simple matter to insert screws in awkward places.

A Fine Adjustable Spanner

SCREW-adjusting spanners are becoming obsolete. Last month we drew the reader's attention to an adjustable spanner whose jaw opening was varied by a sliding piece. Here is another with a cam-operated jaw. The sliding jaw is attached to a spring inside the beam and by rotating the cam with the thumb the jaw opening is immediately varied. There is no back lash and the locking action is absolutely positive. It costs only 6*s.*, and we can recommend it with confidence. [23]



When the jaws of this rapid-action cam spanner are placed over a nut, a movement of the thumb rotates the cam causing them to grip the nut.



Useful direction indicator for cyclists

A Well-designed Model Boiler

THE illustration shows a twin drum boiler 6½ in. long, 3⅞ in. wide, 5 in. high, which will stand a working pressure of 60 lb., and will steam for fifteen minutes on one filling of water and spirits. They are of solid drawn hard copper tube, and are fitted with safety valve and filler plug. They cost 18*s.* 6*d.* [24]

A twin-drum boiler that should prove a boon to model engine builders.

A Radio Service Tool

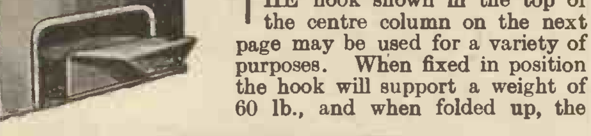
AT the foot of this page is illustrated a tubular spanner accommodating 2 B.A. and 4 B.A. nuts and also two styles of screwdriver. By reversing one screwdriver blade a 6 B.A. nut may be adjusted. Complete with pocket clip it costs 2*s.* 6*d.* [25]

Safety First Device for Cyclists

THE cycle director illustrated indicates as with a motor car the direction in which the cyclist is about to turn, the indication being by means of a red light. It fits under the expander bolt or on the handle bars and is swung to the right or left. The red signal lights automatically. It costs 4*s.* 6*d.*, finished matt black with nickel-plated fittings. [26]

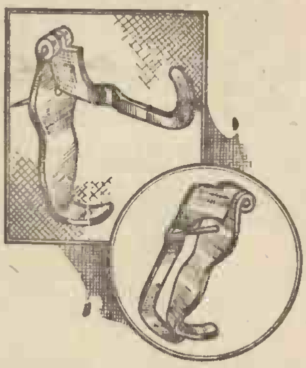
The "Wonderhook"

THE hook shown in the top of the centre column on the next page may be used for a variety of purposes. When fixed in position the hook will support a weight of 60 lb., and when folded up, the



A useful spanner for the radio fan that can be carried about in the waistcoat pocket.

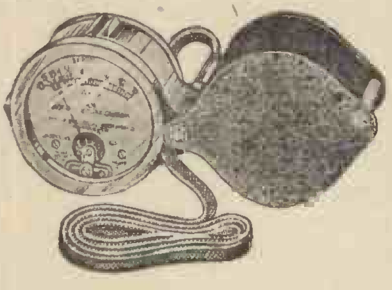
upper hook protects the fixing point, and allows the hook to be carried in the pocket without fear of injury. [27]



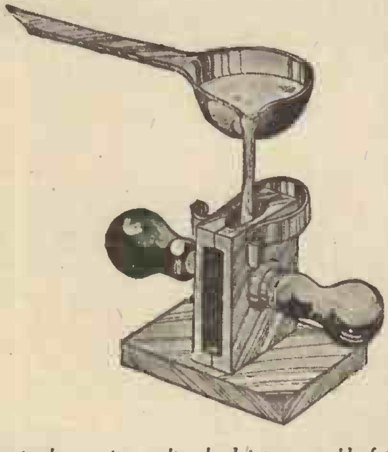
A simple little hook that can easily be fixed to a wall, etc., and can be carried about in the pocket.

A Cine Exposure Meter

THOSE readers who are interested in cine-photography have at some time or another found difficulty in finding the correct exposure for the plate. The small meter shown on this page, which consists of a sensitive electrical instrument and a Photronic photo-electric cell, gives the correct exposure instantly and correctly. The scale of the instrument is calibrated directly in F. numbers from 1·5 to 32. It is provided with a hinged cover similar to that used in a pocket magnifying glass. This cover can be swung back and used as a handle while taking an exposure. A suitable carrying strap is provided. [28]



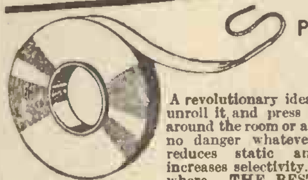
An efficient cine exposure meter.

