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NEWNES

PRACTICAL MECHANICS

DECEMBER

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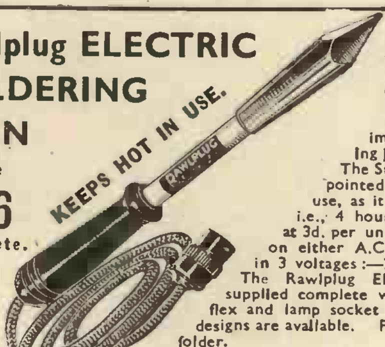

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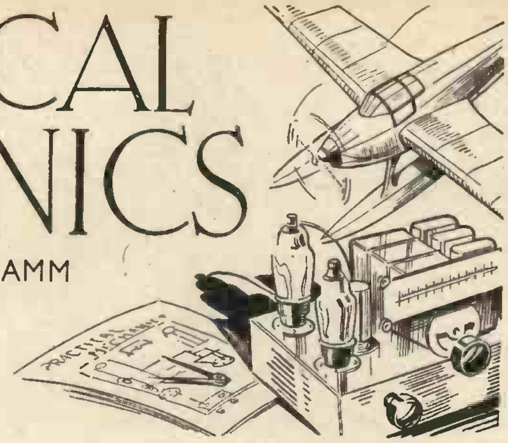
PRACTICAL MECHANICS

EDITED BY F. J. CAMM

VOL. IV. No. 38
DECEMBER
1936



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THE binding case for Volume III, complete with title page and index, is now ready and costs 3*s*. 6*d*. by post from the Publisher, George Newnes, Ltd., 8-11 Southampton Street, Strand, London, W.C.2. The index can be obtained separately if desired for 7*d*. post free. All readers should have their copies of Volume III bound, and thus be able easily to refer to the contents by means of the fully cross-referenced index.

A Nugget of Platinum

A LARGE nugget of platinum weighing 76 ounces has been found by a group of Soviet officials while looking for gold in the Ural mountains. Although the exact purity of the nugget has not yet been ascertained, it is estimated to be worth at least £700.

Hardened Engine Cylinders

A NEW hardening process for diesel engine cylinders has just been developed by the firm of R. A. Lister & Co., of Gloucestershire. The process consists of a coating of chromium, which is deposited on the cast-iron cylinder walls by electro-chemical means.

Lower Cylinder Wear

As a result of a long series of tests it has been shown that cylinders treated by the new process show only about one-third of the wear of ordinary cast-iron cylinders. It is pointed out that although the process has only been applied to diesel engines up to the present, the principles involved apply equally to ordinary motor-car engines, aero engines, and other machinery where the increase of wear resistance is of importance.

Bakelite Airscrews

BAKELITE is continually finding new uses, but a particularly interesting one is its application to aircraft propellers. A variable-pitch airscrew, about 6½ ft. in diameter, has just been constructed by Messrs. de Havilland, and the preliminary tests appear to be highly satisfactory.

Composition of the Material

The material from which the blades are made consists of sheets of cotton fabric impregnated with plastic synthetic resins, formed into a rectangular slab by means of a heated hydraulic press in accordance with established bakelite technique. The airscrew blades are then formed by milling in a profile machine and the blades are finally finished and polished by hand.

NOTES, NEWS, AND VIEWS

A Steel Spider

The blades are mounted on a special steel spider and, of course, the mechanism

Showing the attractive appearance of the bound volume of "Practical Mechanics."

of the variable-pitch hub is also of steel. The new airscrew will undergo very severe tests before being put into service, but the experiments already conducted indicate that bakelite is likely to prove an ideal material for the purpose.

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Motor-boat Speed Record

AN attempt is to be made shortly on Loch Lomond by Mr. H. Roy Fedden, the chief engineer of the Bristol Aeroplane Company, to capture the world's motor-boat speed record. Mr. Fedden's speed-boat is fitted with a Ford V8 engine and is said to be capable of very high speeds.

Arochlor

THIS is the abbreviated name of a chlorinated diphenyl compound which, it is claimed, will be able to supply the world with power when the supplies of oil and coal are exhausted.

Discovered Years Ago

The compound was discovered some years ago by an American firm, and hitherto it has had certain industrial uses; for example, in the moisture-proofing of paper, the cooling of electrical transformers, and as a constituent of cellulose varnishes.

A Heat Transfer Agent

It has been discovered, however, that it has enormous possibilities as a heat transfer agent and a machine has been developed to utilise solar radiation to produce useful power. Although at present only a laboratory experiment, it is believed that almost unlimited supplies of power could be made available when the apparatus has been fully developed.

Cotine, A New Natural Fibre

A NEW textile fibre which can be grown at half the cost of cotton has been developed as the result of twenty years of secret research work, and many remarkable claims are made on behalf of the new fibre.

In appearance, the fibre is midway between flax and cotton, and experiments have shown that it can be spun very readily either alone or in combination with any other textile fibre.

Average Yield per Acre

It is stated that the average yield per acre is three times that of cotton or flax, and as the harvesting is done with ordinary wheat reapers and binders, the costs of production are very low.

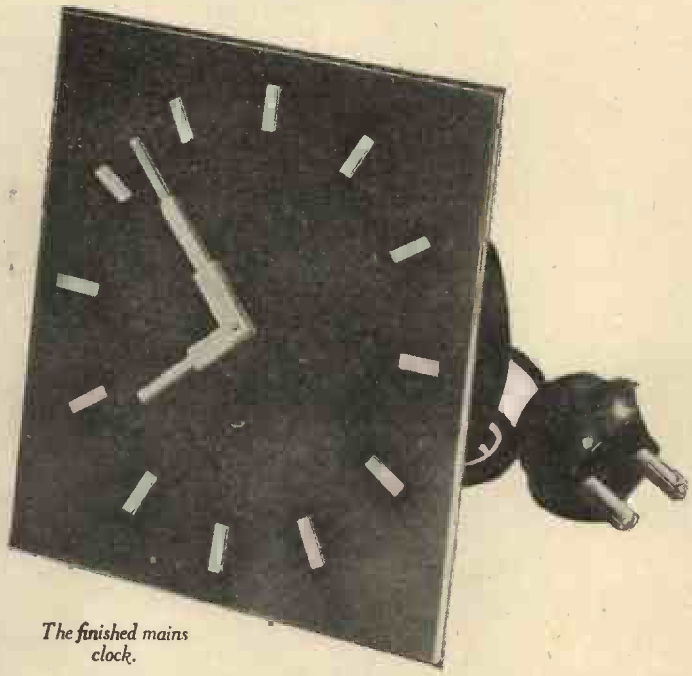
In spite of the conservatism for which the textile trade is renowned, great interest is being shown in the new product and it is believed that its production may help greatly to relieve the industrial depression in the textile industries.

Build Your Own "Perivale" MAINS CLOCK

How to Construct a Thoroughly Reliable and Well-designed Clock for Operation from 50-cycle A.C. Mains. Complete Sets of Parts are Available and the Clock Can Be Made Entirely Without Workshop Equipment. Everything Necessary for the Construction is Supplied with the Kit. It is of Handsome Appearance and Equal to Expensive Commercial Clocks.

By "Home Mechanic."

NO one could have foreseen that the spring- or weight-operated clock would ever become obsolete, for it has undergone very little change during the past fifty years. Time-measuring instruments have passed through many changes through the centuries, and clocks and other time-recording devices can be traced back for more than 2,000 years. Perhaps the first device to record time was the Clepsydra, or Water Clock, in which a tank of water had a small float with an indicating needle and a small hole by means of which the water was enabled to escape. As the level of the water fell, the float descended in sympathy, and the needle with it. Thus, the position of the needle in relation to a series of marks on the side of the tank gave a rough and ready method of telling the time of day. Burning graduated candles, the Gnomon Sundial, were other methods of time recording which preceded the weight-operated pendulum clock. Spring-driven clocks are of more recent origin. It is a fact, however, that even expensive spring or pendulum clocks cannot be made to keep correct time; they are subject to variations due to temperature, position, and mechanical condition, and so long as they have an even rate either gaining or losing, they are considered satisfactory.



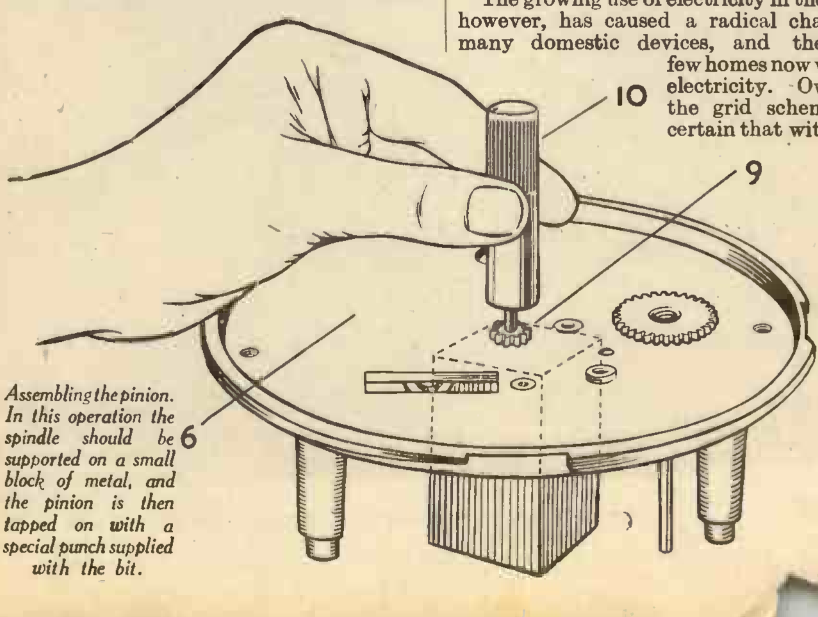
The finished mains clock.

Time-controlled 50-cycle Mains

The growing use of electricity in the home, however, has caused a radical change in many domestic devices, and there are few homes now without electricity. Owing to the grid scheme it is certain that within the next ten years every home will be wired for electricity.

The source of the supply is usually alternating current of a time-controlled frequency of 50-cycles per second. Here we have on tap the very ideal method of making a device which must keep exact time. It cannot gain or lose, hence you will find that most homes nowadays make use of at least one synchronous mains clock. They require no winding, and go without trouble for years. There are no parts which by reason of wear would cause the clock to vary in time keeping. Such clocks do not require to be cleaned frequently; so long as they are connected to the mains they continue to go, in which respect they have the great additional advantage that you cannot forget to wind them up.

Such mains clocks are usually expensive to buy, and many amateurs have devised means of making what I might term a poor imitation of them.



Assembling the pinion. In this operation the spindle should be supported on a small block of metal, and the pinion is then tapped on with a special punch supplied with the bit.

Parts Now Available

Very often this means that it costs as much to make one as to buy one, and usually the result is far from satisfactory. At last, however, a company has come forward and produced a complete set of parts, machined and ready for assembly, by means of which you can within an hour have a handsome, reliable, and well-designed clock, which will keep time as accurately as the six pips from Greenwich. I built one of these clocks in three quarters of an hour, and it is going perfectly as I am writing this article. Moreover, notwithstanding the high quality of these parts, the price is the modest one of 25*s*., with instructions, a screwdriver and punch (all that is necessary to assemble it), clock oil, and clock grease. By means of the part-numbering system you cannot go wrong. The company should have full credit for its enterprise, and I mention them by name. They are: The London Electric Clock Co., 15 Park Street (off Upper Street), Islington, N.1. The kits are obtainable from the usual dealers and large stores, or direct from the company for 25*s*., plus 6*d*. postage. The assembled model can be obtained for 35*s*., postage extra. It should be mentioned that the kit is complete with the adaptor, flex, and plug. A list of parts appears on page 126, and illustrations of the various parts on page 127. By this part-numbering system the assembly becomes a most simple matter.

Principle of the Synchronous Clock

Before proceeding with the assembly, it would be as well briefly to describe the principle of a synchronous electric clock. In the place of the spring used to drive ordinary types of clock, a small synchronous electric motor provides the power. This motor is designed to run at a constant speed always, and will only work on A.C. current of 50 cycles, which is now available in all districts served by the national grid scheme. The speed of the motor is not affected by climatic conditions, and thus the clock will never vary so long as it is connected to the A.C. mains. If the current supply is interrupted, the clock will stop and must be restarted and set to the correct time. No regulating is necessary, and so long as the clock is running, it must give the correct time.

No soldering iron is necessary, and a screw-driver is supplied for assembly purposes. First, compare the various parts with the photographs on the large sheet, in conjunction with the spare parts list which names the various items against their respective numbers. The parts are numbered in the order of assembly, and in these instructions, wherever a part is named, its part number is given in brackets alongside.

Assembling the Minute Spindle

When referring to the clock base plate (6), the back is the side on which the various pillars are cast.

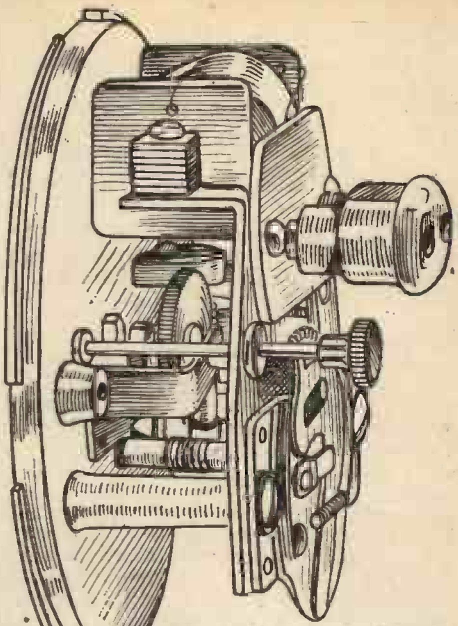
Take the minute-hand spindle (1) and assemble on to it the following parts in the order named, brass worm wheel (2), spring (3), cup washer (4), and horseshoe washer (5), as shown in Fig. 2. The spring (3) must be compressed by the cup washer (4), allowing the horseshoe washer (5) to be slipped into the groove on the stem of the minute spindle (1). Note that the recessed side of cup washer (4) fits round the horseshoe washer (5), preventing it coming out.

The Going Train

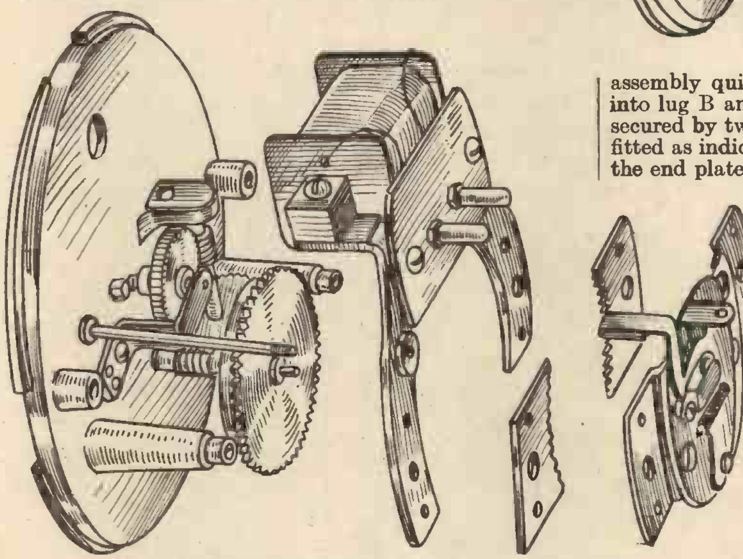
Next take the clock base plate (6) and fit the assembled minute spindle through the centre hole of this casting, and then fit the minute spindle bracket (7), which is located by two pips on the casting, and a screw (8), as shown in Fig. 1.

The small pinion (9) is next fitted on to the minute spindle (1), and for this purpose the spindle must be supported on a small block of metal, and the pinion (9) tapped on with the special punch (10), supplied with the kit. The pinion (9) must be tapped down to the bottom of the small knurling on the minute spindle (1), so that the pinion (9) cannot turn without also turning the spindle (1), and there must be just a little end play for the minute spindle assembly. The pinion (9) *must not* be tapped down so hard that it prevents the minute spindle (1) spinning freely in its bearing.

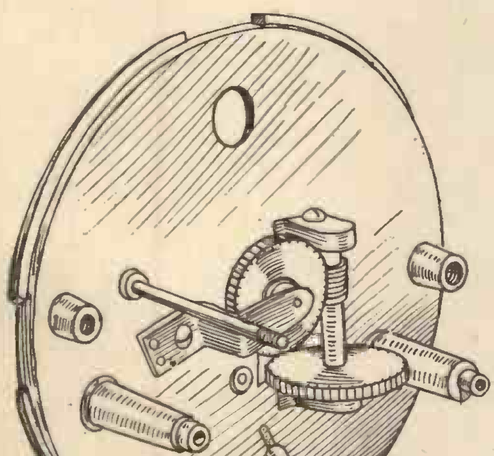
The hour wheel (11) and intermediate wheel (12) may now be fitted on to the front of the clock base plate (6). The hand-setting wheel, together with its spindle, is already fitted to the casting before dispatch. Fit the hour wheel (11) on to the end of the minute spindle (1), and then fit the intermediate wheel (12), locating it by screw (13), which screws into the tapped hole in the casting between the hand-setting wheel and hour wheel (11) as shown in Fig. 4. The screw (13) is locked by nut (14) on the back of the clock base plate (6). Make sure that all these gears revolve freely with each other, before passing on to the next operation.



The assembly of the movement complete, with the exception of parts 31–38.



An exploded view showing later stages of assembly.



Showing the first stage of assembly complete.

The intermediate spindle (15), on which is already mounted the fabric worm wheel, is fitted so as to revolve between the two small lugs (B and C) on the back of the clock base plate (6). There is a rectangular opening (D) in the casting to receive the fabric wheel, and to fit the intermediate spindle (15) the end (E) should be passed through the large hole in lug B, thus allowing the pivot (F) at the end of the spindle to slide into its bearing in lug C, and fabric wheel fits into rectangular opening.

Reference to Fig. 5 should make the assembly quite clear. The bush (16) fits into lug B and the two end plates (17) are secured by two screws (8), and may now be fitted as indicated in Fig. 5. Before fitting the end plate (17), however, the recesses in the two bearings which these plates cover should be filled with the special grease supplied. The brass wheel (2) should now mesh with the worm thread on the intermediate spindle (15), and this spindle should spin freely, transmitting the drive through all the gears already fitted.

Rotor Spindle Assembly

Take the rotor spindle assembly (18) and make sure that the brass carry-over wheel, mounted on the spindle alongside the toothed rotor, is free to revolve, and place a drop of oil at this point. A small bottle of special oil is provided in the kit. Fit the rotor spindle pivot into its bearing in the clock base plate (6) as indicated in Fig. 1, so that the worm thread on the rotor spindle assemble (18) will mesh with the fabric wheel (15) already mounted.

Place the clock base plate (6) complete, with all the parts already assembled on to it, face downwards, with the back of the plate facing the assembler. Place the stators (19) in position, as shown in Fig. 6, passing the hand-setting spindle through the brass bush fitted into one of the stators (19). The ends of the stators (19), which are bent at right angles, must be pointing towards the clock base plate (6).

The Pole Pieces and Rotor

Now fit the two pole pieces (20), making sure that the two small pips on each pole piece face towards the clock base plate, and register with the locating holes in the stators (19).

Next take the rear rotor-bearing plate (21) and, carefully guiding the rear rotor spindle pivot into its bearing, fit the plate (21) so that it rests across the top of the two pole pieces (20) already in position, and the four pips locate with the corresponding depressions on each of the pole pieces (20). Make sure that the bearing plate (21) is fitted the correct way round, as shown in illustration. Screw the two pillar screws (22) into the ends of the pillars, but before screwing up tight, make sure that all the locating pips on the pole pieces (20) and the bearing plate (21) properly register with the holes in the stators (19).

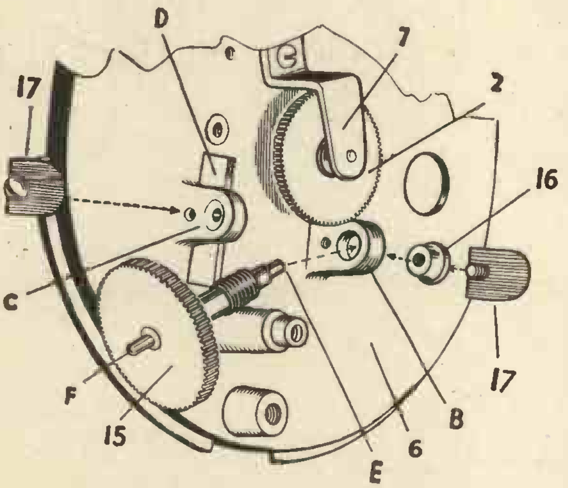
The rotor spindle assembly (18) should now spin freely in its two bearings, and the worm thread on the rotor spindle (18) should mesh with the fabric wheel (15).

The Starter

The starter is already fitted to the plate (21), and by fixing the spring (23), one loop over the small tongue on the starter and the other over the steel rivet on the plate (21), the rotor can be spun by sliding the starter along to the extremity of its slot and releasing.

This action will always start the rotor in the right direction, as it will be noticed later, when the current is connected to the clock, that the rotor will run in either direction. If it is revolved the wrong way, the clock would go backwards.

Mounted on the plate (21) (G, Fig.6) will be seen a small phosphor bronze stepped plate. Loosen its securing screw and swing the plate to one side, thus exposing the rear pivot of the rotor spindle assembly (18). Put one drop of the special oil provided into this bearing, and then pack the bearing with grease all round the rotor spindle pivot.



The method of fitting the intermediate spindle.

Slide the phosphor bronze plate back into position, and tighten its screw.