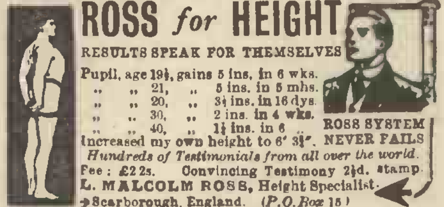


By simply pouring molten lead into a mould of the type shown above, which can be purchased in a variety of designs, you can make your own lead toys.

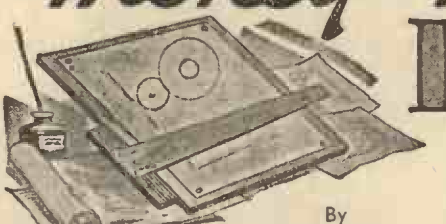
Moulds for Toys

The above solid metal casting mould is one of a large range of numerous designs that are now on the market. You simply pour the molten lead into the mould and in less than two seconds complete figures are cast. They cost 5*s.* 6*d.* each. [29]





Money Making IDEAS



By FREDK. JACE

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

Razor Blade Paste

THIS can be made by stirring 2 parts of the very finest emery into a melted mixture of 4 parts of lard and 1 part of cerasin wax removed from the fire, and continue stirring long enough to prevent settling out.

Making Carbon Transfer Paper

THE substance used for coating carbon paper is a mixture of paraffin wax and oils, the oil being either a petroleum lubricating oil or castor oil; by melting these ingredients together in differing proportions, products that are adapted for various requirements may be obtained. For example, the presence of a large quantity of wax makes the transference of and impression a very difficult matter, but a large increase of the oil will render a transfer possible by mere pressure of the fingers. The colouring matter is, for a pure black, either drop black or gas black ground in a paint mill with the wax and oil mixture named above. The blues and blue-blacks are aniline colours that are soluble in oils. These colours dissolve in the composition by heat merely, and require no grinding.

A Universal Cement

NEWTON'S cement, which goes under the above trade name, is a preparation which has withstood the test of many years; it is useful as a strong adhesive for china, marble, ivory, jet and wood.

Success in its use depends on three things: (1) uniting the objects while both they and the cement are warm, and in a room that is not icy cold, (2) fitting together the parts with the closest possible joint and firmly holding the objects in this position until the cement is set, and (3) taking care that the parts to be joined are cleaned of previous cementing compounds (if any) and are free from grease. Even the natural oils from the fingers will impair a joint made with this cement. If the break is not quite fresh, it is essential that the surfaces should be cleaned with soda (caustic soda, if necessary), that is, of course, if the object itself will allow of such a washing. The cement is supplied in small bottles, and must be sealed airtight when not in use. To bring into use, the cement is usually melted by placing the bottle in a cup of hot or boiling water, and as the cement sets and hardens in air the cork is often so firmly held in the neck of the bottle that it prefers to break up rather than come out whole. It is, therefore, advisable to put the bottle in the hot water upside down for a few minutes, until the cork can be freely withdrawn.

The cement should be applied sparingly to the surfaces of the joint and the work left clamped up tightly for from twelve to twenty-four hours—the longer the better, in fact—especially if it is a china object which will need washing in hot water. When set enough to handle, the exuded cement may be scraped and wiped off.

Accumulator Charging Service

AN excellent spare time income is to be derived by equipping your workshop with an Accumulator Charging Service. There are many cheap charging plants available, and the amateur may easily make his own charging plant from an old motor-cycle engine and a second-hand dynamo. All of the essential facts and methods are fully detailed in "Accumulators: Charging Maintenance and Care," written by the Editor of this JOURNAL, and published by Geo. Newnes Ltd. It costs 1s. (1s. 2*d*. by post) and is packed with information on the various methods of charging, replating and repairing all types of accumulators, and it explains in great detail every method of charging. The book will be found of great service to everyone who uses an accumulator. Arrangements should be made to collect and deliver accumulators at regular intervals for a fixed rate.

A Polish for Cars and Floors

AN excellent polishing wax for use on cars, floors, furniture, etc., can be made from 2 parts paraffin wax, 1 part beeswax and 1 part turpentine; the latter quantities are all by volume. The method is to melt the two waxes in a jar immersed in hot water and then to add the turpentine slowly, stirring the mixture meanwhile. After that, allow the mixture to cool slowly, or pour into suitable cans, according to the way in which it is to be packed for sale.

Colouring Spirit Varnishes

SPIRIT varnishes are coloured with coal-tar dyes soluble in spirit and usually known as "Spirit soluble dyes." As a rule, very little dye is required. Perhaps the best way to apply it is to make a concentrated solution of the dye in spirit, and add this drop by drop to the varnish until it is sufficiently coloured.

Aluminium Solder

THE following alloy is recommended for aluminium solder: 80 per cent. tin and 20 per cent. zinc. This should be fluxed with a composition of 80 per cent. stearic acid. 10 per cent. tin chloride and 10 per cent. zinc chloride.

Mode Aeroplane Lubricant

A GOOD model aeroplane lubricant can be made by mixing 2 oz. of pure soft soap in ½ pint of water and bringing it to the boil. Add a tablespoonful of glycerine.

White Acid for Obscuring Glass

THE white matting acid used by embossers for obscuring glass can be made in the following way: Mix 4 parts by weight of hydrofluoric acid and 3 parts of carbonate of ammonia with 2 parts of water, or drop lump ammonia into hydrofluoric acid until the mixture ceases to effervesce.

Electric Sparklers

ANALYSIS of a sample and experiments suggest the following: Potassium nitrate 1 drachm, reduced iron (or iron dust) 1 oz., powdered charcoal 1 oz., mucilage of tragacanth (a sufficient quantity to make a stiff paste). Iron wire is thickly coated with this paste, and when hard and dry the "sparklers" are ready for use.

Fireproofing Solution

PREPARE a solution of 1 lb. ammonium phosphate, 2 lb. ammonium chloride and 1½ gallons water. If paper or other material is soaked in this and dried, it should be completely fireproof

Liquid Metal Polish

THE following recipe for a liquid polish for metal will be found quite satisfactory. Take ½ lb. of best prepared chalk, 3 oz. of turpentine, 3 oz. of benzene and 1 oz. of liquor of ammonia and thoroughly mix together. Shake the bottle well before using, and apply with a sponge, allowing the mixture to dry before rubbing with a flannel to polish. Another recipe is 2 oz. of best prepared chalk, 1 oz. of oxalic acid, 2 oz. of benzene and 1 oz of turpentine. Thoroughly mix the oxalic acid, benzene and turpentine and then add the chalk, using as before.

Colouring Soap

ANILINE dyes for colouring soaps are usually sold under the names of soap brown, soap yellow, etc. Many aniline dyes are suitable for this purpose. For instance, acid brown might be employed: this imparts a chocolate-brown colour. For lighter brown one of the diamine browns might be used.

Recharging Flash-lamp Batteries

THE composition of the charge in flash-lamp batteries is similar to that in other so-called dry batteries, but in flash-lamp 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 elements 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.

ASTRONOMY FOR AMATEURS

(*Continued from page 164.*)

in the heavens. To unaided normal sight, under favourable atmospheric conditions, it looks like a patch of misty light, which a small telescope, or even a good binocular, will define distinctly as an oval luminous haze. Its astonishing spiral structure needs big instruments or long-exposed sensitive plates to reveal. A fine photograph is here reproduced showing its globular centre and vast curving arms divided by dark rifts. It is evident that the nebula is approximately circular, its elliptical shape being due to the angle at which we view it. The Great Nebula in Andromeda was long believed to be composed of glowing gas, slowly condensing into a compact universe of stars similar to the one within which our solar system is situated. Photography and the spectroscope, however, testify that the process of evolution is already far advanced, and that the flocculent masses of dim radiance really consist of countless multitudes of blazing suns too remote to be discerned separately. So extensive are the limits of this immense stellar whirpool that a ray of light, travelling at 186,325 miles a second, would occupy over 400 centuries in crossing from one side to the other. Its distance from us is even more inconceivable, for it can only be expressed in terms of 900,000 "light years," each of which denotes nearly 6,000,000,000,000 miles! It is the farthest celestial object visible without optical assistance.

All the constellations mentioned in this and future articles can be readily located by the use of Philip's Revolving Planisphere, which shows at a glance what star groups are above the horizon at any given date and time all the year round.

WHAT THE CLUBS ARE DOING

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

THE MODEL RAILWAY CLUB

THURSDAY, October 26th, was Track Night, and a number of interesting models were on view.