The Indicator

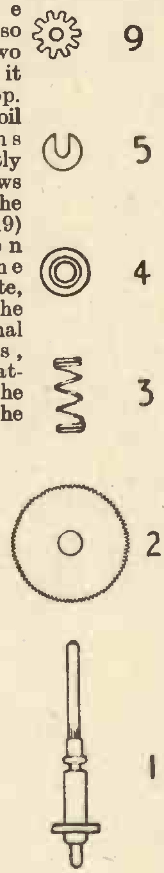
The indicator (24), half of which is coloured red, should now be pushed on to the front end of the rotor spindle, just allowing the tip of the spindle to project beyond the face of the indicator (24). Fit the front rotor spindle end spring (25) by its screw (8), as shown in Fig. 4. Place a spot of grease on the end of rotor spindle, where the spring (25) presses on to it. It is important that the spring (25) does not press too hard on to the end of the rotor spindle. If it does so, it must be pulled away sufficiently to release the spring tension. If the spring (25) does not press at all on the spindle, the clock may be slightly noisy when running.

Oiling the Parts

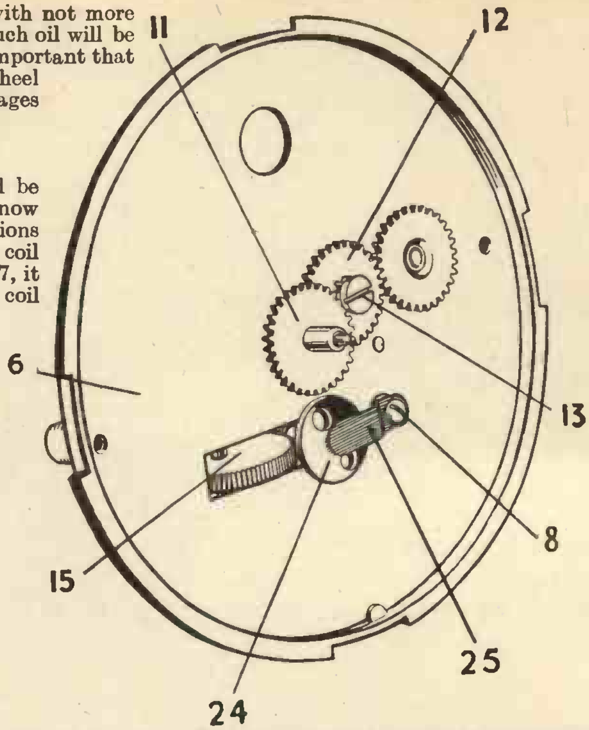
At this stage all bearings and other moving parts may be oiled with not more than *one drop* of oil. Too much oil will be of no benefit, and it is most important that no oil is placed on the fabric wheel or the worm thread which engages with it.

The Coil Unit

The coil (26), which should be handled with great care, may now be fitted. The core laminations (27) are already fitted into the coil (26), and by looking at Fig. 7, it will clearly be seen how the coil (26) is mounted between the platforms at the top of the stators (19). The coil (26) must be mounted so that the two leads from it are at the top. Screw the coil laminations down tightly by two screws (28), on to the stators (19) and then mount the fabric plate, carrying the split terminal contacts, which are attached to the leads from the coil (26). This fabric plate is secured by two screws (29), and it should be so mounted that the split contacts, which it will be noticed are not centrally fitted, are below the centre line of the fabric plate, as in the illustration. It is important that the leads from the coil (26) to the split contacts do not touch or cross.



The various parts to be fitted to the minute hand spindle showing the order of assembly.



The assembly on the front of the base plate should look like this when finished.

Testing the Clock

The movement can now be connected to the mains by means of the flex and small plug (30). Start the clock by moving the starter to its extremity and releasing. If everything appears to be in order, and the movement is running satisfactorily, disconnect the current and complete the clock.

The Dial and Hands

Mount the dial (31) on to the face of the movement, in such a manner that the indicator (24) can be seen through the small hole in the dial immediately above the six-o'clock chapter. The spacing pieces (32) must be placed between the dial and the front of clock base plate (6), so as to prevent the dial touching the indicator, and the dial (31) is held in position by two screws (33), these latter also passing through the holes in the spacing pieces (32), the radius on these spacing pieces conforming to the circle of the clock base plate (6).

The hour hand (34) may now be fitted, followed by the minute hand (35). If they are both set at twelve o'clock, they will register correctly at any other hour; to

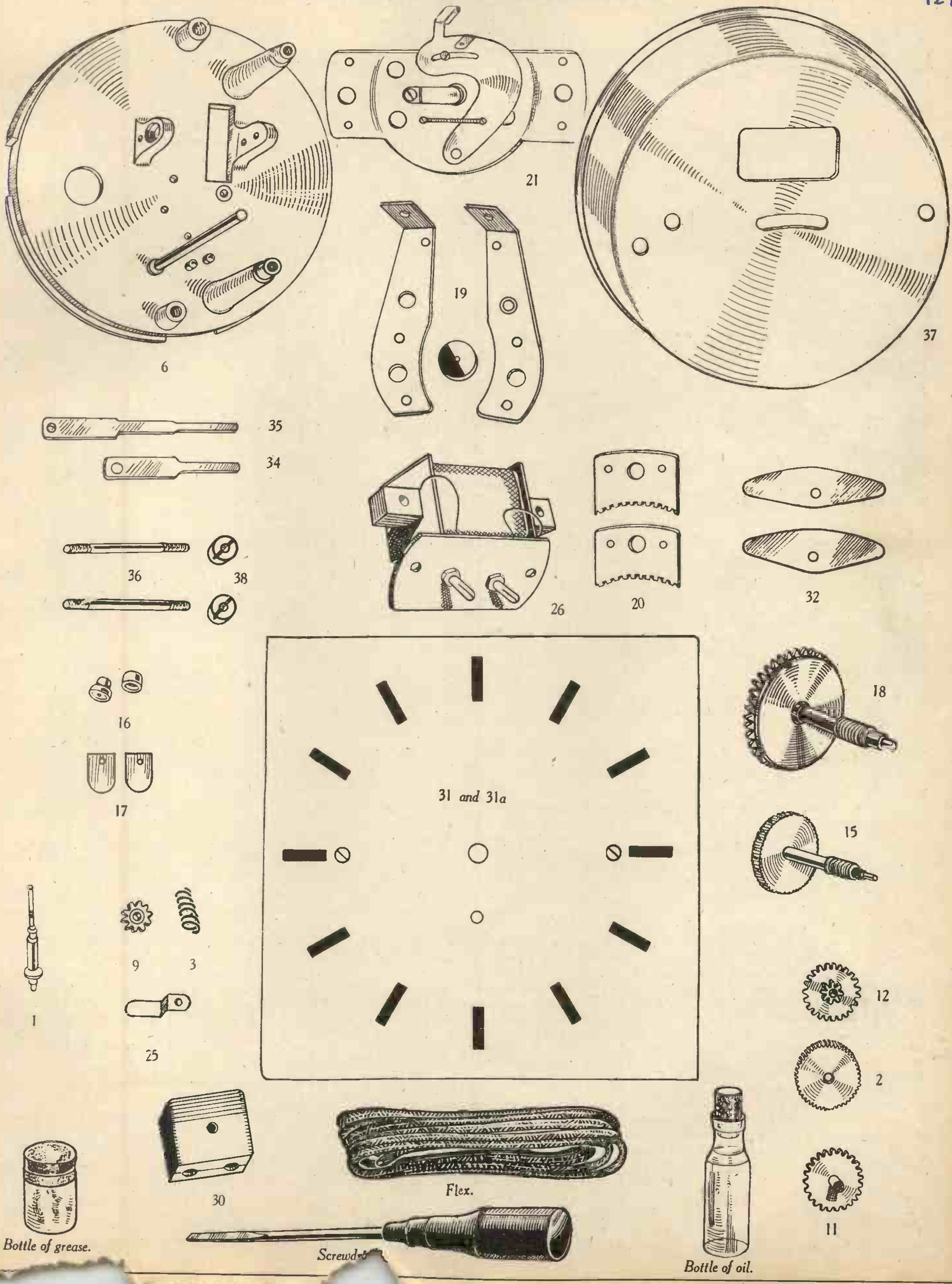
(*Continued on page* 185)

LIST OF PARTS FOR THE CLOCK

Part No.	Part Name.
1	Minute-hand Spindle.
2	Brass Worm Wheel for Part No. 1.
3	Spring for Part No. 1.
4	Cup Washer for Part No. 1.
5	Horseshoe Washer for Part No. 1.
6	Clock Base Plate, fitted with hand-setting wheel and spindle, all holes tapped and ready for assembly.
7	Minute Spindle Bracket.
8	8 B.A. Screws (4 per clock).
9	Small Brass Pinion.
10	Special Punch for fitting Part No. 9.
11	Hour Wheel.
12	Intermediate Wheel.
13	8 B.A. Screw for Part No. 12.
14	8 B.A. Nut for Part No. 13.
15	Intermediate Worm Spindle complete with Fabric Worm Wheel.
16	Brass Bush for Part No. 15.
17	Bearing End Plates for Part No. 15 (2 per clock).
18	Rotor Spindle, Rotor and Brass Carry-over Wheel assembly complete.
19	Stator, right and left hand (2 per clock).
20	Pole Pieces (2 per clock).
21	Rear Rotor Bearing Plate, fitted with bearing and starter.
22	Pillar Screws (2 per clock).
23	Starter Spring for Part No. 21.
24	Indicator.
25	Front Rotor Spindle End Spring.
26	Coil, complete with Split Terminal Contacts mounted on fabric base.
27	Core Laminations for Part No. 26 (15 per set).
28	6 B.A. Screws for Parts No. 26/27 (2 per clock).
29	6 B.A. Screws for Parts No. 26/27 (2 per clock).
30	Plug.
31	Dial for Outfit No. 1.
31a	Dial with small hole at each corner for Outfit No. 1a.
32	Spacing Pieces for Part No. 31 (2 per clock).
33	6 B.A. Screws (oxydised) for Part No. 31 (2 per clock).
34	Hour Hand (finished green).
35	Minute Hand (finished green).
36	Fixing studs for Part No. 37 (2 per clock).
37	Dust Cover.
38	4 B.A. Nuts for Parts No. 36 (2 per clock).
39	Hand-setting Knob.
40	2 each—Small Oxidised Wood Screws for fixing Part 31a to wood panel (4 per clock) issued only with outfit No. 1a.

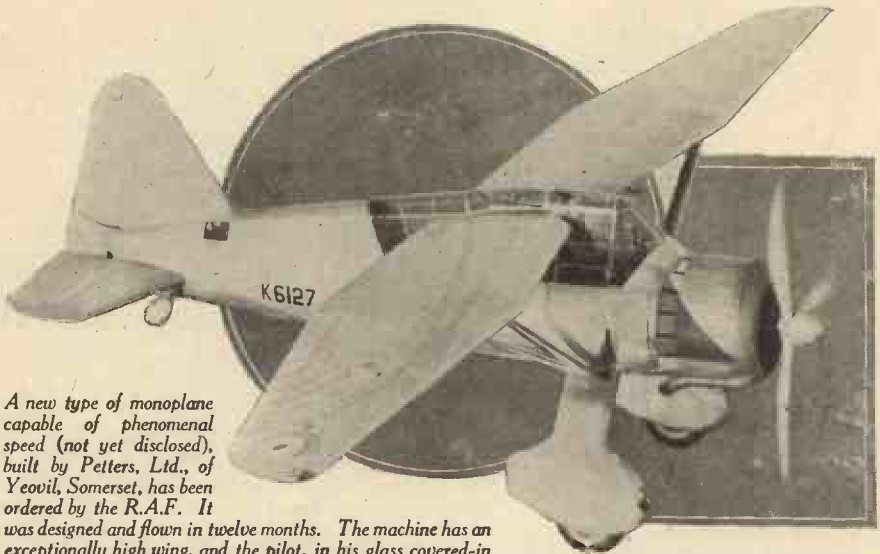
PARTS FOR THE PERIVALE MAINS CLOCK

(*See page 126 for the corresponding names of each part.*)



THIS MONTH IN THE WORLD OF—

SCIENCE AND INVENTION



A new type of monoplane capable of phenomenal speed (not yet disclosed), built by Petters, Ltd., of Yeovil, Somerset, has been ordered by the R.A.F. It was designed and flown in twelve months. The machine has an exceptionally high wing, and the pilot, in his glass covered-in cockpit, has a clear view all round. Its landing gear is streamlined, with powerful landing lights inserted in the wheelcasing. The machine has a long range, variable pitch propeller and slotted wings.

Oxy-hydrogen Motors for Submarines

A NEW type of German U-boat dispenses with electric propulsion under water, and uses an oxy-hydrogen-fired steam turbine unit. It is not clear whether all the oxygen and hydrogen needed for a voyage are charged into cylinders at the outset of a voyage or whether it is generated and stored as required by electrolysis of sulphuric acid or caustic soda in special cells, but the mixture of oxygen and hydrogen which comes off from the cell is then compressed into cylinders for use under water.

Power for Electrolysis

The power for electrolysis in this case would be provided by a generator driven off the above-water diesel engine. This would be the flexible arrangement and provide the vessel with under-water range limited only by its supply of oil fuel. Submarines are, of course, driven under water by electricity stored in ordinary lead accumulators. This system has several disadvantages. The acid spills from the accumulators if the vessel is dived at too steep an angle.

Heavy Accumulators

The accumulators are exceedingly heavy in proportion to the power they store. If sea-water leaks in and gets at the batteries, fumes of hydrochloric acid are generated, which gasses the occupants. The idea of the oxy-hydrogen steam-boiler turbine system is of course not new. But it can only become possible if weight and size of units are designed to low limits. There have of course been many improvements in the construction of gas cylinders and high-pressure compact boiler systems of recent years, which have considerably altered the situation.

Sun Motor

A HALF-horse-power sun motor was amongst the exhibitions at the recent World Power Conference in New York. Its power unit was a high-pressure turbine supplied with steam from a boiler which ran at nearly 200 lb. to the square inch. The water in the boiler was not heated directly by the sun, as that would have entailed long pipes built to withstand the boiler pressure. The heat of the sun was concentrated, by means of mirrors, on tubes of an organic liquid which could be heated to a high temperature without generating high vapour pressures. In addition, it has the property of giving up its heat easily in the steam boiler. This liquid then acted as the conveyor of heat from the sun-concentrating mirrors to the boilers. The system is one of the few successful yet devised.

Film Studio Generator Sets

IT is an interesting fact that all modern film studios are building their own power plants. There are several reasons for this, the first of which are reliability and cheapness. A diesel-engined set can generate at under ·2*d.* per unit. There is no risk of voltage flicker or power failure, but the principal reason has to do with the delicacy of sound recording. High-powered arc lamps are used for lighting sets.

A Noisy Background

If these were supplied with A.C. they would buzz and purr and talking pictures would always have the recording of this noise as a background. The current used in film studios is always D.C. for this reason, and the voltage of generation has a very smooth flux. When putting in generators to obtain this D.C. current, it is cheaper to use diesel drive than electric, and film studios now all have their generating stations turning out several thousand kilowatts.

Diesel Aeroplane Engines

THE diesel engine for aeroplanes has reached a far more advanced design than many people think. The weight per horse-power is now down to 2 lb., which is less than the figure that was thought final for petrol engines less than five years ago. There are several German all-metal monoplanes which have been using 12-cylinder Junkers diesel engines for some months past.

A 4,000-mile Trip

One made a 4,000-mile trip to W. Africa and back recently without refuelling. It had four Junkers engines developing 3,000 h.p. between them. In this country Rolls-Royce have the Napier Cutlass and Culverin engines available, built in the usual cylinder-in-line style of Rolls-Royce aero engines.

A Radial Nine-cylinder Engine

THE Bristol flying company have built a radial nine-cylinder engine, the Phœnix, which looks exactly like their big Bristol Mercury engine. An Atlas machine using one recently reached an altitude of 27,000 ft. and gave an all-round performance which was, if anything, better than that of the same machine using a petrol engine. All these engines run at about the 750-h.p. mark, although a short time ago it was said that diesel-engine units could not be economical in weight under 1,000 h.p. Indeed, the lower limit of size now seems immaterial, for there is a 17-h.p. rated car engine which can and has been fitted quite successfully to private cars, one notable conversion being that of an ordinary 16-h.p. Morris by a London firm interested in the distribution of diesel oils.

Coal-injection Engines

AN engine operating on the fuel-injection system but using powdered coal instead of oil is occupying the attention of engineers in coal-producing countries. The engine works quite well but its life is short, because the problem of exhausting the ash residue of the coal has not been solved. It forms a paste with the lubricating oil and rapidly scores the cylinder linings. Actually, the best performance is obtained on such improbable fuels as flour and starch, which have a very small ash residue.

Separating Combustible Substances

Now chemists have been set to work on the problem of separating the combustible substance in the coal from mineral ash by use of suitable solvents. A considerable degree of success has been obtained, and it is very probable that within ten years we shall not need to rely on oil supplies for engine fuel.

Power from Refuse

IT is not generally known that the Ford Motor Works at Dagenham runs its electric supply boilers on a big part of London's refuse. Actually, to do this sort of thing on anything but the biggest scale does not pay. It takes 7 tons of refuse to supply as much heat as one ton of coal. Ordinary power stations do not care to put in the special furnaces required for refuse burning.

Transparent Mysteries

Interesting Glass Conjuring Apparatus and How it is Used

By NORMAN HUNTER
(The Well-known Conjuror, of "Maskelynes Mysteries" Fame)

Fig. 4.—A transparent lining of cellophane drops into this glass so that anything placed into the glass may be vanished by lifting out the lining under suitable cover.

GLASS as a material for making conjuring apparatus would seem to be most unsuitable because, presumably, its transparent nature would simply give away the secrets. Actually, however, it is this very transparency which is used to produce the illusions, and in a great many instances the transparency itself is more or less of an illusion as well.

One of the simplest glass tricks consists of a tumbler fitted with a vertical partition of mirror which divides the glass into two parts. Anything placed in one part can be changed to a different object previously placed in the other half by simply turning the glass round under cover of a cloth. The mirror is double-sided and by reflecting the front half of the glass gives the impression that the glass is empty, although there is something at the back of the mirror.

A Practical Adaptation

With this glass, however, care must be taken not to hold it too near objects which it is likely to reflect and so give away its secret. A more practical adaptation of the idea is shown in Fig. 1. In this case the partition in the glass is of cardboard and it is covered with paper to match the box which stands behind it. The hand shown going behind the glass reveals the presence of this partition, which normally is quite invisible, and the glass appears to be empty. An article, say, a white handkerchief, placed in the front partition is easily changed to, say, a flag, which in the photograph is already in the back of the glass.

A further refinement is to have the reverse side of the partition painted dead black (Fig. 2). When the glass is covered and turned round it is then placed on another table, in front of a black hat. On uncovering the glass the contents are seen to have changed and this time the black background can apparently be seen through the glass. The fact that the background changes completely removes any suspicions that may lurk in the minds of the spectators that the glass is other than empty.

Fig. 1.—The glass is fitted with a partition that matches the box. The hand held behind the glass shows up the partition but normally the glass will appear empty except for whatever is placed in the front of the partition

Fig. 2.—Showing the reverse side of the partition painted black.

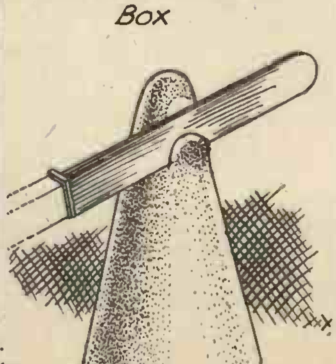


Fig. 3.—Cutting the sand mould.

A Sand Mould

To fit such a partition into a glass the easiest way is to fill the glass with moist sand and turn it out, just like a mud pie. With a large knife carefully cut down the centre of the sand and remove one half (Fig. 3). Place a piece of stiff card against the flat side of the mould and draw round it. The cardboard may then be cut to this outline and will fit the glass perfectly. The glass used should have a foot, as shown in the illustrations. This enables it to be stood some little way in front of the background without the partition being visible against the surface of the table, as it would be if an ordinary tumbler were used.

Fig. 4 illustrates another equally simple and effective conjuring accessory to a glass. This is a transparent lining made of clear cellophane or similar substance. The presence of the lining makes no visible difference to the glass yet anything placed in the glass goes of course into the lining and may be removed under cover of a paper tube by simply lifting out the lining (Fig. 5).

To make such a lining it is advisable first to cut a paper pattern. Mark off on the paper a circle having a diameter equal to the height of the bowl of the glass. Cut this out and remove a generous segment of the disc. Place the pattern into the glass and mark where it overlaps. Trim the paper until it just fits the glass, then cut the cellophane from this pattern, allowing a quarter of an inch overlap (Fig. 6). Stick the edges together with glue and drop a blob of the adhesive into the bottom of the lining to seal up the point. It should be noted that the lining need not follow the slight curve of the glass. A simple cone of the right dimensions is all that is required but the point may be rounded by making short slits in the cellophane, coating them generously with adhesive and pressing the lining into the glass, where it is retained by a weight on top until dry.

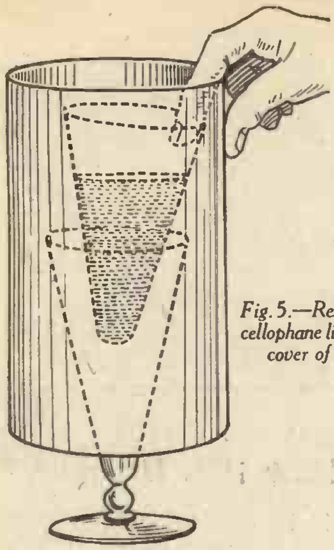


Fig. 5.—Removing the cellophane lining under cover of a tube.

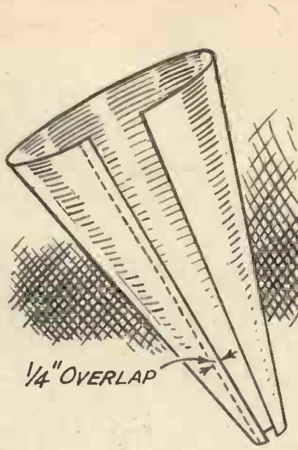


Fig. 6.—Details of the cellophane lining.

Vanishing Articles

To use the glass and lining for vanishing articles, drop the things in question openly into the glass, then cover it with a paper or cardboard tube. Make a few passes over the glass and lift the cover. As you do this your fingers are naturally inside the cover and they are inserted into the glass and draw the lining out within the covering tube. While attention is drawn to the emptiness of the glass the lining and its contents are allowed to drop secretly into a box on the table, or into a small bag fixed at the back of the table.

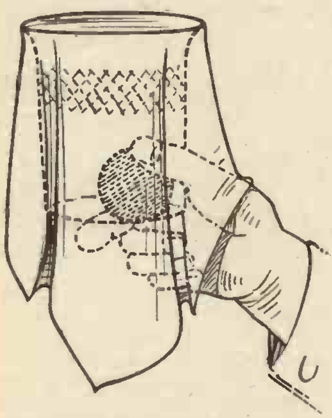


Fig. 8.—A ball held in position by means of a finger placed across the bottom of the glass

The glass is best used to cause the disappearance of a quantity of bran or confetti rather than a single article because an audience might just possibly think you had simply lifted the article out of the glass; whereas, not being aware of the existence of the transparent lining, they cannot imagine it to be possible to lift out a quantity of loose material. In this case the lining may well be got rid of in the box from which the bran or other commodity was taken.

Vanishing Liquids

Carefully made the lining can even be used for liquids and a still more amazing vanish accomplished. In this event the lining full of liquid is allowed to remain inside the tube, which should be a heavy one, say, of metal, and is just stood on the table while the glass is turned upside down to prove its emptiness.

Not quite so easy to make but equally useful is the bottomless glass shown in Fig. 7. The bottom is removed by first drilling a small hole with a twist drill, well lubricated with turpentine. The hole is then gradually enlarged by gently chipping with a hammer and small cold chisel, and the hole finally smoothed off on a small emery wheel. A glass having a stout rim to the bottom should be chosen, as the thick rim gives strength to the finished article. There is a certain element of luck in making a glass of this kind, and it is possible that one or two glasses may be cracked or broken before one is successfully finished, but as suitable tumblers can be bought for a few pence the expense is not great.

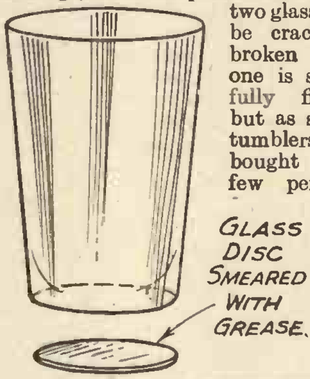


Fig. 9.—Showing how a false bottom is held in place on the glass by means of grease.

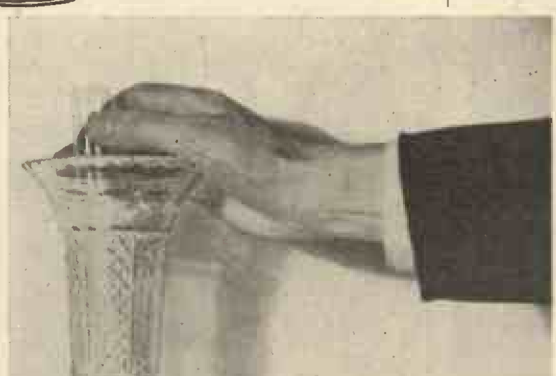


Fig. 10.—Vanishing a stick. The photograph shows the glass tube which previously covered the stick, and from which the stick has been dropped under cover of a handkerchief, partly in the vase. Notice how the cut glass of the vase renders the glass tube invisible.

Using the Glass

Now for the use of the glass. An object such as a ball, a ring, small watch, etc., may be dropped into the glass, being retained by a finger crossing the bottom (Fig. 8). The glass is covered with a handkerchief and set down on the table. The article passes right through when the supporting finger is removed, and drops into the hand where it is hidden, to be reproduced elsewhere later on. The vanish of the object is not as a rule revealed at once: the object, usually a borrowed or marked one, being meantime disposed in another piece of apparatus, pressed into a hole in a loaf of bread, or secretly dropped into a spectator's pocket. To the audience the object is still in the glass, so that when the covering is removed and the glass shown empty, and the missing article instantly reproduced elsewhere and identified, you have a very complete and puzzling mystery.

Naturally the process may be reversed and some object may be secretly introduced into the previously shown empty glass, via the bottom, after the glass has been covered, to be duly revealed later on.

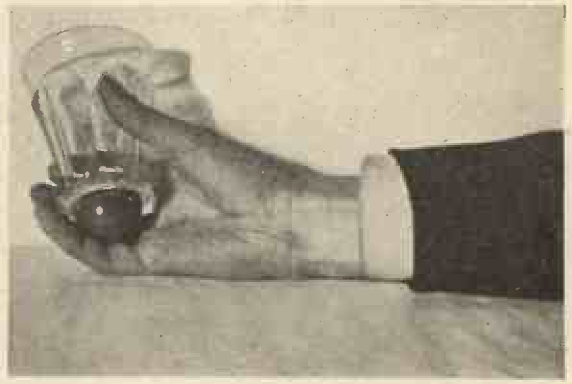
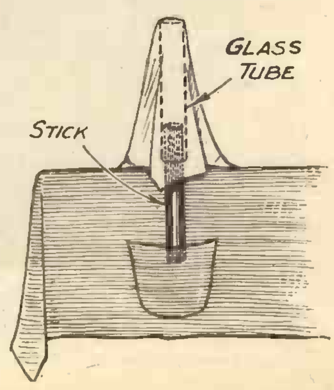


Fig. 7.—The bottomless glass. Small articles placed in the glass can be secretly removed through the bottom after the glass has been covered.

Professionally made bottomless glasses are sometimes fitted with plugs ground to fit snugly into the hole in the bottom. Such a glass may be filled with water and emptied before the trick begins, as a guarantee of its innocence. The plug is then secretly removed in the cloth used to dry the glass.

Making a glass like this is rather beyond the skill of the amateur, but something approaching it can be managed by obtaining a disc of glass the same size as the outer diameter of the base of the tumbler. This disc, coated with Vaseline (Fig. 9), may be kept pressed on the outside of the bottom of the glass and held in place by pressure of the fingers

(*Continued on page* 183)



Fair Comment

by the **EDITOR**

The Shortage of Skilled Labour

A MUTE comment on this mechanised age is the shortage of skilled artisans and craftsmen. The machine has, like some evil robot, destroyed the hand of its creator, until we have reached that position where skilled labour is insufficient to go round. The "situations vacant" columns of the daily papers are filled with advertisements asking for skilled men. "Only skilled men need apply" is the phrase used in most of them, and it directs attention to a problem which the country must solve at once. A machine once made can be operated by unskilled labour, but before its wheels can turn, and produce at an incredible speed masses of articles with sausage-like rapidity and uncanny precision, the skilled hand must toil to make the press-tools, the jigs, and the fixtures necessary for its production.

We are inclined in this age to presume that machinery has abolished skilled labour, when actually it has created a much greater demand for it. Moreover, the skill must be of a higher order, for precision limits grow closer as we approach the modern ideal of perfection, and many of the hand processes of obtaining accuracy have become necessarily obsolete. The skill required to-day is of a different order. Formerly, accurate parts were made one at a time, and the processes of scraping, fitting and drilling were considered as highly skilled trades. Those processes to-day are chiefly confined to repair work and to the tool-room, but even so manufacturers are unable to obtain all the skilled workmen they require.

The Pleasure of Skill

IT was a shibboleth in the engineering trade a quarter-of-a-century ago that it took at least five years to train an engineer. It takes at least that period nowadays, for processes have been invented and machines produced which were then unknown. It is not only in the engineering trades that this lack of skilled men exists. I object to the term "skilled labour," for skilled work is one of those extreme pleasures; nothing can equal the interest of a skilled task either in its execution or in the survey of the finished job. I prefer the term "skilled craftsman," for it accurately describes that individual. Other industries are experiencing this difficulty in obtaining key men, and it may be useful to examine some of the contributory causes.

Influence of the War

IN the first place we must not omit from our ken the enormous influence the last war had on the lives and habits of the people. Many were taken from the workshops, from our training colleges, and even from our schools at an age when they were half-trained. At the cessation of war they were too old to start again. Many of the skilled craftsmen were killed; after the war the inevitable reaction set in. The country was elated at the fact that hostilities were over, and it is perhaps justifiable that many of our youths considered that a year or so of pleasure and relief from the strain of war would not adversely affect their prospects. A war is not finished, however, when each side signs a truce; whilst the war is in operation the nation must draw upon its reserves. The food supply is short, taxation rises, and when the war is ended we find a race physically unfit and the coffers of the National Exchequer severely depleted. Contracts which kept the nation busy in time of war expired, and it was not easy for factories which had been commandeered to change back again to their peace-time occupations.

You Win to Lose

WHEN you win a war you lose, and victory usually means a moral victory. You remember that famous poem, the "Battle of Blenheim," some lines in which run:

"But what good came of it at last?" cried little Peterkin.
"Ah! That I cannot tell," said he,
"But 'twas a famous victory."

The Editor and Staff Join in Wishing Every Reader a Very Happy Chrismas

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Is War Inevitable?

WARS, I suppose, are inevitable, and leave their imprint for many years; since the last war the tendency has been for the school leaving age to be raised, and this lack of skilled men raises the whole question as to whether it is in the best interests of the individual or of the nation for such a large part of the life of a man to be occupied in education. We find that a great proportion of the time at school is spent in sport. A youth of eighteen years to-day wishes to start his career at a salary eight times as high as a pre-war youth. He does not wish to go through the hardships of learning a trade or profession for a small wage, nor does he wish to work so long. These so-called high wages which are paid to those starting out in life merely confer a temporary advantage, for the youth often finds at the age of twenty-five that he is still doing boy's work, but has probably taken on the responsibilities of a man. His salary, however, is static, and finally he finds his way to the ranks of the unemployed. A large proportion of the unemployed are really, perhaps through no fault of their own, unemployable. The unemployed man will tell you that he is willing to do anything. That is just what he cannot do.

You can bolster up this problem for a time with palliatives such as the unemployment benefit, but in my opinion it would be far better for the nation to realise that it does not solve the problem. How much better would it be if the State tackled the cause instead of the effect, and endeavoured to find outlets for its man power!

My Advice

MY advice to the youth of to-day is to shun delights and live laborious days, to maintain a sense of perspective and to ignore the many counter-attractions and amusements which compete for his time.

I am of the opinion that seventeen is the outside limit for leaving school. Evening classes, correspondence courses, and many other excellent means exist to help the ambitious, and once they have started out on a career they will soon decide what additional subjects they should study. Much of that taught at school over the age of seventeen to-day is really valueless. I would also remind the young generation that there is always more room at the top, but you must climb the ladder from the bottom. It is so very true that most boys wish to start half-way up the ladder. Experience is not gained that way, and those who command the highest salaries and fill the important posts are those who have, to use a colloquialism, "been through the mill."

Inventors—the Curious Species

IT is my experience that nearly every inventor sees a fortune in his invention, and his enthusiasm tends to warp his judgment. It makes him suspicious that someone is going to steal his idea. This thought is encouraged by the letters I so frequently receive from those who feel that some notion of theirs has provided them with the magic key to fortune. They write to me expecting me to swing open wide the portals which separate poverty from opulence. If I knew some easy way of doing this I should be the first to apply that method to myself!

It is within my power to advise and help, but those inventors who are so mistrustful of their fellow-men that they cannot disclose details of their inventions cannot expect me to be helpful.

As I have remarked so many times before, it is better to place the matter in the hands of a reliable patent agent than endeavour to muddle along with an idea and to destroy the possibilities by going the wrong way. Every invention submitted to me is dealt with confidentially by one of the leading patent experts. There is no need to write mysteriously to me that you have invented some wonderful new device, and then expect me to advise you merely upon the strength of your enthusiastic statements which lack details of the invention itself; and, I must insist that every query be accompanied by the Coupon cut from the Current Issue. In spite of my recent reminder, many readers are ignoring this important rule of our Free Advice Bureau.

Tall Orders

OUR Free Advice Bureau is intended to answer readers' questions relating to the various fields—technical, scientific, mechanical, and chemical—covered by this journal. Some readers, however, are under the impression that we can extend it to provide information on the construction of some special device. "Please tell me how to build a refrigerator," "Send instructions and diagrams for building a small garage," "I wish to build a lathe, please send full details," are fair samples of the type of letter I am receiving. To answer such questions would require the preparation of dozens of special drawings, and the writing of instructions extending to some thousands of words. Obviously we are unable to undertake this task. Where a query of this nature recurs we instruct a contributor to prepare an article. I hope readers will bear this in mind. Special queries which do not necessitate the preparation of drawings are cheerfully answered.

One other point: we cannot undertake to analyse samples, unless the reader is agreeable to paying our analyst's fee.

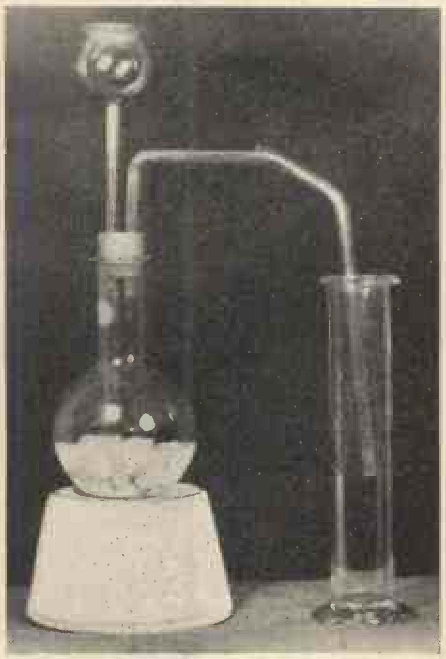
"Passing it On"

QUITE a number of my readers, in expressing appreciation of this journal, tell me that they "always pass their issues on to a friend." No doubt they do this feeling that they are doing the paper a good turn. Actually they are doing it a bad one. The life's blood of a paper is its sales, and whilst PRACTICAL MECHANICS has the largest net sales of any journal of similar type, they would be even larger if readers did not encourage the parsimonious person who, well able to purchase a copy for himself, prefers to cajole a friend into passing along a free copy.

A copy of this journal is in no different category to a ticket for a theatre or a football match. It is intended to be enjoyed by the purchaser alone. There have been some classic cases in the past (particularly among boys' journals), of periodicals which have been killed by their own popularity—they had an enormous reading public, but did not achieve large sales. I do not know to what extent copies of PRACTICAL MECHANICS are passed on, for its sales are brilliant, and at least three times greater than the sales of any of its competitors. Nor am I able to assess what its circulation would be if readers did not pass their copies over to others. It is an interesting computation in the theory of chances as to what the reading public of PRACTICAL MECHANICS numbers. But I would ask my readers not to encourage others to obtain, free of charge, what they themselves have paid for. Some of these "free" readers have the impertinence to use the Query Coupon, although they have not purchased the paper. Our Service is intended for regular readers, and by readers, I mean purchasers. These "ghost" readers extract the maximum value from their free copies—ask innumerable questions, expect every catalogue. In the words of the song, "Play the game, you cads, play the game!"

Chemical Amusements for Christmas

A Well-Varied Selection of Simple, Safe and entertaining chemical Experiments which may be Performed in the home circle with the Simple Chemicals and Apparatus



The apparatus for the preparation of carbon dioxide.

THE amateur chemist, in consequence of the long evenings, usually finds ample opportunities around Christmastide for the making of chemical experiments. Many chemical operations require a properly equipped laboratory for their successful presentation. Others, however, can be performed almost anywhere and of these the present article describes with all necessary detail an interesting selection. All the experiments given below will work. Some, indeed, will work spectacularly. It is not, however, pretended that all the experiments mentioned in this article are "party experiments." Such chemical manipulations have a very limited range of interest and a few of them are actually dangerous to perform. The experiments described below, while being designed to add interest and no little entertainment to spare hours during the festive season, have in themselves a deeper purpose, for they aim at opening up to the onlooker the wonders of chemical science and of providing, as it were, additional material on which the chemical enthusiast may, with interest, exercise his hands—and brains.

A Colour-changing Chemical

Cobalt chloride is a well-known substance. Blotting paper into which this salt has been soaked is coloured pink when damp, but, when perfectly dry, such paper becomes blue in colour. The colour-changing properties of this salt are well known, forming, as they do, the basis of most of the "chemical weather-indicators" which are to be come across from time to time. We may, however, utilise the salt in another curious manner, to wit, for the making of a chemical "thermoscope."

Place a piece of cobalt chloride the size of a pea in a test tube and add to it one or two drops (not more) of water. The cobalt chloride will almost instantly dissolve. Now take a narrow tube, sealed at one end, and almost fill it with the above solution. Finally seal off the other end of

A "lead tree." It is composed of crystals of metallic lead.

SUMMARY OF EXPERIMENTS

Cobalt chloride.
Chemical "thermoscope."
Making lead tree.
Prep. lead acetate lead nitrate.
Plastic sulphur.
Silvering metals.
Rapid oxidation aluminium.
Sneezing powders.
Stink bombs.
Prep. carbon bisulphide.
Ammonia-generating powder.
Fluorescence of fluorspar.
Carbon dioxide experiments.
Interaction of chlorine and acetylene.
Finely-divided lead. Self-igniting powder.
Engraving on glass.
Home soap-making.
Red-cabbage indicator.
Copper nitrate solutions.
Iodine vapour.
Making serpent's eggs.

The carbon dioxide wheel. The carbon dioxide gas is "poured" from the glass jar into the paper cups on the edge of the wheel. Being heavier than air, it fills the cups and weighs them down, thus setting the wheel in motion.

the tube. The chemical "thermoscope" will now be complete.

When immersed in water which is being heated, the liquid in the tube will remain pink up to a temperature of about 45° F. As the temperature of the water is raised to boiling point, the cobalt liquid will change in colour through shades of purple until, at the boiling point of water, it will become bright blue. On cooling, the colour changes will, of course, take place in the reverse direction. For rough purposes, the "thermoscope" can form a very useful temperature indicator.

The "Lead Tree"

The experiment of the "lead tree" is an interesting one for Christmas display purposes. Make up a fairly strong solution of lead nitrate of lead acetate. Place this in a bottle and suspend a narrow strip of zinc in the solution. Within a few hours glistening crystals of metallic lead will make their appearance on the zinc strip and will slowly grow downwards in a tree-like formation. The growth of the lead crystals is much hastened if the zinc strip is connected up to the negative pole of a battery and a wire from the other electrode of the battery immersed in the same solution.

With a great deal of care, the "lead tree" can be removed from the solution and preserved for some time in a bottle of plain water. Usually, however, the "tree" falls to pieces immediately it is disturbed.

If, for the purpose of the above experiment, the necessary lead acetate or lead nitrate cannot be obtained, the latter may be made by dissolving metallic lead in nitric acid and the former by dissolving litharge (lead oxide) in acetic acid.

Why not treat your friends at the Christmas party to some home-made toffee? In this case, however, the "toffee" is tasteless and possesses many amusing teeth-sticking propensities. In fact, the "toffee" consists actually of plastic sulphur, a peculiar variety of sulphur made by heating ordinary sulphur to near its boiling point and then by pouring it in a thin stream into cold water. The sulphur will congeal to a dark plastic mass which may be shaped and rolled into the form of toffees, caramels and other sweetmeats. If, inadvertently, a little of the sulphur should be swallowed by the "subject" of the joke, no harm will result. Such "toffees," however, should be made not more than twenty-four hours previous to their "use," for the sulphur gradually loses its plastic condition and reverts back to its hard state.

Silvering Powder

Here is a simple home-made silvering powder which has many uses. Place in a basin a teaspoonful of powdered chalk and add to it one or two globules of mercury (quicksilver). Grind the chalk and the mercury together until the latter disappears and a grey powder is formed. Now take a rag moistened with methylated spirits, turpentine or some similar liquid and dab a little of the powder on to it. With the charged rag, rub over the surface of an article of brass or copper. Almost instantly, the article will become "silvered."

The effect of this powder on an aluminium surface is very striking. When rubbed on to a surface of aluminium, the powder results in a rapid oxidation of the aluminium, so much so that the latter metal can actually be seen "growing whiskers," as the saying is, the aluminium oxide being formed at a visible rate. Any aluminium articles of value should not be subjected to this experiment, for a trace of mercury can play havoc with an aluminium surface.

Stink Bombs

Amateurs are sometimes curious to know the composition of the liquid used for filling stink bombs, and also the nature of sneezing powder. The latter powders are varied in composition, but the most powerful sneezing agent is an organic dyestuff-intermediate known as "dianisidine." It should be borne in mind that ordinary castile soap powder mixed with common pepper forms a very good sneezing powder. Stink bomb liquids are usually composed of carbon bisulphide, an evil-smelling liquid made by passing sulphur vapour over red-hot carbon. Carbon bisulphide, incidentally, is *highly inflammable*.

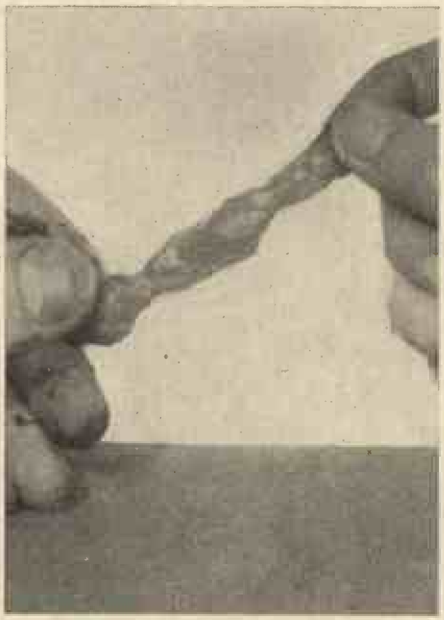
Make up a mixture of powdered sal ammoniac (ammonium chloride) and slaked lime. Place a quantity of this mixture in a basin and then request your "enemy" to stir it for you. His stirring operations will not be very prolonged, for the mixture will give off copious fumes of ammonia.