The voting of the Competition resulted in C. R. Wood gaining first place, A. J. Thorn second and W. A. Hill third.

A General Meeting was held on Thursday, November 9th. Auditors for the ensuing year were elected, and a long discussion took place on the General Policy of the Club, which proved very interesting.

The Meeting concluded with a Cinema Display of films kindly lent by Mr. W. J. Bassett Lowke, which were very much appreciated.

Fixtures for December were as follows:
Thursday, December 7th—Track Night.
Thursday, December 14th—Social.

THE MALDEN SOCIETY OF MODEL AND EXPERIMENTAL ENGINEERS

THE above society possess a large workshop which is well equipped with tools, at New Malden, Surrey.

The subscription is 3s. a month, and club nights are on Tuesday and Friday from 6 to 10, and there are no members under eighteen.

The membership at the present moment is eight anyone interested in mechanics or engineering generally are always welcome.

Of course, as membership increases, it will be possible to reduce the subscription. All communications should be addressed to the Secretary, Mr. R. W. Blake, 31 Idmunston Road, Worcester Park, Surrey.

ANGLO-AMERICAN RADIO AND TELEVISION SOCIETY

"WILL all those in the Birmingham district, who would be interested in the formation of a Birmingham Branch of the Anglo-American Radio and Television Society, kindly communicate with R. O. Barnett, 87 Brockhurst Road, Birmingham 8, who is co-operating with R. Clews? Please enclose stamp for reply.

"Persons not already members of the Society should first write to the Honorary President, L. W. Orton, Kingsthorpe, Willowbank, Uxbridge. Membership is free."

BRIEF ITEMS AND TOPICAL THOUGHTS CONCERNING MANUFACTURERS AND THEIR PRODUCTS

That Fault in your Wireless Set?

THE Automatic Coil Winder and Electrical Equipment Co. Ltd., a name well known in the wireless trade, have recently introduced to the market an all-in test meter that will prove a boon to the wireless constructor, and is sold under the name of the "AvoMinor." It enables you to test every type of receiving valves, batteries of all types, mains and eliminator voltages, resistances and all domestic electrical apparatus. Neat and compact, it is sold at the reasonable price of 40*s*.

A Unique Working Railway

ONE of the special attractions at the School Boys' Exhibition will be a wonderful working model depicting London transport.

The general lay-out of the model will typify the various districts served by the London Passenger Transport Board, including factory areas, suburban districts and the countryside.

The model will show buses, trams, and other means of transport which London Transport controls, and the chief feature will be a working railway of the latest type used on the Underground and an up-to-date London underground station. Among other novelties, this will be signalled by automatic colour light signals, the latest thing in railways.

This splendid model has been designed and constructed by Bassett-Lowke Ltd., of Northampton, for the London Passenger Transport Board.

Fun with a Microphone

THE Scientific Supply Stores have just placed on the market a microphone which is wonderful value for money. It enables you to give announcements and running commentaries for the home cinema and amateur theatricals, and also gives excellent results with home-recording outfits and amateur transmitters. Easily adaptable to detectorphone circuits if removed from the stand and concealed. It is easily connected to a wireless and is marked in two models at 12*s*. 6*d*. and 17*s*. 6*d*. complete.

The Pelman Institute

IT is given to few men to put a new word into the English Dictionary, and Mr. W. J. Ennever may well consider the inclusion of the word "Pelmanism" in the New Oxford English Dictionary as the crowning achievement of his life work. "Pelmanism" is described in the abridged edition of this new work as "a 20th century memory training system." Few people, however, will need to "look it up," for it is common use and common understanding that put it into the Dictionary.

Aircraft Products

AN interesting pamphlet containing a number of bargains in watches, binoculars, opera glasses, etc., is obtainable free from the above firm, whose offices are situated at 87 New Oxford Street, W.C.1. All readers interested should write at once for this list, as these bargains are all moderately priced and are excellent value for money.

An Invaluable Handbook

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

LATHE WORK

(*Continued from page* 182.)

shots in the casting (hard spots in the metal which can only be cut by grinding), uneven density of metal (soft in some spots and harder in others), oval bores (due to shake in the headstock bearings or loose mounting of the work), bell-mouthing (due to too heavy a cut or flexible boring tool or bar), and taper bore (due to flexible tool or lack of truth in the slide rest setting).