If you can obtain a small quantity of powdered fluorspar, some very pretty experiments can be performed with this material. Heat an iron plate to just below redness and then throw a pinch of the fluorspar on to it. At each contact of the fluorspar with the heated plate, the spar will give a vivid glow of light, the light lasting for quite a few seconds. The experiment may be varied by dropping small amounts of the fluorspar into a jar containing thick oil which has been heated until it nearly boils.

Many interesting experiments can be performed with the gas, carbon dioxide, which is very easily made by dropping dilute hydrochloric acid on to pieces of chalk, marble or limestone contained in a flask. (Note: the ordinary "chalks" used for drawing purposes are frequently not made of chalk at all and are more or less unaffected by hydrochloric acid.)

An Interesting Beverage

Carbon dioxide is a heavy gas. It is soluble in water, and by bubbling it through the latter liquid we can make quite an interesting beverage. To collect the gas, we must employ the method of "downwards displacement" which is the method shown in the illustration. Here, the carbon dioxide enters the glass jar, and, being heavier than air, quickly fills the jar and pushes the air out of the latter. If we plunge a lighted match or a taper into a jar of carbon dioxide, the flame will instantly be extinguished. It is, indeed, a very spectacular experiment to have in a large glass jar or basin three or four candles burning at different levels. Carbon dioxide is led into the receptacle. It immediately sinks to the bottom of the vessel, but, as its quantity increases, it rises and extinguishes first one candle flame and then another, the candles going out suddenly as if they were snuffed by some invisible hand.



Plastic sulphur, made by pouring very hot sulphur into cold water, makes an excellent imitation for caramel or chewing gum.

Bubbled through lime water, carbon dioxide produces a milky deposit of chalk, and, when similarly allowed to act on solutions of many chemical salts, it precipitates the carbonates of the metals.

One of the most striking experiments with carbon dioxide gas is that of the "carbon dioxide wheel." The wheel is made by taking a 4-in disc of light card and by gluing to its edge a number of paper cups. The wheel should be made as lightly as possible and the cups must be well balanced. The wheel is now mounted on a suitable axis, care being taken to see that it runs perfectly truly. Now take a jar full of carbon dioxide gas and invert it over one of the cups of the wheel. Almost instantly, the wheel, if it is properly balanced, will commence to revolve, and it may be kept revolving by emptying further jars of carbon dioxide gas into its cups.

In principle, of course, the "carbon dioxide" wheel is exactly the same as a common water-wheel, the heavy carbon dioxide gas filling one of the cups and thereby causing the wheel to revolve under the influence of gravity.

For the Workroom Only

Not a "drawing-room" experiment, but a workroom one, is the following. Place at the bottom of a tall jar a layer of chloride of lime and pour on it a little dilute hydrochloric acid. After a few minutes, throw into the jar one or two small pieces of calcium carbide. Flashes of flame will be produced and large volumes of soot generated. In this experiment we have acetylene gas (generated by the carbide) acting on chlorine gas (obtained from the chloride of lime), the action being so energetic that actual flame is produced.

A powder which sets itself on fire is an interesting material to exhibit and it is quite safe to handle, provided that ordinary precautions are taken. To a solution of lead acetate or lead nitrate add a solution of tartaric acid or cream of tartar. A white insoluble precipitate of lead tartrate will be formed. This is filtered off, dried and put into a test tube and heated very gently. Gradually the white lead tartrate will become brown and then almost black, giving off fumes during the process. When it ceases to give off fumes, the test tube should be well corked and its contents allowed to cool down. The test tube now contains metallic lead in powder form. The powder is so fine that when it is scattered into the air, it will take fire and fall to the floor in the form of a shower of sparks.

Engraving on Glass

It is quite a good idea to engrave Christmas messages on glass. This can be effected readily by covering over the surface of the glass with a film of wax or varnish and by writing the message on the varnish with a sharp point so that the varnish is entirely removed in the track of the letters. Now place in an iron or enamelled basin a quantity of powdered fluorspar and cover it over with concentrated sulphuric acid. Place the glass, varnished side down, over the top of the basin and place the latter in a larger pan containing hot water. The fluorspar and sulphuric acid will evolve hydrofluoric acid gas and this will etch the glass in the areas unprotected by the varnish. After about half an hour's action, the glass sheet should be removed and its varnish scraped, dissolved or melted away. The required message will then stand revealed, eaten permanently into the glass.

By boiling up red-cabbage leaves with water we obtain an excellent chemical "indicator" for telling whether a liquid is acid or alkaline. If, for instance, to a small quantity of the dilute red-cabbage extract, prepared as above, we add an acid liquid, the red-cabbage liquor will become bright red, whereas if the added liquid is alkaline, a blue colour will result. White blotting paper "dyed" with the red-cabbage liquor shows a similar result.

Dissolve a scrap of copper in a few drops of nitric acid and then dilute the resulting blue liquid with water until it is almost colourless. On adding to it a few drops of ammonia, its blue colour will return, while if, after this, we make the liquid acid by adding a few drops of an acid to it, its blue colour will at once be discharged. These colour changes can be affected repeatedly and, performed in test-tubes, they are apt to be very mystifying to the spectator.

Seal a single crystal of iodine in a large test-tube. At ordinary temperatures, the test-tube will appear to be empty, but immediately the tube is heated, it will be filled with a beautiful violet vapour. This experiment can be repeated any number of times.

Haunted Houses and their Story

By G. LONG, F.R.G.S.

Is this a Ghost? or just a Blemish on the Negative?

In Last Year's Christmas Number we Published an Article on how to Fake Spirit Photographs. Below we Describe some Reputed "Haunted Houses."

Here is another "Ghost" photograph. The "Ghost," however, is due to a fake!

IT is a strange fact that a wide-spread belief in spooks persists in this scientific age, and fresh apparitions are constantly being reported in our daily papers. The writer has long been interested in the subject, and during the last quarter of a century has visited a very large number of real or reputed "Haunted Houses," some of them within a few days, or even hours, of the time when an apparition had been seen.

Interviews with many of those who had actually seen or heard the ghost have convinced me that most of them were honest and truthful persons who really believed that something supernormal had happened.

Folland Churchyard, Cornwall. This place was long dreaded as the scene of ghostly happenings.

Ghost Invented

I fancy however that in a very few instances the ghost had been boldly invented for publicity purposes, either to attract interest to a house, or to get one's name in the papers. During the last decade I have found two instances which I am certain were fakes of this kind, but in spite of this I am certainly NOT prepared to say that *nothing* of a supernormal character has *ever* happened. I have myself seen the ruins, or visited the sites, of half a dozen ancient manors, which had been deliberately allowed to fall into decay because nobody would live in them, even if rent free. Some of the cases which I have investigated seem inexplicable if the witnesses were telling the whole truth. At the same time we recall Mr. Maskelyne's famous challenge to the spiritualists, to the effect that he would undertake *to produce by trickery, any* supernatural (?) phenomenon effected by any medium. It is undoubtedly true that a large number of mediums have been caught out by investigator's in the perpretation of the most bare-faced fraud. It is only fair to say that the spiritualists usually denounce and expel mediums detected in trickery, but I fancy some groups have been slow to believe that fraud has been used. It is not safe however to declare that all mediums are fraudulent, since phenomena have occasionally been seen which have baffled the most expert scientific investigators, and the same remarks apply to some well-known cases of haunted houses.

Practical Jokers

There can be no question that a considerable number of hauntings were the result of natural causes, or to the deliberate action of practical jokers.

I have been impressed by the fact that a certain number of remarkable hauntings occurred between 1750 and 1840 (that is during a period when smuggling gangs were very active round our coasts, and even far inland) and the scene of such events was not infrequently an isolated building not far from the sea, that is an ideal spot for the storage of contraband goods. Various methods were used by the smugglers to terrify the people, so that they would not come near places where the "Free Traders" were working.

One clever dodge was the headless horse, complete with rider, also minus his top-section.

A *black* horse was whitewashed, with the exception of his head and neck, and the rider wore white clothing but covered his head and face with a close-fitting mask of dead black. On a dark night the effect was that of a headless horse and rider galloping along the roads.

The Drummer of Hurstmonceaux

The Drummer of Hurstmonceaux was long the terror of that pleasant Sussex village. The ruined castle, and the adjacent churchyard were formerly used by smugglers to conceal contraband spirits; and when they were working, the lanes in the vicinity were patrolled by a ghostly drummer, whose tap-tapping in the darkness terrified the simple country people, some of whom believed that to meet the apparition face to face meant death within a year. Those who dared peep through their window blinds saw a tall white figure, whose features glowed with an unearthly radiance—phosphorus no doubt. The few, who—bolder still—dared to approach the demon drummer, sustained sundry bruises from the smugglers, and quickly decided it would be wise to go away.

The lonely little churchyard at Talland, perched high above the sea on a lonely stretch of Cornish coast, was long dreaded as the scene of ghostly happenings. Terrified villagers declared that the place was often visited by an infernal crew, and the few who had ventured near spoke with bated breath of the grisly figures they had seen flitting among the tombs, while horrible shrieks and demoniacal laughter was heard far away. This was of course all acting by smugglers.

The "Ghost House"

One of the most remarkable unexplained instances of haunting occurred at Sampford Peverell, in Devonshire, in an old building which is still known as the "Ghost House." I obtained my information about this from an old book in the British Museum, which was published more than a century ago, by the Vicar of the Parish, who himself offered a reward of £100 for a solution of the mystery, while the owner of the house promised a further £250.

The "hauntings" continued for a period of twenty years, from 1810, and were seen and heard by scores of people. The manifestations were of the "poltergeist" kind, that is noises were heard, and things were thrown about, but no apparition was seen. There have been many cases of this kind, and some of them have been proved to be the work of practical jokers, and such should always be suspected in cases of this kind. At first the trouble was confined to noises which were heard chiefly by night, but sometimes by day. Bangs and knocks were constantly heard, with loud footsteps; but presently objects were thrown about, bed curtains were shaken, or even torn down, and a heavy Bible was flung across the room, carrying with it an officer's sword which had been placed on it. The Vicar states that on one occasion he heard two hundred blows, like a strong man hitting a bed with all his strength. Sometimes the blows struck *people*. There were six women servants sleeping in this large rambling old house, and they were constantly attacked and beaten by invisible hands until they were badly bruised. There was one attack upon two of them which I think affords a clue to the mystery. Mary Dennis and Sally Case were lying in bed together when they were both violently pummelled by a clearly seen hand and arm, *to which no body was attached*.

I have myself visited the place, and have also corresponded with a lady who lived in the house as a child, and who knew much about the hauntings, which had happened not long before her father went to live there.

Hollow Walls

I am told the walls are hollow, forming a passage wide enough for a man to walk through. Smugglers were very active in the West Country in the first quarter of the nineteenth century—when these things happened—and it is suggested that they had been in the habit of using the house for contraband, and that the noises were caused by their moving through the inner walls to perhaps some hidden store-house. It is certainly remarkable that though *men* slept in the house as well as women, no man was ever punched while lying in bed. He might have had the *courage* to grab the arm, and the *strength* to retain his hold, till help arrived! The blows from a visible hand and arm, having no body, provide a precious clue. A well-known trick of dishonest mediums, produces the illusion of a hand and arm attached to no body. The trickster is entirely clothed in black, with a black mask over his head and face, with small holes for the eyes. The hand and arm are bare to the elbow and (to-day) are rubbed with powdered luminous paint. This gives the effect of a spectral hand and arm, glowing in the dark; but an almost equally eerie apparition would be caused by rubbing the limb with *flour*, and plenty was available since at that time the house was used as a baker's shop, as it is to this day.

Tricks of Mediums

Some of the tricks of dishonest mediums are worth describing, and a jolly evening could be spent in organising a trick séance.

Remember first of all that on no account must light be permitted, and your audience are required to hold hands round a table, and to promise not to release their hold—then they cannot grab the spook.

The most important item in the crook spiritualist's stock-in-trade, is a supply of WHITE NET. This can be obtained from certain theatrical supply stores. It is the finest and thinnest material made, and can be compressed into such a small compass, that a costume large enough to clothe an

Hurstmonceaux Church, the lanes in the vicinity of which were controlled by a ghostly drummer.

adult from head to foot can be hidden in the waistcoat pocket, or crammed into a hollow

Ghost House, Sampford Peverell.

boot-heel, or dummy watch. Let us suppose our amateur medium has entered the

The white lady of Stanton Harcourt.

séance room secretly, either by means of a hidden trap-door, or by manipulating the ropes which are supposed to bind him in the cabinet. He wears black from head to foot, with a black mask over his face and dark rubber shoes. This means that he can move through a darkened room silently, and unseen. If there is any risk that his movements may be heard, the audience are requested to sing a hymn.

A Luminous "Spirit"

Concealed in his clenched fist is the net robe. He opens his hand and lets a bit of it fall on the floor. It is visible as a growing spot of light, and as he allows more to pass and spreads it out, the effect of an infant is given, which soon grows into a child, and finally becomes an adult woman moving about the room. The "spirit" thus materialised, can be readily "de-materialised" by reversing the process.

If his hand and arm have been rubbed with luminous paint, or even flour, the effect of a slowly materialising spectral hand can be given by covering the limb with a black silk tube—like a stocking with an open end. The tube is pulled up with the other hand, and the luminous fingers first appear, then as the black stuff is moved up, the hand and arm become visible. They can be made to vanish in the same way.

A gloriously grisly spectral hand effect is produced as follows: Get an ordinary kid glove, stuff it full of cotton-wool, and dip it in cold water, shake off the drops, and tie a loop of string to it. It is then extended at the end of one of the trick rods which conjurers use, and passed over the heads of the audience. As it goes along it touches here a face, there an ear, and next the top of a bald head.

Trick Rods

These trick rods have a small hook at one end, and are made in two patterns. There is the telescopic type, in which a rod about the size of a fountain pen can be pulled out in sections, and the lazy tongs pattern, which is too well known to require description.

These are essential items of business for any amateur wishing to produce spook effects. If you are tied in your cabinet and cannot get out, these rods can be pushed through, and various objects with them. Thus a trick guitar, or other musical instrument, can pass over the heads of the audience, playing all the time, since it has a musical box in its tummy. Spooks of various shapes and sizes can be compounded of net, and moved through the air at the end of these useful trick rods.

Professional mediums are always tied with ropes or cords, the knots being sometimes sealed. There are various methods, known to every conjurer, of getting out of bonds, but they are too complicated to explain without elaborate illustrations.

The hints I have given however contain suggestions for an amusing evening.

BUILDING A MODEL AUTOGIRO

By S. R. Crow

How to Construct and Fly a Replica of the Model Autogiro which Holds both H.L. and R.O.G. Records (British) and also Won the S.M.A.E. Autogiro Contest, 1936

A view of the finished model.

THE model described in the following article is the latest product of a long line of previous model autogiros built by the author. It was designed especially to compete in the S.M.A.E. competitions for model autogiros, and has, with the exception of a few minor faults, been a very consistent flier. Previous to the S.M.A.E. contest it raised both the R.O.G. and H.L. records to 39·5 seconds R.O.G. and 49·4 H.L. Although the duration is reasonable for this type of model, the author is convinced that further development will be made which will place the model autogiro more in line with the duration of the average fixed wing craft. The high lift qualities of the rotating aerofoils give the model a climbing angle far steeper than that of the monoplane machine, which, if it were to attempt such a climb, would stall. The model rarely stalls, as the rotating blades take the full weight of the model, and adjust their rotational speed to allow the model to sink slowly vertically. It is constructed throughout in the simplest way (a point well worth considering when building model aircraft), and can be built by even the newest recruit to the ever growing ranks of aero-modellers. It is necessary to obtain a full size blueprint (obtainable from Geo. Newnes Ltd., 8–11 Southampton Street, Strand, price 1*s*.), as the model is built *on the drawing*. To preserve the drawing, cover it with a sheet of the thinnest grease-proof paper, which on getting stuck to the balsa framework increases the strength of the joints with very little addition in weight.

Fuselage

It is suggested that this be built of $\frac{3}{32}$-in. square, not $\frac{1}{16}$-in. square as original model.

Cut four longerons of hard balsa $\frac{1}{16}$-in. or $\frac{3}{32}$-in. square, allowing about 2 in. excess at each end. Follow this by cutting from the side elevation two spacers off each. Take two of the longerons, and with pins to hold them in position, bend them to shape along the top and bottom of the fuselage (side elevation). The spacer can now be cemented in. You now have one side of the fuselage finished, which can be taken up when dry. Repeat this process for the other side of the fuselage. Whilst this is setting, cut the spacers for the top and bottom of the fuselage.

By using weights and boxes to prop up the two sides, cement spacers A and B in position, which, on drying will enable the spacers on either side to be fixed easily. You now have a fairly rigid frame, and by bending in the front and rear of the fuselage to plan shape, cement in the rest of the spacers, working outwards from A—B. Look at the fuselage from the front before letting it set to make sure it is square.

Tailplane

A strip of $\frac{3}{8} \times \frac{1}{16}$-in. balsa, tapered as shown on the drawing for the trailing edge, and a $\frac{1}{8}$-in. square balsa leading edge are laid down and the ribs cemented in. Sand off the leading and trailing edges when all is set. The upturned tips are of very thin bamboo, circular in section, bent in steam. By pointing the ends of the bamboo it can be pushed into the balsa and then given a touch of cement.

The Fin

By placing three 1-ft. lengths $\frac{1}{16}$-in. square medium hard balsa in boiling water for ten minutes, and with the aid of many pins at the bends, the outline of the fin is made. Care must be taken with this as balsa is more difficult to bend than bamboo. Thin bamboo is used for the main bend, this also can be pressed into $\frac{1}{16}$-in. square balsa and cemented. The fin is now cemented to fuselage and strengthened by $\frac{1}{16}$-in. and $\frac{1}{8}$-in. balsa uprights.

MATERIALS REQUIRED

- 6 lengths of $\frac{3}{32}$-in. square Balsa (or if being built as original, 10 lengths of $\frac{1}{16}$-in. square).
- 4 lengths of $\frac{1}{16}$-in. square Balsa (hard).
- 1 block $\frac{1}{16}$-in. Balsa (soft).
- 1 4-ft. length $\frac{1}{16}$-in. square Spruce.
- 2 brass Bushes, 1 20 S.W.G., 1 18 S.W.G.
- 1 coil 18 S.W.G. Piano Wire.
- 1 coil 20 S.W.G. Piano Wire.
- 1 tin Dope.
- Small piece Plywood 1 mm.
- Length Bamboo.
- 1 dozen Cup Washers.
- 1 length $\frac{1}{8} \times \frac{1}{8}$-in. Balsa.
- 1 block Balsa $9\frac{1}{2} \times 1 \times \frac{1}{2}$-in. (medium hard).
- 6-in. Celluloid Tubing to take 20 Gauge Wire.
- Small block Balsa for nose block.
- 4 sheets Tissue (coloured, improves look of model).
- 1 tube Aeroglue.

Undercarriage

Study the detail drawing before commencing this. A strip of crisp notepaper is firmly rolled round the oval bamboo legs ($\frac{1}{8} \times \frac{1}{16}$ in. tapering to $\frac{1}{16} \times \frac{1}{16}$ in.), a touch of cement being added to keep the tube in shape. The required angle to give the correct undercarriage track is obtained by cementing a balsa fillit in between the bent tube (see drawing). The legs may now be withdrawn from the paper tubes (this type of undercarriage is a boon when transporting the model), and the paper tubes cemented and reinforced to the fuselage, binding lightly with thread. 20 S.W.G. piano wire is shaped and bound to the bamboo legs (add a touch of cement) as axles to take the wheels, the latter being $\frac{1}{8}$ in. thick (two layers of $\frac{1}{16}$-in. balsa) bushed with celluloid tubing. A disc of $\frac{1}{32}$-in. balsa is cemented to the end of each axle.

Rotor Pylon

Make two sides of the pylon from the drawing, in the sections shown, as the direction of the grain is important. Two short lengths of $\frac{1}{16}$-in. square spruce (see plan) are used for the spars across the rotor pylon base. Cement them in holes made to take them, clipping an elastic band round the pylon top until the cement is set. Wire hooks are now cemented to the four corners to enable the pylon to be clipped on the fuselage with elastic bands. 20 S.W.G. piano wire is used for the rotor axle; it is essential to cement latter at the correct angle although final adjustments can be made when trimming by means of balsa blocks under the pylon.

Rotor Blades

A template made of metal or plywood is cut to the aerofoil section given, and from this cut sufficient ribs from $\frac{1}{16}$-in. balsa. It has been found essential, through experiments, to keep the weight of the rotor blades down to a minimum, as this increases the rotational speed. Build three blades from the drawing in the following manner. The main spar of $\frac{1}{16}$-in. square spruce is laid down and held firmly by drawing pins. A touch of cement is then given to the spar, the ribs being placed on as each blob is made. The leading and trailing edges are $\frac{1}{16}$-in. square balsa. A thin bamboo strip is utilised for the curved rotor tip, this absorbing any shock made through bad landing.

The constructor will notice that the ribs are not evenly spaced, a fact which adds considerably to the rotational speed.

Rotor Hub

A small disc of 1 mm. plywood is bushed with a cut down brass bush of 18 S.W.G., and beneath this are cemented the rotor spars. This must be done on the drawing as the correct 120 degrees is given. Overlap the trailing edge slightly (see drawing), cementing also, to give a small negative angle to the blades at the centres. More negative can be steamed into the blade tip later.