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

The Meaning of "P.O.P."

"SIR,—As a newcomer to photography I am anxious to know the meaning of P.O.P., how it is made and how I can use it to the best advantage." (L. J., Lancaster.)

P.O.P. means printing out paper, and it is used for the production of photographs. It is coated with an emulsion of silver chloride and silver nitrate. On exposure to daylight under a negative, it darkens to a reddish colour (*i.e.*, prints out) producing a positive print. It is toned in a solution of a gold or platinum salt and fixed in a bath of sodium thiosulphate (hypo), which dissolves out the unaffected silver compounds and so renders the print immune from further change in the light. After this fixing process, the hypo is removed by long washing in water.

Cutting a Hole in a Glass Bowl

"Sir,—I wish to cut a hole 4½ in. in the bottom of a glass bowl. As I do not want to spoil the bowl, not being certain of the method of boring, could you tell me how I can do this and what tools are necessary?" (M. A., Manchester.)

It would be very risky to attempt to cut a 4½-in. hole in the bottom of a glass bowl. A small lathe would be necessary, and on the spindle a small copper disc should be mounted. The edge of the disc should be fed with fine emery powder and sweet oil. The hole should be marked the exact size on the bowl and the bowl held by the hands against the revolving disc, the cut being made on the marked line. The cut must be right through the glass, not merely on the surface, with a view to breaking the centre piece out afterwards. It will be advisable to try and cut a hole in a piece of crown sheet glass before attempting the bowl.

Wireless Set Distortion

"Sir,—I have recently made up a three-valve wireless set, but so far the results have been very unsatisfactory. When I switch on all I can get is a bad coarse tone. I have carefully checked all the connections and they appear to be O.K. Can you suggest a cure for the distortion?" (J. D., Glasgow.)

Quite evidently the last valve is overloaded. The valve you are using takes a greater current than 4 milliamps when it has the correct H.T. and grid bias values. Try using more H.T. and the trouble should cease. Also make certain that the moving plates of the variable condenser are connected to earth.

Airgun Licence Query

"Sir,—A week ago I purchased an airgun which I use for target shooting in my back garden. A number of people have told me that I require a licence for using the gun. Is this correct?" (J. K., Preston.)

No licence is required for an air gun, providing that you use it on your own premises, and that the pellets are not fired over a public highway, road, or path. That is to say, the pellets must land within the ground of your own house. If you use it elsewhere than on your own property a licence is necessary.

Plaster Moulds

"Sir,—The following is quoted from a well-known book on recipes: 'Nearly all fine grades of metals can be cast in plaster moulds providing only a few pieces of the castings are wanted. Dental plaster should be used, with about one-half of short asbestos. Mix the two well together, and when the mould is complete, let it dry in a warm place for several days, or until all the moisture is excluded. If the mould is of considerable thickness it will answer the purpose better. When ready for casting, the plaster mould should be warmed, and smoked over a gas light; then the metal should be poured in, in as cool a state as it will run.' Is dental plaster a refined plaster of paris, is it easy to obtain, and what is its approximate cost for a small quantity?" (A. E., Preston.)

Dental plaster is plaster of paris of a fine grade and is so named on account of its suitability for dental moulds for artificial teeth. It is to be obtained from most chemists.

Making a Shock Absorber

"Sir,—I shall be glad to receive your advice on the following problem: A stamper drops ½ in. on to a moving wooden board and it is required to have no recoil after impact. The stamper drops regularly at even periods and some damping device or shock absorber of friction type might suffice to deaden blow. Approximate weight dropping ½ in. equal to 3 lbs." (A. C., Hounslow.)

Perhaps you could adapt a shock absorber from off a motor car to suit your requirements, or the steering damper of a motor cycle might be employed. You should choose an adjustable type in which the friction damping can be slackened right off, then you can tighten up the adjustment until the damping effect is sufficient. If you could arrange to use a hydraulic press instead of a stamper, this would of course, be free from recoil.

Making a Small Gas Mask

"Sir,—I wish to make a small gas-mask for chemical experiment, but do not know the chemicals used in the container. Could you tell me how to make one at a small cost?" (S. C., Oldham.)

The absorbing or neutralising agents employed in a gas mask are necessarily dependent upon the nature of the contaminating gas which it is desired to remove. For instance, to free air from carbon dioxide it would be necessary to draw it through caustic potash solution.