Nose Block and Propeller

The nose block is made from hard balsa, backed by a cemented piece of $\frac{1}{8}$-in. balsa, the latter plugging into the fuselage. Drill a hole through the block and cement in the 18 S.W.G. brass bush. Through this pass the prop shaft which is also pressed into the propeller, bent over and cemented. Do not forget to insert two cup washers between the propeller and nose block. (A free wheel is not required on the model given as the forward speed when the motor is finished is very slight.)

The model is covered with superfine tissue, and after steaming the model proceed to dope thinly; do not dope the tailplane or fin.

Assembly and Flying

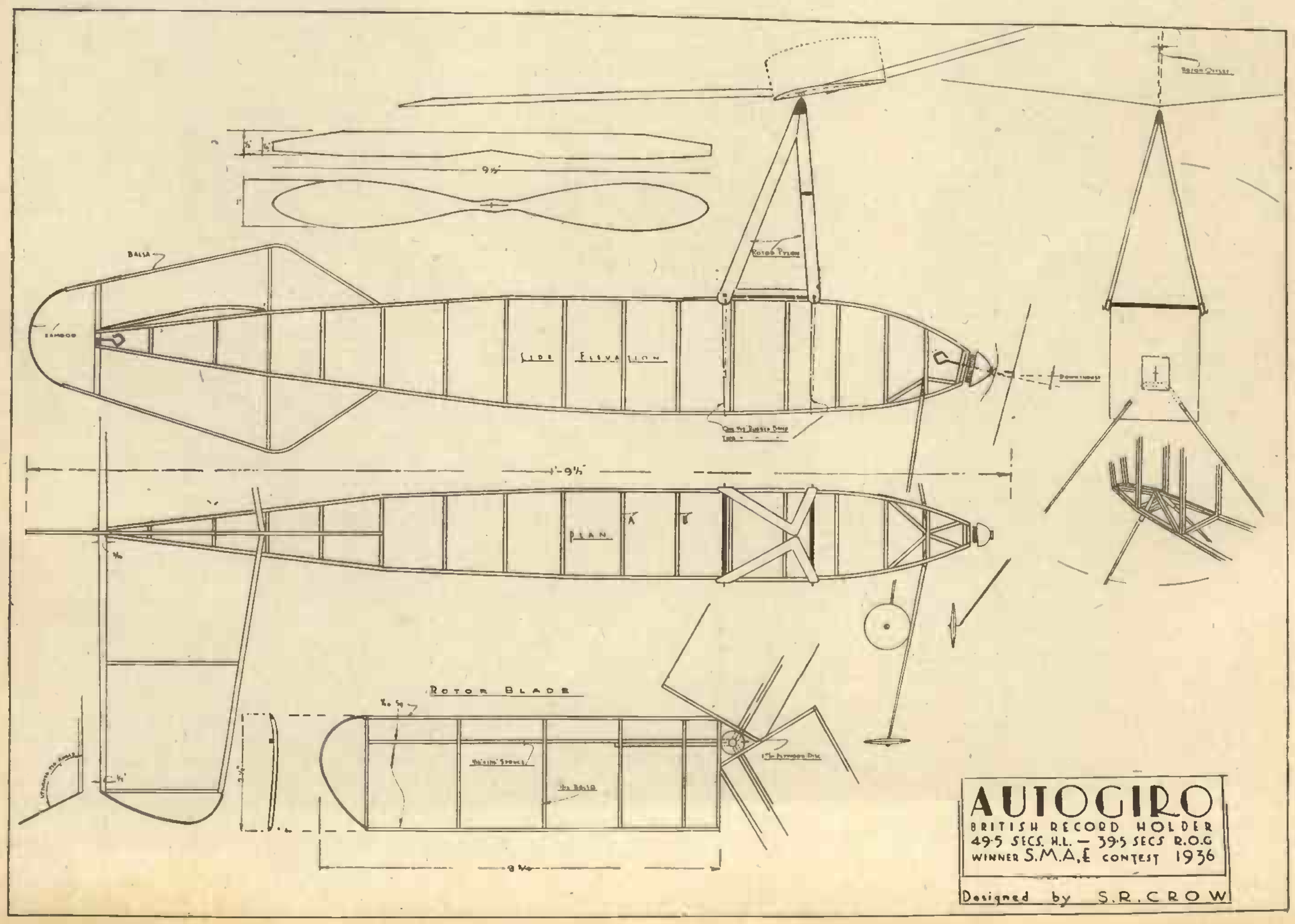
The motor is made up of two loops (four strands) of $\frac{1}{4} \times \frac{1}{32}$-in. rubber. $\frac{1}{32}$-in. rubber bands hold the pylon to the fuselage. It is advisable to put an extra band on the front of the pylon, as the rotational speed will tend to lift it up and the rotors may hit the fin. Fly the 'giro only when the wind is light. If on 200 turns the rotors tend to lose speed and the model roll in flight, try tilting up the front edge of the pylon. Should the model now climb steeply and "sit on its tail," offset the rotor disc by placing a block under the pylon (right-hand side from front). R.O.G. flights can be made by holding the propeller and rear end of the fuselage firmly; and then, by bringing the model forward and downward, rotational speed will be gained until, when the ground is touched, sufficient speed for release is gained. The model will take off with very little forward run.

Rise from Rough Surfaces

Unlike the aeroplane, the direct take-off type of autogiro can make use of fields with any kind of surface, ploughed, stony, or even marshy, and when fully developed, it will be able to jump high enough to clear any ordinary obstacles, such as small houses and trees, from a distance of only a few yards. At present, jumps of the order of 20-25 feet are being attained, but theoretically it will be possible to jump 60-100 feet without reaching prohibitive accelerations. For practical purposes, however, jumps of the order of 20 feet are likely to be all that are necessary.

I think that we can say that with the final development of the direct take-off principle, the autogiro is reaching perfection, and its practical utility will, I believe, make it the machine of the future for the private owner.

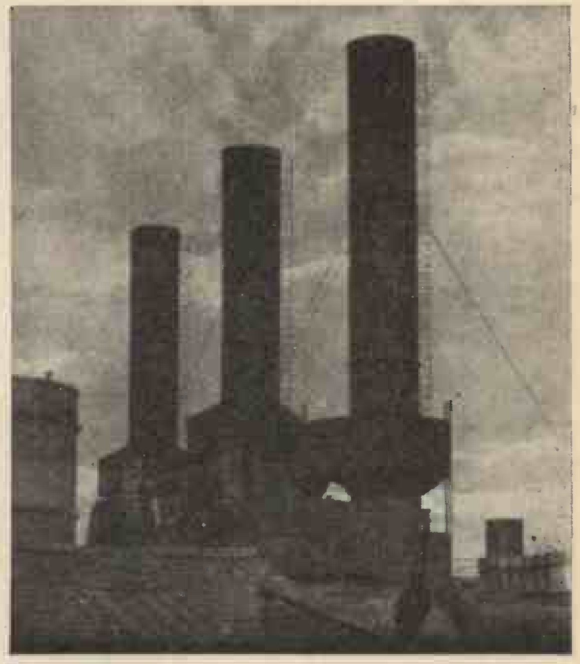
One cannot but admire the tenacity, skill, and amazing capability and forethought of Senor Juan de la Cierva. Ridiculed for years, and taken seriously by very few, he has succeeded, very nearly single-handed, in introducing a new technique of flying. More than one authority has placed Cierva's work second only to that of the Wright brothers, and indeed, one may well consider that he has accomplished more than any other to bring aviation within the reach of the private owner.—G.



POWER OF THE FUTURE

A mysterious region situated thousands of light-years out in space and photographed through a giant telescope. It is in such areas of space that nature is thought to manufacture her own energy supplies.

The Coal and Oil Resources of the World are not Unlimited. Read in this Article of the Possible Energy Supplies which may Become Available



Coal, industry's main power source, is passing. What will succeed it, only the future can tell. This illustration shows one of the latest types of coal-consuming plants for steam power production.

THE wheels of our present civilisation run chiefly upon three sources of power: the energy derived from coal, oil and water. Withdraw these power sources and civilisation, industry and most of the multifarious activities of present-day mankind would cease almost as abruptly as the note of a violin when the string breaks.

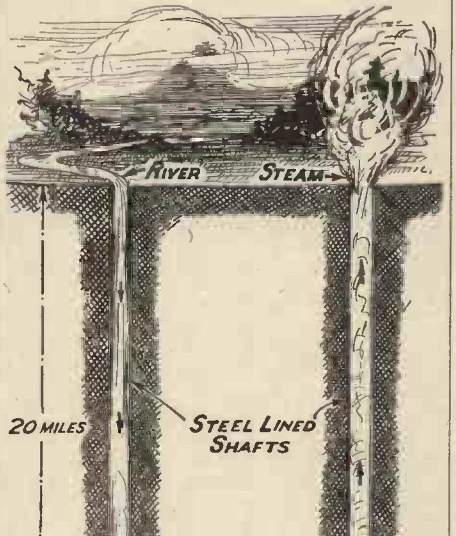
We cannot live in civilised communities without power supplies of one kind or another. Modern life, with all its comforts and conveniences and—if you like—with all its disadvantages, rests upon a basis of power. Nations vie with one another for the possession of gold, but an adequate and plentiful supply of power, of energy, is of far more importance to a civilised community than a whole mountain of gold and, fortunately for the future ages, mankind is beginning to recognise the essential truth of this fact.

Energy in Coal

Our present-day civilisation may be dated from the time, some two hundred years ago, when the energy contained in coal was utilised for the raising of steam and the obtaining of mechanical power by means of the steam engine. The steam engine held the field as almost the sole provider of power for more than a hundred years. Then came, almost together, the oil and petrol engines, the electric motor and the turbine.

Such "prime movers," as these power-providing engines are termed in mechanical parlance, do not, of course, derive energy from themselves. They have to be fed with a source of energy, just as our bodies require feeding with natural food. And so, upon consideration, we see that the power supplies of the world are, for the most part, contained in coal, oil and water. Coal raises steam in boilers, oil provides the fuel for internal-combustion engines, whilst water power—the force of falling water—is employed to drive dynamos and so to produce electrical energy.

Water power is pure gain on the energy balance-sheet of civilisation. All other present-day practical supplies of energy represent increasing loss. Day by day, the world's resources of coal and oil grow less and less. There is, indeed, no doubt that a time will come when it will no longer pay to delve deep into the earth to bring up that increasingly scarce mineral, coal, or to sink deeper shafts up which to pump the last of Nature's oil stores.



A method for obtaining power supplies for a future age. Two inter-connected steel-lined shafts are bored in the earth to a depth of 20 miles. A river is turned down one of them, and re-appears as steam up the parallel shaft.

Solving a Problem

None of us living at present will see such a time. In spite of this fact, however, it is interesting to conjecture the attempts which, before that period arrives, will have been made to solve the problem of the increasing scarcity of the world's power resources.

Water power—the power of waterfalls and cascades—will always be with us. The Irish Free State at the present day, by means of its gigantic water-power electric generating station near the mouth of the Shannon, generates sufficient electrical current to supply the entire county with energy. The harnessing of the Falls of Niagara for the provision of electrical energy has long been accomplished, whilst the production of electrical power by means of hydro-electric stations operated by the mountain torrents of Norway is, also, a well-known feat. Such power stations will, so far as one can see, serve the needs of the surrounding communities for quite an indefinite period.

Many countries of the world—England among them—are more or less without water power and it is such countries that will suffer the most when the supplies of coal and oil begin to fail. True it is that by that time we may have discovered practical methods of transmitting large quantities of energy half-way across the earth by radio. Nevertheless, it seems unlikely that, even assuming this condition, there will be found sufficient water power on the earth to provide the entire planet with energy. Additional sources of power will, therefore, have to be sought and, as coal and oil become increasingly scarce, the search for fresh power sources will become more and more urgent.

Potatoes, corn, beet and other planet products have been suggested as future sources of energy, for from such materials power alcohol can be fermented. It is doubtful, however, whether sufficient tracts of country could ever be devoted to the growing of such products in quantities large enough to supply even a tithe of the world's power requirements.

"What about acetylene?" say other scientific prophets. "Acetylene can be converted into alcohol and from alcohol motive power may be obtained."

Acetylene, however, requires to be made. It is produced most cheaply from the interaction of calcium carbide and water. But, in order to manufacture calcium carbide, we have to fuse together lime and coke in an electric furnace, a process which would not only require the provision of increasing quantities of that increasingly scarce commodity, coke, but which, also, necessitates the expenditure of much electrical power in heating up the furnaces. Thus it is that the acetylene-alcohol source of power proposition which has been put forward by would-be seers into the future is quite an inadmissible one.

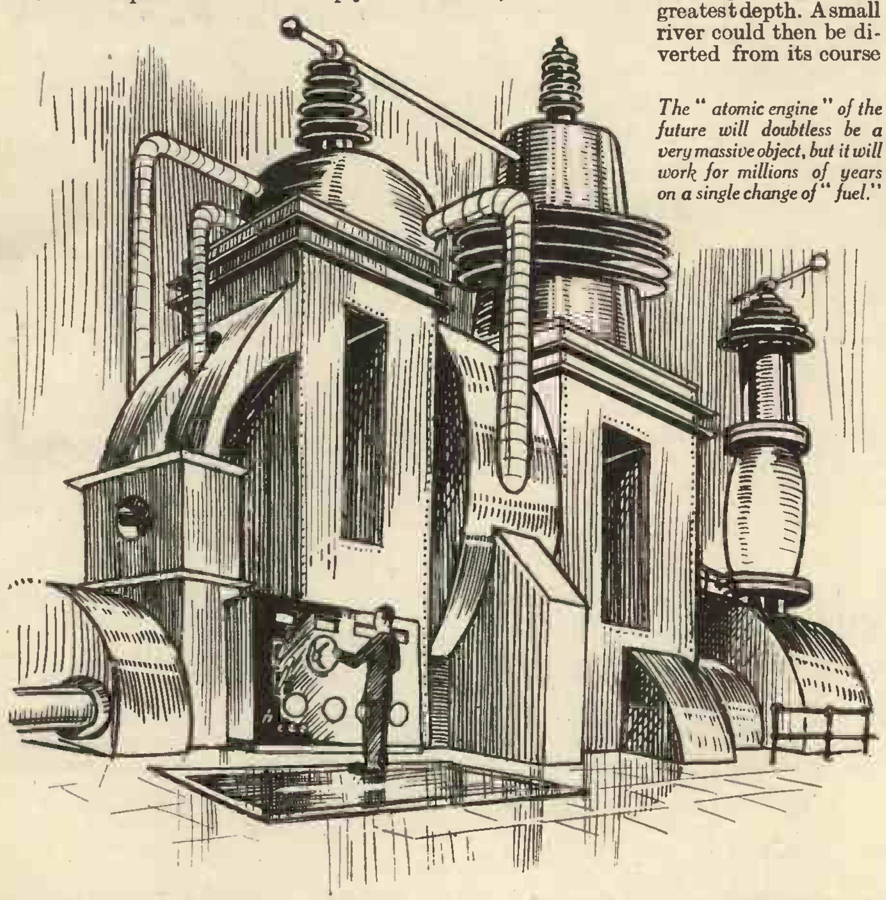
Of wind power, sun power and tide power, we shall say little or nothing, for such power sources have been tried out in times past and, for the most part, have been found sadly wanting. True it is, of course, that some future genius might find out a method of utilising the radiated energy of the sun, but even if such a discovery were made the practical result would be of little importance, for it can be proved that the energy radiated by the sun is only about a horse-power for every three thousand tons of its weight.

Devising Machines

Many attempts have been made to devise machines capable of supplying energy in virtue of tidal power, but, up to now, such efforts have been unsatisfactory, inadequate and impracticable and have invariably yielded much disappointment.

A very possible method of obtaining energy would consist of drilling a hole in the earth and in pouring water down it. The water would come back in the form of steam, which could be utilised to work steam engines, turbines, etc.

In actual practice, what would have to be done would be to sink two approximately parallel steel-lined shafts some twenty miles down into the earth and, by some means or other, to connect them together at their greatest depth. A small river could then be diverted from its course and made to fall down one of the shafts. In virtue of the intense heat of the earth's crust at even the comparatively slight depth of twenty miles below its surface, the water would become vaporised and would pass up the other shaft in the form of a fierce steam blast.



The "atomic engine" of the future will doubtless be a very massive object, but it will work for millions of years on a single change of "fuel."

Many difficult problems await solution before the above notion could be put into practice. Yet it is by no means an impossible scheme, and its power-producing results are pretty conclusive.

Dame Nature produces mechanical power in her animals by much more efficient methods than those adopted by Man. Our muscles, for instance, are wonderfully efficient power-producing devices. They give up supplies of controlled power with an efficiency which is relatively very great. For very few heat engines have an efficiency of more than 27 per cent., whilst an animal or a human muscle has an efficiency of more than 50 per cent. Up to the present, however, nobody has succeeded in making an artificial muscle. Perhaps, in the not distant future, such a feat may be accomplished. Such "muscle engines" will utilise certain chemical substances as their sources of fuel. They will have to be lubricated adequately, but they will not produce heat and therefore they will go on working for very long periods without wearing out.

The "Muscle Engine"

The "muscle engine," while being a very interesting possibility, does not really solve the difficulty of the world's future power supplies, for, even assuming that large-scale "muscle engines" worked by artificial muscles could be set up, they would still require feeding with some form of energy from without.

Without discussing the matter at undue length, it may be remarked that the ultimate sources of the world's energy are but two in number. They are (*a*) the Energy of Heat of Uniform Temperature and (*b*) Atomic Energy.

Both forms of energy are at present beyond the utilisation of man and, probably enough, the first energy source mentioned above will for ever be unattainable.

Consider what is meant by the "Energy of Heat of Uniform Temperature." You strop your razor on a leather strop. The leather becomes warm, due to the conversion of mechanical energy into heat energy. After a few minutes, the strop returns to its normal temperature, the heat energy having flowed into its surroundings and having become inextricably mingled with the heat energy of the latter.

The whole earth is at a more or less uniform temperature. When we perform any action which generates heat, the waste heat energy mingles with the extremely large reservoir of the earth's heat energy and becomes for evermore unattainable.

Heat Energy

If it were possible to abstract quantities of heat energy out of this vast sea of "heat energy of uniform temperature," to make use of it to derive mechanical power from and then to return it again into the reservoir of heat energy from whence it came, the world's power problems would immediately be solved once and for all.

A ship travelling across the Atlantic and equipped with a series of such ideal heat engines would extract a quantity of heat from the ocean as it went along. It would make use of the heat energy for power-production purposes and then return the unwanted heat energy to the ocean again.

Unfortunately, an engine operating upon such a principle will for ever be impossible. It is contrary to the laws of Nature for heat energy to be picked up from a sea or reservoir of such energy and transformed into useful work. The entire subject is, of course, an abstruse one, but the statement above made is what it all boils down to.

The Atomic Engine

The atomic engine of the future will probably be enormously massive in construction, weighing, perhaps, a few tons. It will have a very low power output, but its great advantage will be that it will go on working for several million years on a single charge of sand, soil or some other form of coarse matter.

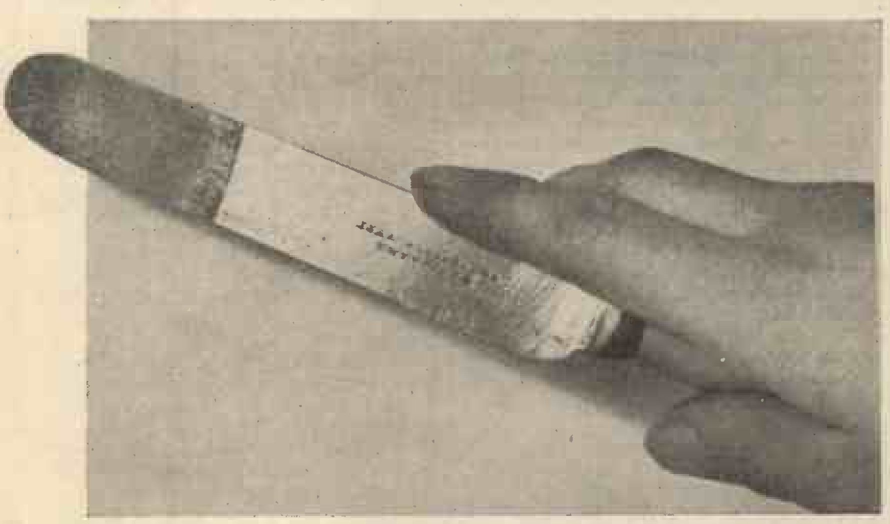
There is always the chance that some genius of science may one day come along with a practical method of tapping sources of power existent in other worlds.

Plating Metals Without Electricity

How to Obtain a Range of "Non-electrical" Metal-platings with the Simplest Apparatus and Materials

ON a commercial scale, nearly all metals are electrically deposited for plating purposes, since not only do electro-plating methods lend themselves very readily to large-scale operation, but, also, because electro-plated metals are more durable than are metals which are deposited non-electrically.

Despite the acknowledged superiority of electrically plated metals, there is no reason why the individual amateur should not try his hand at plating metals non-electrically. Quite a number of metals can be plated successfully by chemical means alone and, apart from the interest attached to such processes, these purely chemical methods of plating can sometimes serve a useful purpose for small-scale work.



The end of this knife blade has been copper-plated by means of the simple process described in this article.

Simple Method of Plating

The very simplest chemical plating consists in the deposition of a layer of copper on an iron or steel article which is immersed in a bath of copper sulphate solution. The steel or iron article must be scrupulously clean and, preferably, its surface should be bright and polished. Do not have the copper sulphate solution too strong. A moderately weak solution is sufficient, for the copper deposited from such a solution will adhere much better to the steel object.

Some consider that more effective copper-plating may be attained by immersing the iron or steel article in a bath consisting of equal volumes of moderately weak solutions of copper sulphate and cream of tartar. This bath precipitates the copper in a more golden-coloured form, but it does not work any better than the former simpler bath.