The simplest type of mask would have the container loosely packed with activated charcoal. A less simple type would contain some neutralising chemical or a filtering system, while the most efficient pattern is self-contained and makes good any oxygen deficiency. For this purpose a small cylinder is carried round the waist.

No gas mask can be universal, but if the container is packed in successive layers in the order given below, it will be effective enough to combat most gases Querist is likely to come in contact with:

(i.) Activated Charcoal. (A specially prepared form of charcoal in which all hydrocarbon impurities have been removed.) This removes organic vapours.

(ii.) A cotton-wool filter for the mechanical removal of smokes, dusts and mists.

(iii.) Sodium Hydroxide fused on pumice to neutralise acid gases.

(iv.) Calcium Chloride (fused).

(v.) A mixture of the oxides of copper and manganese. By catalysis this causes oxidation of carbon monoxide to carbon dioxide.

(vi.) Silica gel for the absorption of ammonia.

Converting Low-resistance 'Phones

"Can I convert low-resistance 'phones to high-resistance?" (P. V., Sevenoaks.)

Yes; high-resistance 'phones are wound with a large number of turns, and it is well to bear in mind that the resistance is really a necessary evil. The sensitivity of the 'phones depends upon the number of turns, and the greater the number of turns the greater will be the voltage drop through them. Thus, although the low resistance 'phones do not match the circuit, there is a possibility that the extra resistance will also prevent efficient working owing to the lack of voltage. The present winding should be removed and a finer gauge of wire employed to completely fill the bobbins.

The "Gear" of a Cycle

"Can you tell me how I can calculate the 'gear' of a cycle?" (O. G., Ipswich.)

The method of calculating the "gear" of a cycle is to multiply the number of teeth in the large chain wheel by the diameter in inches of the rear wheel and divide the result by the number of teeth in the small chain wheel or sprocket, the answer being the gear in inches. A machine geared to 80 in., for example, means that one revolution of the cranks will carry the rider the same distance as an "ordinary" machine with an 80-in. driving wheel.

Seeing Saturn

"Would you please tell me whether the rings of Saturn are visible in a telescope of 3-in., using a power of 200. If my calculations are correct, they should be visible, because the average diameter of Saturn is 18 in., therefore if multiplied by 200 would appear to possess a diameter of 60 ft., being twice the diameter of the moon (which is 30 ft.). It is obvious if the moon was a planet possessed of rings they would be easily seen, and by doubling that size they should be seen with ease. Would you please tell me whether this is correct practically?" (V. W., Barking.)

A good 3-in. telescope with achromatic object glass should certainly show Saturn's rings and even Cassini's division. Saturn and the moon are generally seen very close together and, if the planet be observed through the telescope with one eye while the moon is viewed unaided with the other, a comparison of their relative visual dimensions may be obtained.

Patent Advice

By A. MILWARD

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

A Luminous Electric Light Switch

"Sir,—I have an idea whereby the electric light switch cover which is sold by electrical firms could be improved on if the word switch is printed in Radio Light as used for figures on alarm clocks, watches, etc. If this was done, I believe that it would be a great advantage to people in finding switches in the dark." (M. F., Guernsey.)

Your idea of marking electric light switch covers with letters in luminous paint should be a useful addition to such devices to enable their position to be readily located in the dark, but it is not seen how you will be able to reap any reward for your idea. The application of luminous paint or radium paint to enable letters or figures to be read in the dark is not in itself novel, as you are aware from the fact that the idea occurred to you from seeing the figures of watches and clocks so painted. There can be no subject matter or invention for a patent (the only possible way in which such an idea could possibly be protected), in applying a known thing for an analogous use. No invention is required to adapt the known idea of luminous words or figures to electric light switch covers. There was another invention proposed many years ago, which is perhaps more apposite to your idea than watch figures, and that was to paint with luminous paint the escutcheon night locks so as to facilitate finding the key-hole at such times when they appear to be elusive.

A Universal Variable Speed Device

"Sir,—Having designed a 'Universal Variable Speed Device,' suitable for use in the transmission system of motor vehicles, I am now in the position to proceed with provisional protection. Part of the device comprises a non-friction free wheel which does not necessitate the use of ratchet wheels, pawls or springs and can be utilised for a variety of purposes other than that mentioned above. Would it be necessary for me to make this the subject matter of an additional patent in order to obtain full cover for it?" (C. E. L., Hendon.)

If the free-wheel or one-way clutch device forms an essential featnre of the variable speed device, it would necessarily require to be embodied in the Specification of the Patent Application, but if any known form of one-way clutch would serve, though not perhaps so effectively, then the Patent Application for the variable speed gear need not be restricted to the use of the new clutch device.

In any case, if the one-way clutch device is novel *per se* and is applicable for a variety of purposes, then it will be necessary to file a separate Patent Application covering the device broadly. If it be included in the variable speed gear Patent Application, it can only be claimed in combination with such gear, so that any one might use it for other purposes without infringing any patent that may be obtained for the gear.

The last paragraph of the letter is not quite clear, but if it be intended to mean that the clutch device could form the subject matter of a Patent of Addition to the Patent for gear, the supposition is not correct: it would require to be the subject matter of a separate and distinct Patent Application. Patents of Addition are only granted for modifications or improvements on the invention forming the subject matter of the original patent.

Blinding Head-lights

"Sir,—I think I can solve the problem of blinding head-lights when two cars are passing at night. The idea is this: If a lamp (of which I have a design) was fitted to all cars it would show the oncoming car how much room it would have. Of course the head-lights would have to be very dim; in fact, they could be out altogether. Can I patent such an idea?" (A. O., Polperro.)

The idea of using a lamp on the offside of cars to illuminate the road for an oncoming car is not broadly novel. There have been quite a number of patents utilising the idea, but so far as is known there is none in use. This is probably accounted for by the fact that head-lights are still necessary for driving and would still need to be dimmed on passing another car. Even at present, a large number of motorists are too selfish even to dim their head-lights in passing, and they are not likely to adopt an invention which is of no benefit to them, but is simply helpful to the oncoming car.

A Non-Drip Shield

"Sir,—I enclose details of a non-drip shield. The gadget can be fitted to teapot spouts, whole or broken, milk bottles, oil cans, etc., by means of rubber bands. The action of the shield is very simple. The liquid runs through the pouch or pocket, combines with the liquid running over the top of the shield thus forming one stream, when the shield is brought back to the normal position the liquid running over the pocket inside the shield forms a vacuum, the drop of liquid is simply sucked into the shield again." (J. D., Warwickshire.)

The non-drip shield for teapots and like receptacles is simple and ingenious, and is believed to be novel so far as is known from personal knowledge. It is presumed that the object of the rubber band is to form a joint between the shield and spout, otherwise it is thought that liquid would still run down the spout. It is apparently fit subject-matter for protection by Letters Patent, but if the inventor is content to obtain protection for the shield as made it would be less expensive to obtain protection by registration as a design. A design only gives protection for the shape or configuration of the article, and does not include any fixing or jointing means, such as the rubber band. A design is registered initally for a period of five years, two further extensions of five years each may be obtained, making the total protection possible fifteen years, against sixteen years, the duration of a patent.

An Internal Combustion Turbine

"Sir,—I enclose herewith a copy of a provisional patent which I took out recently. I should very much like your opinion on the idea, as I am not in a position to obtain an unbiased opinion here. Please tell me anything which you think may be of value or interest to me regarding my patent." (R. W., Hastings.)

The Applicant has applied for a Patent with a Provisional Specification for an internal combustion turbine, which so far as is known from personal knowledge discloses subject matter for protection by patenting. The Applicant is probably aware that quite a number of patents have already been granted for internal combustion turbines, but, so far as is known, none has been a commercial success, probably due to the complication of parts, from which defect the Applicant's construction also suffers. It is thought that some considerable difficulties will be experienced in constructing a successful turbine according to the invention, not the least being the difficulty in packing the valve disc. Many types of rotating disc valves for internal combustion engines have been proposed and tried, but so far without success, not that this is written in discouragement, but with a view to advising the Applicant of the difficulties he is likely to encounter.

It is not usually considered advisable to file drawings with a Provisional Specification for the reason that the Applicant is thereby unduly limited when filing his Complete Specification.

A Number of Ideas

Below are given replies to a reader (W. M., Scotland) who sent in a number of ideas for patenting, which unfortunately have been in use a considerable time.

The inventor has only given such meagre details of his five inventions that it is not possible to give him such full advice as is desirable. However, dealing with *Invention No.* 1. It is not understood how a mirror fitted on the rear mudguards of a car will indicate to the driver an approaching car from the rear. If the inventor intends the mirrors to be fitted on the *front mudguards* the idea is old, as it is now common practice to fit a mirror on the offside front mudguard.