Zinc articles can be copper-plated in the following manner:

Mix equal volumes of fairly weak solutions of copper sulphate and sal ammoniac (ammonium chloride)—the exact strength of the solutions, as in most of these chemical plating liquids, is immaterial. Clean and polish the zinc surface and then brush the above solution over it with a soft brush. A fine film of copper will be deposited upon the zinc. Do not use too much of the solution, otherwise the copper deposit will become flaky and drop off.

Imitation Silvering

What we may term "imitation silvering" is very easily accomplished. There are two good methods of effecting this result, both of which are very easy to apply. The first of these we will call the "dry method." It gives on copper, brass, iron, steel and other metals a very fine silvery film, which, in the case of copper and brass, may be deposited so thinly that it only just modifies the characteristic colour of the underlying metal.

To carry out this "silvering" method, adopt the following procedure. Place a globule of mercury about the size of a pea in a mortar or other suitable grinding vessel and add, also, two teaspoonfuls of powdered chalk. Grind the chalk and the mercury together. After about half an hour's grinding, the mercury will have entirely disappeared and the chalk will have acquired a grey colour. We have now prepared the well-known *Hydrargyrum cum Creta* (Mercury-with-Chalk), or "Grey Powder," of the pharmacist, and it is this readily although somewhat tediously prepared material which constitutes our "dry silvering" powder.

Making a mercury "silvering" solution. A small quantity of mercury and 4 or 5 times its volume of nitric acid are warmed up in a test tube.

Moisten the end of a soft rag with a little methylated spirit and then take upon the moistened area of rag a quantity of the "grey powder." Rub this over the *clean* surface of the article to be silvered. Within a few seconds, a thin shimmering silvery film will form on the metal surface, which film can be thickened by continuing the rubbing with a further quantity of the powder.

The "Wet" Method

The "wet" method of imitation silvering consists in dissolving a few globules of mercury in *strong* nitric acid, using about five times as much acid as mercury. When the mercury has all dissolved, add to the solution three times its volume of water and bottle for use. This "silvering liquid," when rubbed over the surface of clean copper, zinc, brass, iron and other metals, will almost immediately deposit a brilliant silvery film of considerable thickness. Only a small quantity of the liquid need be used and thus it need not be made in large amount. Bear in mind the fact that the liquid is *poisonous* and, therefore, that it should be kept under responsible control.

The "silver" film obtained by the above methods is, of course, a film of metallic mercury. While being a very brilliant film and a closely adherent one, it is, unfortunately, not a permanent one. A little of the deposited mercury sinks into the body of the underlying metal, but the majority of the mercury deposit actually evaporates off the metal surface, leaving the

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latter, after the elapse of about two days, in its original unsilvered condition. If, however, we place a very light layer of varnish over the "silvered" metal, the evaporation of the mercury will be stopped and the "silvering" will be more or less permanent. Spirit or celluloid varnish is suitable for this purpose, but it must be perfectly clear and very thin, otherwise it will dull the silvery surface very considerably.

Another silvering solution may be made by dissolving mercury in nitric acid according to the instructions given above, but, instead of diluting it with water, by adding to it an equal volume of a 5 per cent. solution of silver nitrate. This solution, when rubbed over metal surfaces, will deposit an amalgam of mercury and silver, and thus the deposited metal film will be more truly in the nature of a real silver film.

Aluminium Articles

Liquids or powders containing mercury should not be allowed to come into contact with aluminium articles. If they do, the aluminium article will be ruined, for the mercury will attack the aluminium, causing it to undergo a very peculiar species of rapid oxidation. It is, indeed, possible to "burn" a hole in a thin sheet of aluminium by dropping one of the above mercury solutions on to it.

The real silvering of metals can be accomplished non-electrically and without much trouble and, in this case, the chemical-plated silver film is more or less permanent.

Dissolve a few unwanted pieces of scrap silver in the minimum amount of warm, moderately dilute nitric acid and, after all the metal has dissolved, add to the solution about an equal bulk of a strong solution of common salt. This will precipitate white silver chloride. The latter is filtered off, dried in a warm oven and bottled for use.

From the above we can make a rubbing paste which, when rubbed over the surface of copper, brass and other articles, will deposit a film of pure silver. The rubbing paste is composed of 1 part of silver chloride, 2 parts of cream of tartar, 2 parts of common salt and sufficient water to make the ingredients up into a thickish paste.

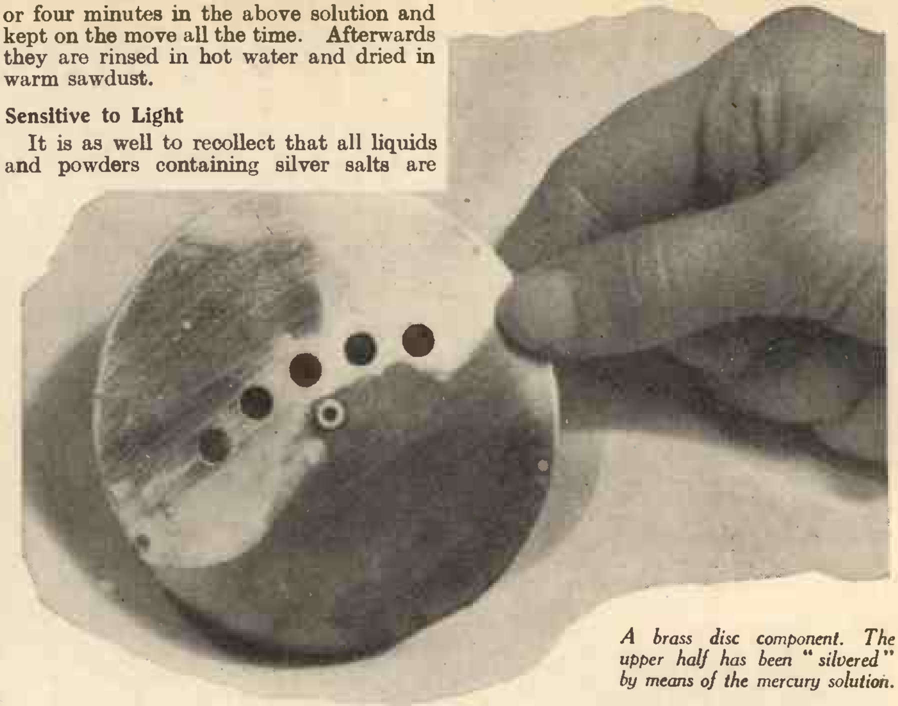
The following liquid will also deposit pure silver on metal objects which are immersed in it:

Silver nitrate	3 parts
Caustic soda	3 parts
Water	10-12 parts

The metal articles are immersed for three or four minutes in the above solution and kept on the move all the time. Afterwards they are rinsed in hot water and dried in warm sawdust.

Sensitive to Light

It is as well to recollect that all liquids and powders containing silver salts are sensitive to light. It is best, therefore, to carry out all work with them in artificial light and, also, to store such preparations in amber-coloured bottles which are kept in the dark. Do not allow silver solutions to come into contact with the skin *in daylight*, otherwise almost indelible black stains will be produced.



A brass disc component. The upper half has been "silvered" by means of the mercury solution.

Non-electrical gold-plating is, naturally, an expensive procedure these days, but provided one can obtain a small scrap of gold, such a process can be carried out very easily.

Dissolve a tiny scrap of gold in a mixture of two parts of concentrated hydrochloric acid and one part of concentrated nitric acid, using as little of the acid mixture as possible. This acid mixture is known as *aqua regia*—"Royal Water," the name having been applied to it for centuries on account of its property of dissolving the "Royal Metal," gold.

When the gold has dissolved, add a few crystals of green iron sulphate (ferrous sulphate) and boil the liquid. This will precipitate all the gold in the pure form as a dark brown powder, and the copper and other metals admixed with the gold will be left in solution. Filter off the precipitate and re-dissolve it in the minimum amount of *aqua regia*. A yellow solution will result. This is a solution of pure gold chloride, containing, of course, more or less excess of acids.

Now pour a little of this solution over a small piece of linen rag and afterwards burn the rag over a small saucer, carefully collecting the ash. The latter will comprise principally a mixture of finely divided metallic gold and carbon. Now take a rag moistened with water or methylated spirit, dip one end of it in the above ash and then rub it vigorously upon the polished surface of the article to be gilded. A film of metallic gold will be deposited and it will increase in brilliance with rubbing.

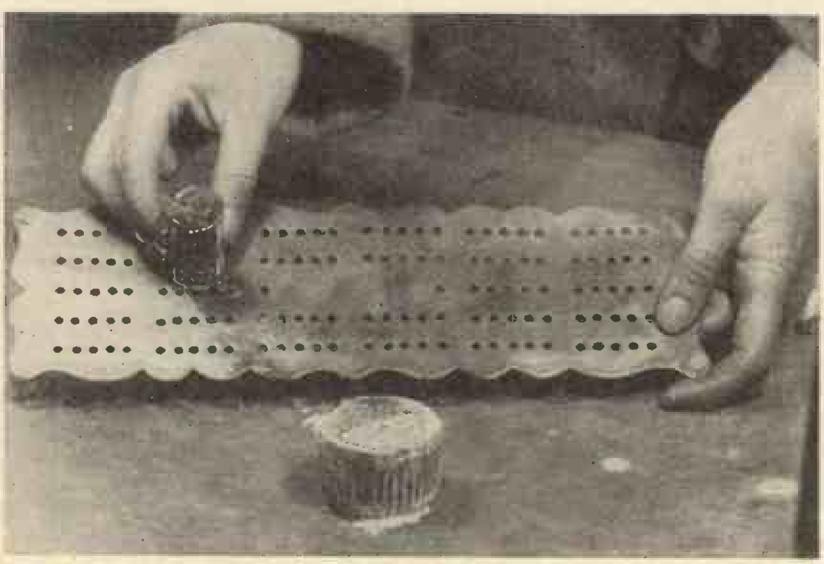
Gilding

By shaking up pure gold chloride solution with ether, an ethereal solution of gold will be obtained. This acts as a very excellent gilding solution, particularly for iron and steel articles.

It is not possible to deposit chromium by chemical methods alone, nor, for that matter, is the chemical deposition of nickel usually attended with reliable results. If, however, the amateur wishes to try his hand at non-electrical nickel-plating, he may do so as follows:

Mix equal amounts of moderately strong solutions of zinc chloride and nickel sulphate. Place one or two small pieces of clean scrap zinc in this bath and heat it to near boiling point. Now immerse in the bath the metal objects to be nickelled. After about a quarter of an hour, the reaction will be complete and the articles will be covered with a film of nickel, but usually this film tends to flake off.

A chemical brass-plating liquid can be made by dissolving in a pint of water approximately half an ounce each of stannous chloride and copper sulphate. Have the solution slightly warm, clean the iron or steel objects thoroughly and then drop them into the solution, stirring them round until they attain the colouring desired. Rinse the objects in hot water and dry them in warm sawdust.



Using plating powder. A brass article being "silvered" by means of mercury-chalk powder rubbed on its surface on the end of a cork.

Grinding the heat-indicating material through a wire sieve in the preparation of the heat-sensitive paint.

Temperature-Recording Paints and Their Preparation

How to Make a Number of Very Useful Paints and Enamels which change their Colour with Variation of Temperature

THE subject of temperature-recording paints is one concerning which very little has been written. Yet such paints are, on the whole, exceedingly efficient substances and, to the amateur chemist, their preparation is likely to afford a good deal of practical interest.

Although there is known to chemical science quite a number of different materials which change colour with variation of temperature, the only really practical heat-indicating substances are those which contain mercury. In some respects, this fact is rather an unfortunate one, for all mercury compounds are poisonous. Since, however, the paints described in this article are not soluble in water, there is little danger accruing to their preparation, provided, of course, that reasonable precautions are taken to prevent any of the paint materials from entering open cuts or similar slight wounds in the fingers and hands.

Simplest Heat-indicating Substance

The simplest heat-indicating substance which is of any practical use is mercuric oxide, a bright scarlet powder obtained by the prolonged heating of mercury in air. When it is heated to temperatures over 100°C., mercuric oxide begins to darken, and at considerably higher temperatures it turns black. If such temperatures are not exceeded and the mercuric oxide is allowed to cool down, it will reverse its colour changes, returning ultimately to its original vivid scarlet hue. If, however, the oxide is heated to too high a temperature it will split up into mercury metal and oxygen, and, of course, in such circumstances, the reverse colour changes will not take place.

Mercuric oxide, however, is not a suitable paint-making material because its colour changes take place at temperatures which would injure any varnish or oil with which it was mixed.

Mercuric Iodide

There is another compound of mercury, which forms the basis of all heat-indicating paints. This is mercuric iodide, a compound of mercury and iodine. If the individual experimenter intends to make heat-indicating paints for serious uses, he would be advised to purchase an ounce or so of this material from any firm of wholesale druggists or laboratory suppliers. It is, however, possible to make mercuric iodide in the home laboratory by grinding up in a mortar a mixture of 2·5 parts (by weight) of iodine crystals and 2 parts (by weight) of metallic mercury, these quantities being weighed out accurately. During the grinding process, the materials should be just moistened with a little methylated spirit. Very quickly, the colour of the iodine crystals will disappear and a bright scarlet powder will result. This is the necessary mercuric iodide. It may be purified by washing with water. Mercuric iodode may also be prepared by mixing approximately equal amounts of potassium iodide and mercuric chloride or mercuric nitrate solutions, the precipitated mercuric iodide being subsequently washed and dried.

When mercuric iodide is heated to 126° Centigrade it suddenly changes from a vivid scarlet to a lemon yellow, the colour change being a very striking one. Unfortunately, however, the reverse colour change (*i.e.* from yellow to scarlet) proceeds very slowly after the mercuric iodide has cooled down and may, in fact, be a matter of weeks, provided that the iodide is not disturbed in any way. This fact, therefore, precludes the use of mercuric iodide itself in the preparation of heat-indicating paints, but, before we pass on to the practical consideration of such paints, a highly interesting experiment connected with mercuric iodide and its characteristic colour change may be described.

An Experiment

Rub a little of the mercuric iodide on to a sheet of white blotting-paper so that the latter acquires a fairly uniform scarlet appearance. Now very cautiously hold the paper in front of a warm fire. The colour change of the mercuric iodide from scarlet to yellow will quickly be noticed. If, however, the now yellow paper is laid down on the table and allowed to cool, the scarlet colour will not reappear if the paper remains undisturbed. But if we take a light hammer and bring it down sharply on to the yellow surface of the paper, the latter will instantly change to scarlet around the area struck by the hammer. In the same way, if we write on the yellow paper by means of a match-stick, the characters will appear in red.

The above effects are due to the fact that the yellow form of mercuric iodide tends to remain in that state unless it is mechanically disturbed. If, however, the tiny crystals of the yellow mercuric iodide are mechanically disturbed in any way at all they instantly change back to their original red colour.

The most satisfactory heat-indicating materials for amateur use are copper mercuric iodide and silver mercuric iodide.

Copper mercuric iodide possesses the chemical formula $Cu_2I_2 \cdot 2HgI_2$. It may be purchased ready prepared from some firms of chemical suppliers or else it may be made at home by the amateur himself merely by grinding together for a few minutes a mixture of 2 parts of mercuric iodide and 1 part of copper (cuprous) iodide. The latter substance can be made by mixing together solutions of copper sulphate and potassium iodide and by washing and drying the precipitate. Such a material, however, will contain a little free iodine. Thus it is best, if possible, to purchase the cuprous iodide for the heat-indicating paint preparation.

A Bright Red Colour

Copper mercuric iodide has a bright red colour at normal temperatures. When slowly heated, it goes through the following colour changes, and on cooling it undergoes the colour changes in the reverse direction:

Up to:

55° C. (130° F.) .	Bright red.
57° C. (135° F.) .	Darker red.
63° C. (145° F.) .	Maroon.
68° C. (155° F.) .	Light chocolate.
71° C. (160° F.) .	Dark chocolate.
88° C. (190° F.) .	Very dark chocolate.
100° C. (212° F.) .	Almost black.

Pouring hot water into a pint measure on the side of which a strip of heat-sensitive paint has been placed. The colour change, indicating the hot-water level within the measure, is very plain.

It will be noted that the colour change of copper mercuric iodide begins at about the temperature of warm water and is complete at the temperature of boiling water. On no occasion should the temperature of a copper mercuric iodide paint be taken above about 130° Centigrade, otherwise it saccuracy of colour change will be destroyed permanently.

Silver mercuric iodide is a material which undergoes a reversible colour change at a lower temperature than copper mercuric iodide. Like the latter substance, silver mercuric iodide may be purchased from laboratory-supplying concerns or it may be prepared by mixing 2 parts of mercuric iodide and 1 part of silver iodide. The latter should be freshly precipitated by the addition of potassium iodide solution to silver nitrate solution and the silver iodide and mercuric iodide should be ground together in the slightly moist state and finally allow to dry without heat.

Silver mercuric iodide is a canary-yellow powder which undergoes the following reversible colour changes:

Up to:

38° C. (101° F.) .	Canary yellow.
42° C. (108° F.) .	Darker yellow.
47° C. (117° F.) .	Orange.
50° C. (122° F.) .	Orange red.
52° C. (126° F.) .	Bright red.
60° C. (140° F.) .	Vivid scarlet.

Colour-changing Properties

Unfortunately, silver mercuric iodide darkens in bright sunlight, although its original colour is restored in darkness. Its colour-change properties are, therefore, somewhat interfered with when it is used out of doors.

Paints containing silver mercuric iodide should not be taken to the temperature of boiling water and, if their sensitivity and accuracy of colour change is to be preserved over long periods of time, they should only be exposed to artificial illuminations of the ordinary variety.

The preparation of the actual paint or enamel from the heat-indicating material is a very simple matter. The heat-sensitive material (copper mercuric iodide, silver mercuric iodide, etc.) should be ground forcibly through a fine wire mesh (an ordinary tea-strainer will suffice) and finally forced through a piece of coarse muslin or butter-cloth. In this way a very fine powder will result.

This powder is then stirred into a small quantity of a clear, thin and non-acid varnish, the powder being added a little at a time. In place of ordinary paint varnish, shellac varnish may be used or any other type of spirit varnish.

The heat-sensitive material having been thoroughly incorporated with the varnish medium, the resulting paint or enamel should be stored in a small air-tight tin, in which receptacle it will keep quite indefinitely.

Heat-recording Paints

Heat-recording paints made as above will indicate the approximate temperature of any surface on which they are laid. If, for instance, we paint a vertical strip up the side of an ordinary household hot-water cylinder, the colour change of the paint strip will indicate the level of the hot water inside the cylinder.

This effect is shown clearly in the photograph on this page. Hot water is being poured into a pint measure, on the outer side of which a strip of copper mercuric iodide paint has been placed. The resulting colour change of the paint from vivid scarlet to almost black is well apparent in the photograph, and it serves to indicate the hot-water level within the pint measure.

Many applications for heat-sensitive paints of the above description will occur to individual experimenters. Such paints, for instance, may be coated around axles and other machinery parts and the ensuing colour change will indicate any undesirable heating effects at such parts.

Provided that the heat-sensitive paints are not exposed to temperatures much above those of their final colour changes, they will function accurately for quite indefinite periods, and the readiness with which their indicating colour changes are effected is not in the least influenced by the number of times such colour changes are made to occur.

Heat-sensitive paints, however, should not be placed on aluminium surface sunless the aluminium surface is first of all heavily varnished with a clear varnish and the latter allowed to harden thoroughly. Between metallic aluminium and heat-sensitive paints a chemical action takes place and the paint is slowly destroyed.

A Useful Device

If a piece of glass tube, as, for instance, an ordinary test-tube, is painted inside with a heat-recording paint and then hermetically sealed, a very useful instrument will be thus provided for estimating the temperature of water and other liquids. Such an implement can be used for cookery and other purposes, for the paint itself will not come in contact with the liquid in which the tube is immersed.

In all cases in which layers of heat-indicating paints are exposed continually to the air, the painted surfaces should be protected by means of a covering layer of clear varnish applied after the paint itself has thoroughly dried.

For readers who are of an experimental turn of mind, it may be mentioned that certain little-known compounds arising by the grinding together of mercuric iodide and thallium iodide with or without silver iodide have been shown to be heat-sensitive. Such compounds are certainly interesting, but, so far as can be ascertained, they show no advantages over the cheaper and more readily prepared copper-mercury and silver-mercury iodides.

A OO-GAUGE RAILWAY STATION

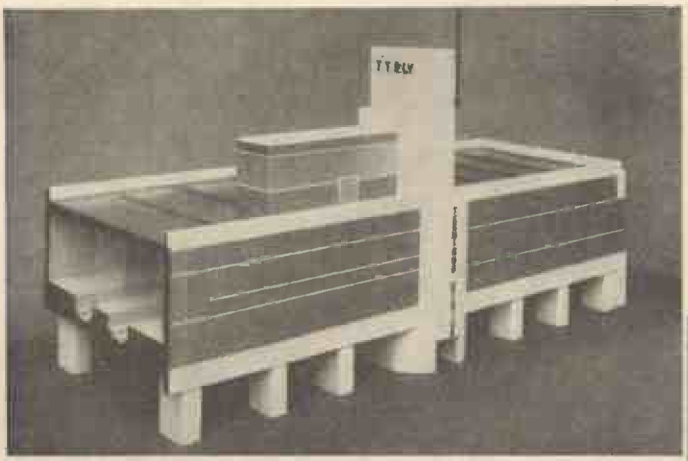


Fig. 1.—The finished station—sectioned end.