Invention No. 2. The broad idea of warming the inside of a car by radiation is not new: the usual practice is to lead a portion of the exhaust gases through radiators inside the car. It may be novel to circulate the cooling water of the engine through radiators, but it is not thought that the additional trouble or expense involved in such an arrangement would be of any commercial value.

Invention No. 3. This is already in use, particularly on long-distance trains such as the Scotch Expresses. There is no novelty in the idea.

Invention No. 4. The description of this is unintelligible. If a 3-cylinder engine is meant, each fitted with three valves, there is no novelty in the idea.

Invention No. 5 appears to be for a motor driven caravan. Broadly, the idea of motor caravans is not novel. It may be that a particular construction of the body work as regards the internal arrangements may be novel, but it is not thought that any protection that could be obtained for such a construction would have any great commercial value.

Catalogues and Publications Received

OUR FREE CATALOGUE SERVICE

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

For the Wireless Constructor

THE well-known firm of Messrs. Dubilier have just issued their latest catalogue covering a wide range of all types of condensers. From start to finish, Dubilier components are made with the idea of giving the home constructor something that can be relied upon. That is why you can incorporate Dubilier condensers and resistances in your set, confident that you will not be let down. Mica condensers, paper condensers, paper condenser blocks, non-inductive condensers, electrolytic condensers, metallised resistances, in fact, nearly every known type of the above are listed in this catalogue at moderate prices. The catalogue is obtainable free of charge upon application. [19]

Maps for All

GEORGE PHILIP & SON LTD., 32 Fleet Street, E.C.4, well known as an authority on maps and educational literature of all types, has recently issued a number of interesting catalogues. Their list of General and Educational Publications is a splendid 78-page catalogue packed with useful information on many subjects. Equally good are their catalogues on Library and Commercial Maps, Map-fitting and Globes, Touring Maps and High-grade Reference Atlases, all well illustrated. All these catalogues are obtainable free of charge upon application. [20]

The Road to Success

THE successful I. C. S. method of teaching by post was first introduced by the International Correspondence Schools in the year 1891. This method was developed by means of instruction papers written for home study, and with the aid of a unique plan for the direction of students' lessons and the correction of their exercises. Many years of successful teaching show that this system supplies one of the greatest needs of modern times; it carries practical and profitable knowledge to thousands who can afford neither the time nor the money to go to school or college. Write at once for a range of their catalogues, sent free of charge, stating in what particular subject you are interested. [21]

"What Trade Shall I Take Up?"

THE above question generally crops up when a person is contemplating starting out in business. If you are undecided let the Bennett College help you. They publish separate prospectuses on nearly every known subject. The Bennett College began its work a good many years ago with a staff of well-trained and fully-qualified tutors with practical experience. The lessons, of course, are varied and changed to meet the changing requirements of the different examinations. Write now for details of their courses, which will be sent on application. [22]

Lotts' Bricks Ltd.

THE above well-known firm have recently published a number of illustrated pamphlets on constructional sets, chemistry sets and electricity sets. Model railway enthusiasts will appreciate a box of Lotts' bricks, for with them he can build railway stations, signal boxes, goods sheds, etc.—in fact, all the buildings that make a model display just like the real thing. Chemistry sets ranging from 2s. to 105s., and electrical sets from 6s. to 21s. are all listed in their pamphlets. Readers interested should write at once for these lists, which will be sent free of charge upon application. [23]

Practical Chemistry at Home

CHEMISTRY at home makes a fascinating hobby, and many interesting and instructive experiments can be performed with simple apparatus. Messrs. Beck & Sons have just issued their new catalogue covering a wide range of moderately priced apparatus. They supply standard equipment for use in conjunction with any text-book on chemistry. This list is obtainable free of charge upon application and is well worth perusing. [24]

Pifco Products

THE Pifco "All-in-One" Radiometer has now been on the market a number of years, during which hundreds of thousands have been sold all over the world. The "All-in-One" is the lowest-priced radiometer of its type. By its aid all kinds of tests can be carried out by radio enthusiasts, etc. More elaborate and expensive instruments can also be obtained. Pifco heaters, decoration lamps and cookers are also obtainable at moderate prices. Write for their leaflets giving full details of these ranges. [25]

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This coupon is available until January 31st, 1934, and must be attached to all letters containing queries.

PRACTICAL MECHANICS, JANUARY, 1934.