A design for a terminus for a twin-train miniature railway, with constructional details

BY E. W. TWINING

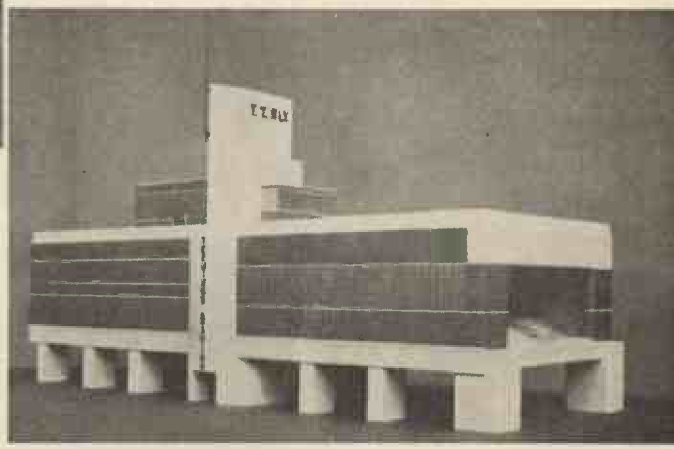


Fig. 2.—Showing the track entrance end of the finished station.

THE Station shown in the accompanying drawings and photographs for placing on a twin-train miniature railway is the result of a request which I recently received to prepare a design for a terminus for the exhibition T.T. Railway now working in the London showrooms of Messrs. Bassett-Lowke, Ltd. I was given a free hand except for restrictions as regards space available, but at the same time Mr. Bassett-Lowke told me that he would prefer "Something like that"—showing me a small photograph of a station designed and made by Mr. Roy Taylor for his railway at Stoke-on-Trent. This station which the photograph showed, although for a different track arrangement, was so much to my liking, looked so attractive, and was so modern in architectural style that I decided to follow the scheme of its design very closely, with the result here given for the benefit of anyone who cares to copy it. After my drawings were completed the model itself was made and is now at 112 High Holborn, W.C.1, where it may be inspected by those who are considering something for their own line.

Modifications if Desired

The drawings show the Station exactly as it was made for Messrs. Bassett-Lowke, Ltd., where it is used as a terminal station, but there is no reason why the reader should not, if he wishes, carry his track right through it; in which case he can lengthen the platforms and alter the proportions if necessary. It will be seen that at the left-hand end of the front elevation, Fig. 3, the walls and windows are purposely cut through, this being done in order to show that the whole of the work is not modelled. Obviously, therefore, if the Station is not placed at the end of the railway the left-hand end would require to be finished the same as the right, both ends being made as in the end elevation, Fig. 5. Whether the tower and main entrance are placed, then, in the centre of the length or to one side of the centre is a matter of taste and perhaps of the arrangement of roadways leading up to the entrance. Personally, I think that the tower would be best placed out of centre, in which case extension can be carried on to the left to any desired limit.

It will be obvious that the Station is of the elevated type. The space underneath it can be a roadway or simply used as a parking place for cars. No details of what is inside of the main entrance have been gone into, but obviously, being modern, there would be besides booking offices, book stalls, etc., elevators and/or escalators leading up to the platforms. There would further be a lift to the roof level, where the small buildings are intended to constitute a café and restaurant.

There are three platforms, the proportions of which and the distances between the centre of the two lines of track are as given in my article in the July issue, page 597. The measurements of these details are

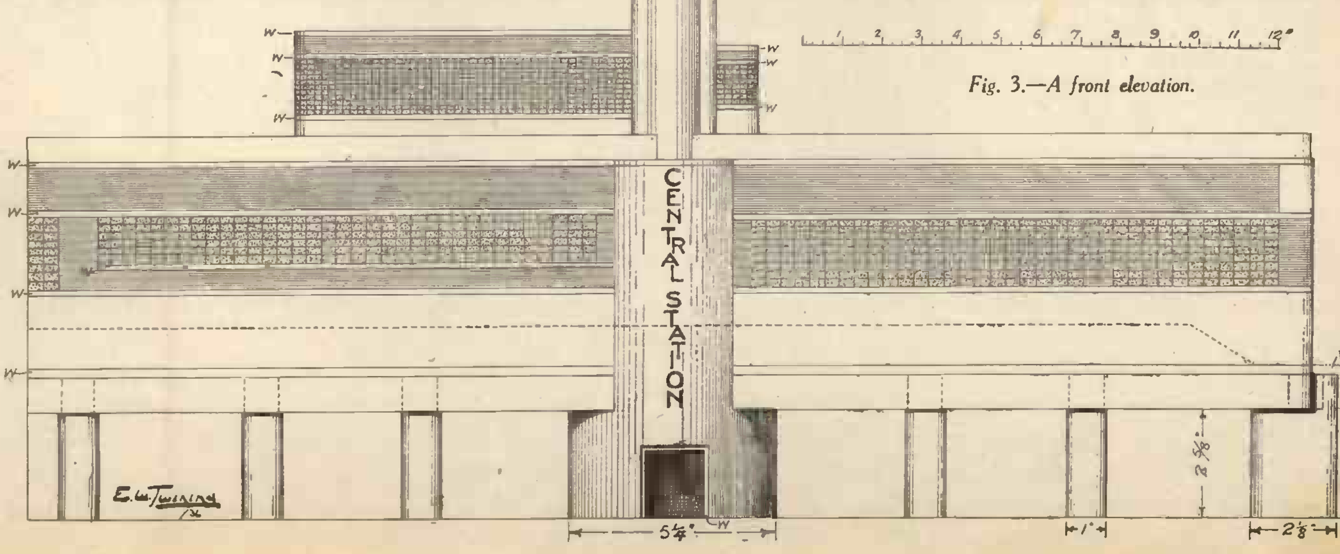


Fig. 3.—A front elevation.

repeated in Fig. 5 and a cross-section is shown in Fig. 4.

Construction and Materials

At first sight the Station may appear to be a rather difficult one to build. Actually, this is not by any means the case. It is made throughout in wood, plywood for the walls and a few odd pieces of 7/8 inch thick red deal board for piers and the central portion, including the tower. In a few cases where thicknesses exceed 7/8 inch two pieces or more of this

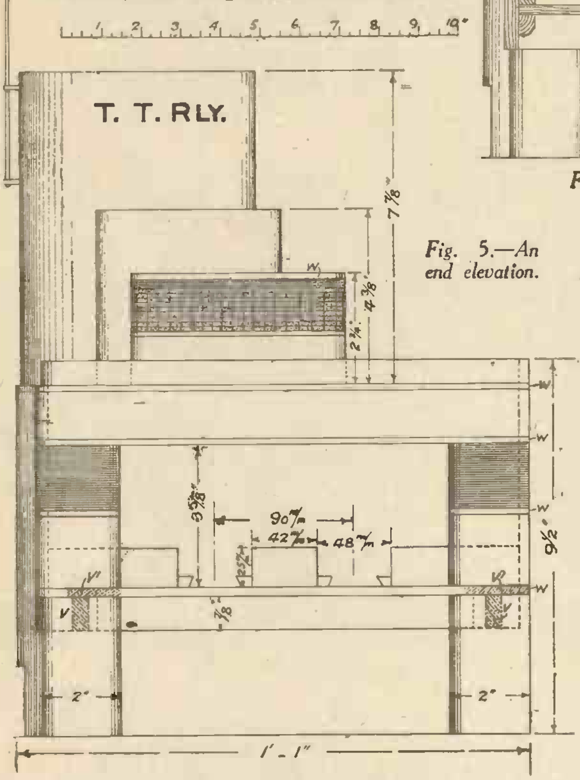


Fig. 5.—An end elevation.

deal can be glued together. The tower, for instance, can be so made of two pieces with the glued joint down the centre behind the flag mast. After glueing and clamping, the curvature in plan would be worked by planing. The vestibule will also be built up, so will the end piers, all as shown in the plan, Fig. 6.

It will be noticed that in the plan the centre tower, enclosing the vestibule underneath the tower, forms a perfect semicircle and it is suggested that this be constructed as a separate unit before fixing underneath the Station. The front portion, however, in which the entrance doorway is cut, runs up level with the roof of the Station. This roof is flat and in Messrs. Bassett-Lowke's model is covered with lead foil, which is obtainable from a wallpaper stores.

The end piers and a cross bearer between them project beyond the floor of the Station. (This bearer, by the way, ought to be tenoned into the piers.) The object of this projection is to provide a support for the shelf V1, which must serve as a viaduct to carry the railway outward from the Station. The design for this viaduct is beyond the scope of my article. I would merely suggest, however, that it should be a simple affair representing concrete construction and may very well follow the shape of the piers and girders of the Station, the girders of the viaduct being marked *V*.

There is one little detail which I would call attention to in Figs. 4 and 5. Between

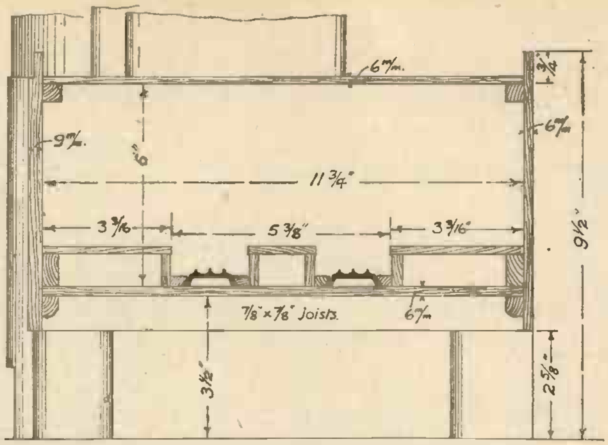


Fig. 4.—A cross-section showing construction details.

the platforms at the rail level strips of wood are fixed with a chamfer, as I have indicated. These provide a means of retaining the moulded plastic bases of the rails central between the platforms.

Finishing the Walls

In the main the material to be represented in the painting of the Station is concrete. Now, just what colour this should be is a matter of taste. It can be natural cement, such as Walpamur "Dove Grey," or cream, or pure white. In Messrs. Bassett-Lowke's model it was cream, although personally I prefer the grey.

The windows have above them and, on the left-hand side of the centre, below them, red brick. The portions in Figs. 3 and 5 which are covered with fine horizontal lines are the brickwork. Between the windows and the brickwork and also in other positions on the concrete are white lines. These are marked *W* in the drawings. Now, this brickwork and the windows themselves can be very readily represented by carefully pasting on, after the rest of the surface is painted, two of the Merco papers which are obtainable from Messrs. Bassett-Lowke, Ltd. For the brickwork obtain No. 12 (Red Brick) and for the windows No. 6, which is known as "Sash Paper, Silver Finish." There are two sizes of this on one sheet: for the windows of the Station itself use the larger size and for the café the smaller pattern.

Before leaving the treatment of the exterior I would say that the name of the Station should be in raised metal letters, as also the initials "T. T. Rly." on each side of the tower. These letters, obtainable from Messrs. Bassett-Lowke, Ltd., are provided with pins, which should be pushed into the wood only a sufficient distance to hold them. They will thus stand clear of the surface on which they are mounted. In the finished model, Figs. 1 and 2, these letters are enamelled a brilliant blue, whilst the flag mast is a deep vermilion.

(*Continued on page* 152)

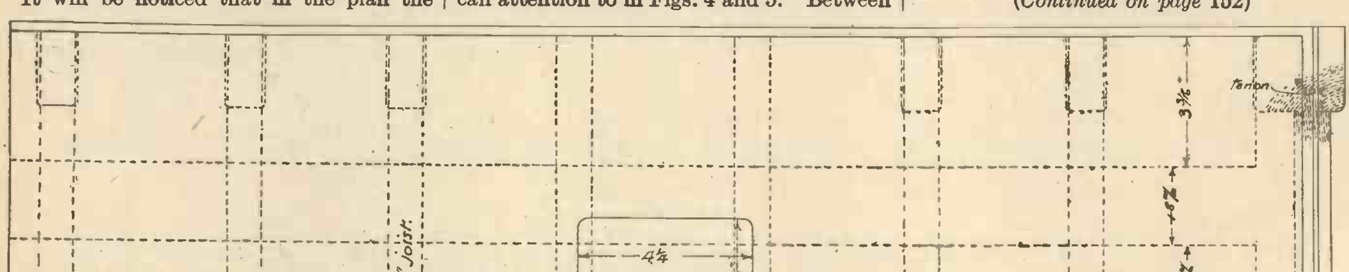


Fig. 6.—A plan view of the station.

(*Continued from page 150*)

Lighting the Station

I have said that the roof is covered with lead foil. From this it will be understood that there are no roof lights. The illumination is intended to be wholly artificial and this gives the reader an excellent opportunity for wiring and fitting small bulb lamps in a row over each platform. Obviously no light will be derived from the "windows."

In Fig. 1 the reader may see the confirmation of what I have said regarding the cut-off left-hand end. The platforms, walls, and roof, where they are sectioned, are painted black and the opening covered by a sheet of transparent celluloid.

I hope that Mr. Bassett-Lowke will forgive me if I say that I do not like the title which has been chosen for the Station. The two words "Terminus" and "Station" used together do not sound to me altogether grammatical, though, of course, "Terminal Station" could not very well be used as a name. Unless a place name is given I think "Central Station" sounds much better. After all, a terminal station can be central: there are plenty of them in London.

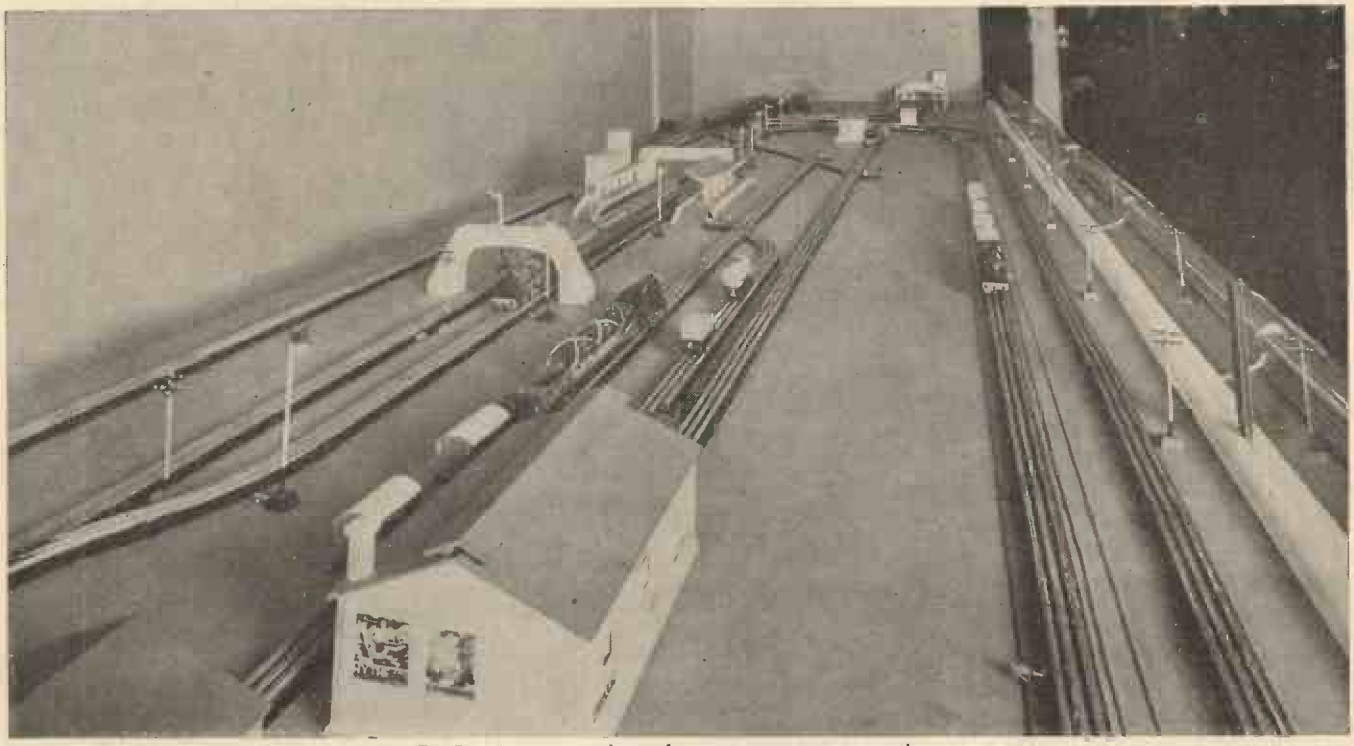


Fig. 7.—An attractive layout for a twin-train miniature railway.

Items of Interest

A Spout for Your Saucepan

EVERY housewife has experienced the inconvenience of pouring the liquid contents of a saucepan into a vessel with a narrow mouth, such as a jug. The liquid is apt to spread itself with the result that it is spilt. To guard against this unpleasant happening, a Scottish lady has rendered the members of her sex a valuable service by devising a detachable spout for saucepans. The contrivance, which may be made of aluminium or white enamelled metal, is shaped to fit over the side of any saucepan. That familiar cooking utensil—a lineal descendant of the pot which slandered the kettle—will now be able to have a spout.

Paper to the Front

PAPER deputises for linen in more than one article. For example, there are paper serviettes and handkerchiefs. And, in the reign of Queen Victoria the laundry-robbing paper collar was often a too obvious substitute for linen. Now, on the other side of the Atlantic, an inventor has conceived the idea of a paper apron. This is composed of a single sheet of paper having a semicircular opening for the neck and a gracefully cut skirt. Such an apron could be of any colour, and might be printed with a design after the style of wallpaper. And spaces might even be devoted to advertisements. It remains to be seen whether the paper apron will prove a popular front.

Electricity and Music

THE piano-accordion is a musical instrument which is very much in vogue at the present time. It is one of those wind instruments whose dynamo is not the lungs, power being provided by the hand. This entails a certain amount of manual labour on the part of the performer. An ingenious brain has devised an electric accordion, which appears to be worked on the principle of a vacuum cleaner. A switch is operated, and all the player has to do is to regulate the supply of wind and manipulate the keyboard. Without further details, it is impossible for me to state whether a mechanically blown accordion is capable of those gradations of tone which are one of the chief charms of music. One imagines that such an instrument would not invariably be appreciated by the occupiers of the neighbouring flats.

Sound Footing for Horses

THE advent of Jack Frost leads us to expect that one morning we shall awake to find the roads like glass. During the heyday of the horse, this meant a queue of carthorses outside the blacksmith's shop waiting to be what is known as "roughed," the process being the insertion of nails or spikes into the shoes of the animals. There is still a limited number of horses on our roads, and to protect these in frosty weather an improved non-slip shoe has recently been devised. This is a wrought-iron shoe formed with a groove in which is located a strip of asbestos or cotton fibre, impregnated with a chemical, the strip being kept in place by means of copper rivets.

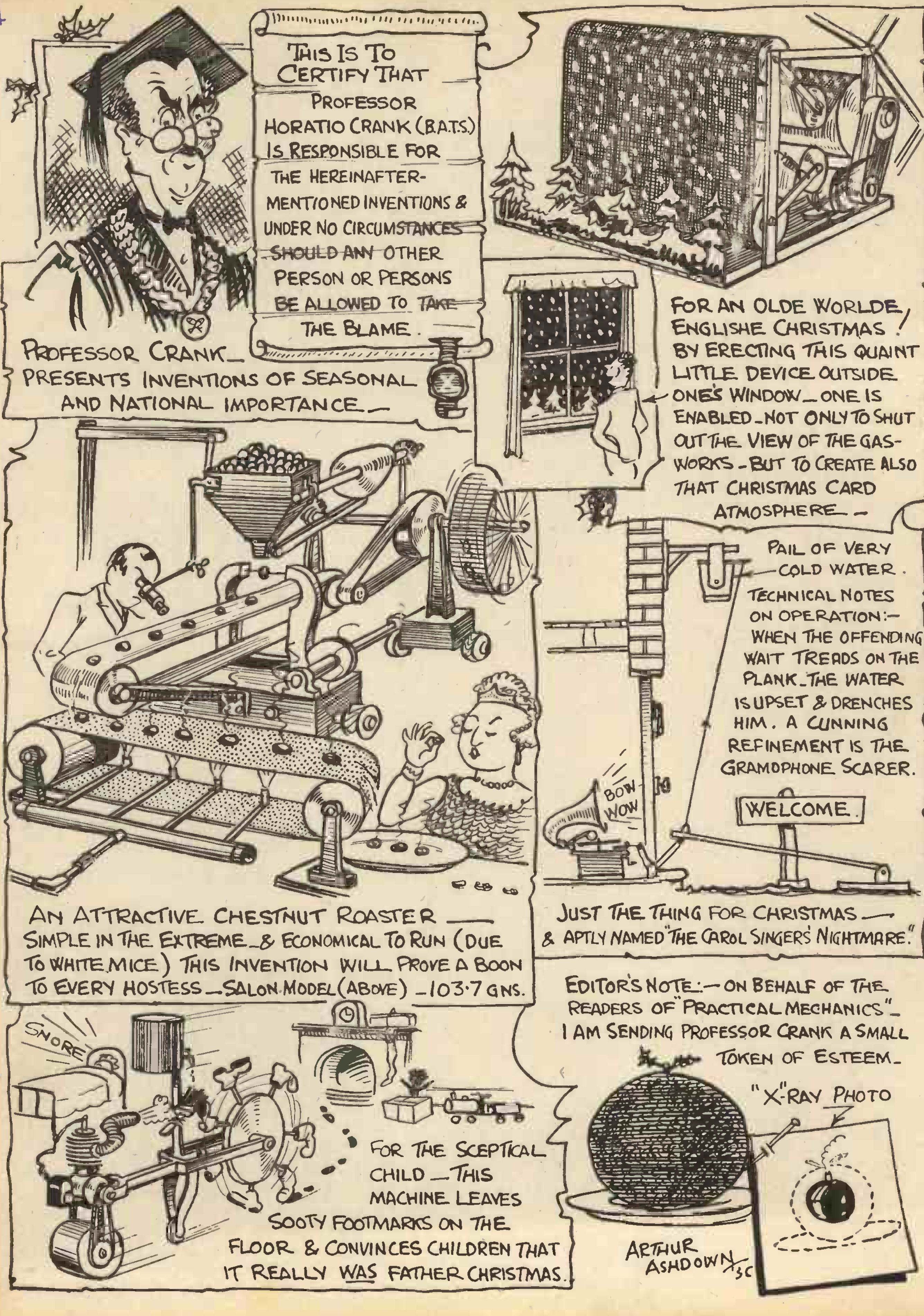
Deep-sea Television

THERE has appeared on the horizon a newly-devised ship with television receiving apparatus, a submarine eye and means for withstanding deep-sea pressure. This will enable motion pictures of submarine scenery and dramas to be televised. It should reveal the hidden beauties of "the dark, unfathomed caves of ocean." And it may materially assist scientists in the exploration of the bathosphere.

A Carrier for Babies

NATIVE women in Africa and elsewhere have for many a long day adopted methods for reducing to a minimum the labour of carrying infants along the roads and through the forests. A similar expedient has now been introduced in more civilised regions in the form of a portable seat for a baby. The appliance comprises a U-shaped frame having arms of unequal length; a flexible seat suspended from the frame; a strap attached to the outer end of the longer arm; a second strap attached to the inner end of the shorter arm; and a shoulder joining the ends of the two straps. The baby's seat being at the side of the mother, it is convenient for mother and child to commune with each other.

DYNAMO.


THIS IS TO CERTIFY THAT PROFESSOR HORATIO CRANK (B.A.T.S.) IS RESPONSIBLE FOR THE HEREINAFTER-MENTIONED INVENTIONS & UNDER NO CIRCUMSTANCES SHOULD ANY OTHER PERSON OR PERSONS BE ALLOWED TO TAKE THE BLAME.
PROFESSOR CRANK_ PRESENTS INVENTIONS OF SEASONAL AND NATIONAL IMPORTANCE_
FOR AN OLDE WORLDE, ENGLISHE CHRISTMAS! BY ERECTING THIS QUAINT LITTLE DEVICE OUTSIDE ONE'S WINDOW_ONE IS ENABLED_NOT ONLY TO SHUT OUT THE VIEW OF THE GAS-WORKS_BUT TO CREATE ALSO THAT CHRISTMAS CARD ATMOSPHERE_
AN ATTRACTIVE CHESTNUT ROASTER___ SIMPLE IN THE EXTREME_& ECONOMICAL TO RUN (DUE TO WHITE MICE) THIS INVENTION WILL PROVE A BOON TO EVERY HOSTESS_SALON MODEL (ABOVE) _103·7 GNS.
PAIL OF VERY COLD WATER.
TECHNICAL NOTES ON OPERATION:- WHEN THE OFFENDING WAIT TREADS ON THE PLANK_THE WATER IS UPSET & DRENCHES HIM. A CUNNING REFINEMENT IS THE GRAMOPHONE SCARER.
BOW WOW
WELCOME.
JUST THE THING FOR CHRISTMAS__ & APTLY NAMED "THE CAROL SINGERS' NIGHTMARE."
SNORE
FOR THE SCEPTICAL CHILD_THIS MACHINE LEAVES SOOTY FOOTMARKS ON THE FLOOR & CONVINCES CHILDREN THAT IT REALLY WAS FATHER CHRISTMAS.
EDITOR'S NOTE:- ON BEHALF OF THE READERS OF "PRACTICAL MECHANICS"_ I AM SENDING PROFESSOR CRANK A SMALL TOKEN OF ESTEEM_
"X"-RAY PHOTO
ARTHUR ASHDOWN/36

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR DECEMBER

SUNSPOT activity is increasing as the 11-year cycle advances towards the next maximum. Though no spot of naked-eye dimensions has appeared recently, one may do so at any time. Those with even the smallest telescopes should therefore examine the Sun for lesser specimens whenever atmospheric conditions permit; provided their instruments are fitted with suitable dark caps or prism eyepieces to protect the sight from serious damage. For direct observation a heavily smoked piece of glass should be held up in front of the eyes. If a single spot or group survives the journey across the solar disc, it may reappear in twelve to fourteen days at the opposite rim. It is interesting to watch the changes of form and shape assumed from hour to hour by these curious perforations in the Sun's surface. An isolated spot will often break up into smaller ones, or a scattered group coalesce into a single yawning cavity. With sufficient optical assistance gleaming "faculae" may be perceived floating around their margins, especially when the spot is situated near the edge of the Sun's disc.

The Moon at first quarter as seen through an astronomical telescope, which inverts the image of the object viewed.

The Moon

The Moon offers almost inexhaustible fields of fascinating exploration from end to end of its "terminator," that slowly shifting broken boundary denoting the division between lunar night and lunar day. The uneven and rugged earth-like surface is revealed along this strip only by a good land glass and presents different aspects under morning and afternoon illumination; i.e. before and after "full." The summits of some of the higher mountain peaks will be seen standing out, lit up like stars against the blackness in which they are still submerged. Soon they and the valleys below become flooded with the glaring radiance of the rising Sun, for there is no dawn or twilight on our airless satellite. Later on, many hillocks, ridges, pits, shallow depressions and ripple-like formations, scattered over the comparatively smooth and extensive plains (termed "mare" by the old astronomers), gradually emerge into bold relief. Striking photographs of the Moon at first quarter and the Milky Way are illustrated on this page.

Companion Worlds

The planets—our companion worlds racing round the Sun in that vast roundabout of one-way celestial traffic called the solar system—are not very conspicuous this month. Mercury, the smallest, is always difficult to glimpse. However, it may possibly be detected as a glittering yellowish "star" low in the south-west, shortly before 5 o'clock during the last evenings of December. Venus is in the same region and more conspicuous. It is getting brighter and will soon be a prominent object after sunset. Mars is coming into view again after a long absence; but at present is to be seen only in the east from 2 a.m. to dawn. It can be recognised by its reddish hue and thus be distinguished from the adjacent real star Spica in the constellation Virgo. Saturn, the ringed planet, may be found moderately high up in the south about 6 p.m., and does not set until nearly midnight. Its unique ring system is now turned edgeways to the Sun and, owing to its extreme thinness, does not reflect enough light to be visible except in very large instruments. Two or three months hence the rings will begin to "re-open" and ultimately expand sufficiently to once more come within the range of small telescopes. Meanwhile, Saturn exhibits no more than a cream-tinted faintly streaked ball, decidedly flattened at the top and bottom.

Fixed Stars

Among the so-called "fixed" stars attracting attention at this season is Fomalhaut in the constellation Piscis Australis. If the southern sky line is clear it may be easily located in the early evenings, flashing like a lustrous diamond beneath and to the right of Saturn. Fomalhaut is a fairly large sun nearly twice the diameter of ours and is believed to consist of a dense central core enveloped in an outer shell of thick layers of incandescent gases, chiefly hydrogen. It is relatively close to the solar system, for its light takes but twenty-four years to reach us; whereas that of many other stars, though travelling at the same rate of 186,325 miles a second, occupies several centuries. The misty arch of the Milky Way, or Galaxy, spans the heavens from east to west. It takes in the bright star Capella in Auriga, the double star cluster in Perseus, the well-known W of Cassiopeia, and the stars Deneb in Cygnus and Altair in Aquila. Its entire course is marked by myriads of luminous points, many of them coloured, and each representing a shining sun at an inconceivably remote distance. On a dark clear night even an opera glass will disclose the stellar character of this wondrous cloud-like belt. A particularly crowded patch embraces the little constellation Perseus, notable for the double cluster already mentioned; also for being the spot in the sky from whence the once famous Leonid meteors used to appear every thirty-three years, and astonish mankind with their magnificent displays of shooting stars.

Island Universes

Overhead stretches the straggling constellation Andromeda, containing the celebrated Great Nebula, the largest of the known "Island Universes" distributed throughout space. It is perceptible to normal unaided vision as a hazy blur but is actually a gigantic spiral structure of stars and nebulae, constituting a complete universe in an advanced stage of development. Through a small astronomical telescope it assumes an irregular oval shape due to being viewed partly on edge; but in long-exposed photographs its circular form is very evident. It is the farthest celestial object perceptible to the naked eye and its distance can be comprehensibly expressed only as 900,000 "light years." In the north-west scintillates Vega, the chief star in Lyra. It served the purpose of our pole star 14,000 years ago and will do so again 11,000 years hence. Meanwhile, we are using Polaris in Ursa Minor, to which the "pointers" in Ursa Major, the Great Bear (sometimes called the "Plough"), direct the eye. The latter constellation now lies over the northern horizon and is really a very scattered cluster; being circumpolar it never sets in these latitudes.

Identification of the constellations and most of their important components can be rendered simple by means of Philips' cardboard revolving planisphere. This handy contrivance shows all the star groups above the horizon at any hour on any date throughout the year, and may be obtained from any stationer for a few shillings. A star atlas is also useful to locate fainter objects. Queries are invited from readers interested in stargazing as a hobby, and should admit of brief replies and conform strictly with the rules on page 186.

The Milky Way. A crowded patch around the double star cluster in the constellation Perseus.

† *Fig. 1.—A Kodak Pola Screen as used for photographic purposes*

Some Marvels of

by G. R. M.

Polaroid and Pola Screens and

A VERY short time ago, the subject of polarised light was one which meant nothing to anyone who had not had an advanced training in optics or physics. Its applications were strictly limited to the realms of advanced science, and partly because of the somewhat incomprehensible nature of its uses and partly because the difference between ordinary and polarised light cannot be detected by the unaided human eye, the whole subject was one having little popular interest.

A year or two ago, however, a discovery was made which will have a number of important applications of everyday interest, but to understand these it is necessary to have some idea of the meaning of the somewhat inexpressive term, "polarised light."

Most of us are aware that sound consists of waves in the air. Now, these waves of sound travel outwards, more or less in all directions from the source, and consist of what might be termed "push-and-pull" pulses in the air. The air at any one point is alternately compressed and rarefied as the sound waves travel outwards.

A Stone Thrown into a Pond

Light waves, however, are quite different, as they consist not of "push-and-pull" waves but of transverse oscillations, such as occur, for example, when a stone is thrown into a pond. The little waves which result from the stone striking the water travel outwards in all directions on the surface, but the only actual movement of the water is a small "up-and-down" motion. In other words, the water is oscillating at right angles to the direction of travel of the waves.

Another simple example of a transverse wave occurs if we lay a long rope along the ground and shake one end of it. Waves travel along the rope; if we shake it up and down the waves will also be up and down, and if we shake it sideways the waves will be horizontal ones. Technically we should describe the up-and-down waves as being vertically polarised and the sideways waves as being horizontally polarised.

These waves in the rope are very much like waves of light, and if we can imagine countless thousands of lengths of rope stretching from every point of the source of light in all possible directions and vibrating at every conceivable angle, then we shall have a fair idea of the true nature of light waves.

A Narrow Beam of Light

For simplicity, let us consider just a narrow beam of light. The numerous waves which make up the beam will not all be vibrating in one plane. A few may be vertical, a few may be horizontal, and all the rest will be vibrating at random angles between the two. The light in such a beam would be ordinary unpolarised light.

Now suppose we do something to the light waves which makes them all vibrate in the same plane. We have now got what is known as polarised light, and the extraordinary part is that the naked eye would be unable to detect the slightest difference. The important thing to remember, therefore, is that while the waves of ordinary unpolarised light are vibrating at all random angles, the waves of polarised light all vibrate in the same plane.

For many years, certain crystalline substances have been known which have the power of polarising a ray of light. Crystalline calcite, or Iceland spar, is the best known of these substances, and if a beam of light is passed through a specially cut prism of Iceland spar at the correct angle, the emerging light is perfectly polarised. The only action apparent to the eye is an appreciable loss of brilliancy, because the prism will only transmit those rays which are vibrating in the correct plane and this results in about half the light being stopped.

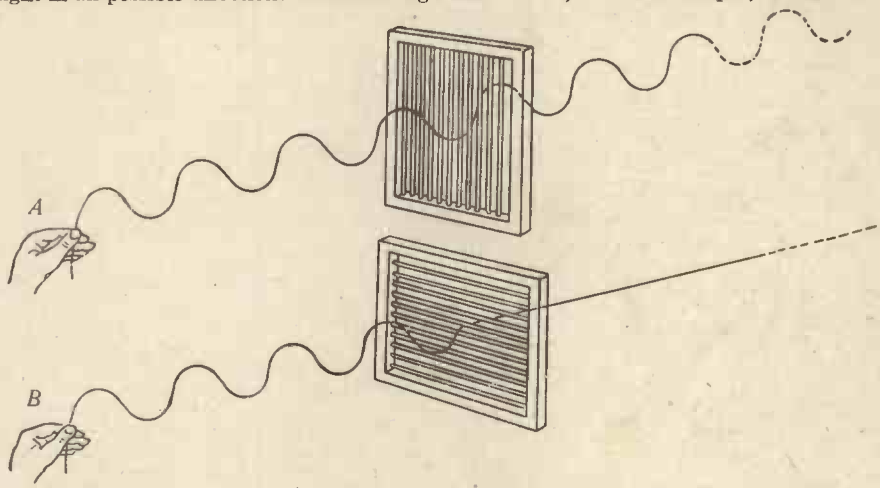


Fig. 2.—Diagrammatic analogy of polarised light. A shows how a polarised ray passes through a polarising screen if the axes coincide. B shows the polarising screen at right angles to the plane of the ray which cannot pass through.

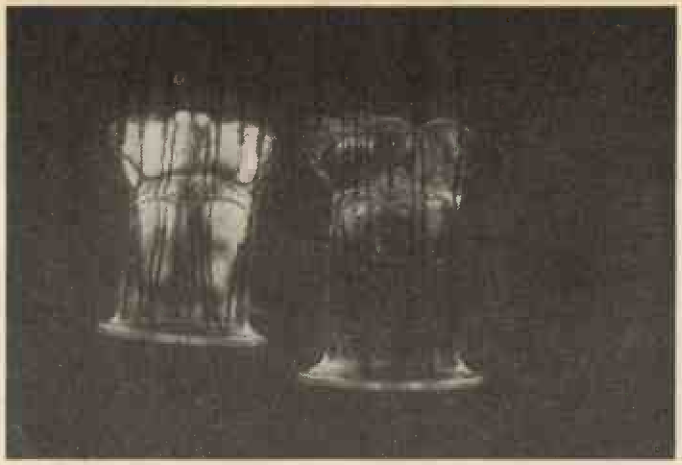
**Fig. 3—(Left) An untouched photograph of motor-car headlights at night.*

**Fig. 4—(Right) The same car after placing Polaroid screens over the headlights and camera lens.*

Polarised Light

Garratt

their Present-day Applications



* *Fig. 7.—The base of a wireless valve photographed with Pola Screens. The one on the left has not been annealed and the light patches show the existence of strains in the glass. The right-hand one has been properly annealed.*

As a matter of fact, the behaviour of Iceland spar in polarising a beam of light is a little more complicated than this, but the above description will serve us here. Suffice it to say that good crystals of Iceland spar are expensive and large pieces are very rare. It is mainly for this reason that almost its only application is in scientific instruments, although there are several everyday uses it could fulfil if it were cheaper.

A New Synthetic Material

A synthetic material has recently been discovered, however, by E. H. Land, which can be manufactured in fairly large sheets and which has the property of almost completely polarising light which passes through it in much the same way as prisms of Iceland spar, but without their several complications.

Polaroid, as the new material is called, actually consists of a cellulose film, which is usually mounted between two glass plates and which forms a matrix for minute doubly refracting crystals which are so small as to be invisible in a high-power microscope. It is stated that there are about ten million million crystals in a single cubic inch, and in order that the polarising properties shall be obtained, it is essential that the crystals, which exist in the form of tiny fibres or needles, shall all lie parallel to each other in the plane of the film.

† *Fig. 5.—(Left) View of a shop window showing the reflections of a building on the opposite side of the road.*
† *Fig. 6.—(Right) The same scene photographed with a Pola Screen in front of the camera lens.*

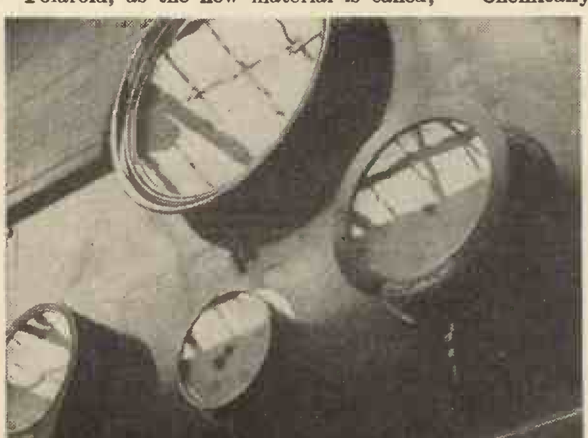
Chemically, the crystals consist of a colloidal suspension of herepathite—a periodide of quinine sulphate. The herepathite is produced in the form of a jelly, which is thoroughly mixed with a nitrocellulose solution until a viscous mixture is formed. In order to orientate the crystals so that they all lie parallel to each other and so develop the polarising properties, the mixture must then be extruded through a die in the form of a narrow slit. This process produces a flat film which is subsequently hardened and suitably mounted between plain cellulose films and glass plates.

To transmitted light, the film appears to be a pale neutral-grey tint, not unlike a piece of lightly smoked glass. The extraordinary nature of the material, however, can best be realised by looking through two of the films together. If the two films are set so that their polarising axes are parallel, they appear almost perfectly transparent, but if one of them is turned so that its polarising axis is at right angles to that of the other, the two films will be completely opaque to light of ordinary intensity. This result is obtained because the front film passes only the light waves which are oscillating in a particular plane, and if the second film is turned so that its polarising axis is at right angles to the former, then no light at all can pass through the second screen.

This somewhat amazing effect has one possible application of the greatest value in providing a complete solution to the dazzle problem so serious to all motorists at night, and it is by no means impossible

* *By permission of Messrs. Polaroid Products Ltd.*

† *By permission of Messrs. Kodak Ltd.*



† *Fig. 8 (Left).—Instruments in a boiler room.*

† *Fig. 9 (Right).—The same instruments photographed through a Pola Screen.*

that its use for this purpose will eventually be made compulsory for all motorists.

Headlight Dazzle

In order to eliminate headlight dazzle, it is necessary to place a screen of Polaroid over both headlights and to set the films so that their polarising axes are parallel and at 45 degrees to the vertical. Another screen of Polaroid is fitted to the windscreen in a hinged frame, so that it can be turned into the driver's line of sight when required. This screen must also be set with its polarising axis at 45 degrees and parallel to those covering the headlights.

When two cars so equipped approach each other at night, the driver of each will be able to see the approaching car and any other object in the roadway, brightly illuminated by the light of his own headlights, but the headlights of the oncoming car will be almost invisible, since the light from them is polarised at right angles to the polarising axis of the viewing screen in the other car and thus cannot pass through to the driver's eyes. The sidelights of each car will still be visible to opposing drivers, since the light from them will be unpolarised.

Although this application of Polaroid provides a complete solution to the dazzle problem and renders the dipping or dimming of headlights unnecessary, it is clear that every car would have to be so equipped if the system is to be really effective. This is so because the fitting of a Polaroid viewing screen is useless for cutting out dazzle unless the rays from the oncoming lights are also polarised.

Actually, the fitting of a Polaroid viewing screen alone is of some value, as it cuts out a considerable proportion of the light reflected from the surface of a wet road.

It is a curious fact that ordinary light is largely polarised by the act of reflection from any polished non-metallic surface such as plate glass, a polished table-top, a wet road, or glazed porcelain. The effect varies according to the angle of the incident rays, and is a maximum for most materials between 30 and 40 degrees. For ordinary purposes, however, the angle is not critical, but no polarisation occurs with light reflected at 90 degrees.

Polarised Light

Another source of strongly polarised light is that from a clear blue sky arriving at right angles to the sun's rays, and when this light is reflected from any surface or even from water, the reflected rays are also polarised. The unaided eye cannot detect the polarisation, but many ordinary objects assume a new and strange beauty when viewed through a Polaroid screen.

The fact that ordinary light is polarised by reflection renders the use of Polaroid invaluable in certain branches of photography, and the "Pola Screens" which are now to be obtained from the Kodak Company are coming into wide use.

Pola screens consist of a thin sheet of polaroid carefully cemented between optically flat pieces of glass and mounted in a suitable ring, which is generally fitted with a small handle. If one of these screens is held before one's eyes and gradually rotated through a right angle, an extraordinary change in the appearance of certain objects is observed at certain angles, due to the cutting out of reflected rays of light.

Suppose, for example, that a polished table is situated between the observer and the window. A partial reflection of the window will generally be seen on the table-top, and this reflection will entirely hide the grain of the table. Now look at the same object through a Pola screen. Probably little difference will be observed at first, but if the screen is slowly turned, it will be found that there is one particular angle at which all trace of the reflection from the window disappears. Simultaneously, the grain or pattern of the table-top shows up as distinctly as if it were illuminated by a very soft and perfectly diffused light.

If it is required to photograph the table-top, it is only necessary to place the Pola screen in front of the camera lens at the same angle as has been found by inspection and all the details of the table will be brought out on the photographic plate, whereas, without the Pola screen, nothing but a white reflection of the window would have been produced.

It is notoriously difficult to photograph objects in a shop window on account of stray reflections in the glass. The various objects in the window appear to be muddled up with a ghost-like image of the buildings on the opposite side of the road.

Almost all these reflections disappear as if by magic when the scene is viewed through a Pola screen rotated to the appropriate angle and the photography of such scenes is rendered almost as easy as an open-air snapshot. Photography of a glazed picture or of an oil-painting is rendered far easier, now that the unwanted reflections can be cut out, and it is scarcely an exaggeration to say that the Pola screen is now becoming an indispensable item among the equipment of every process photographer.

TRANSFERRING FILMS TO RECORDS

Making Records from the Actual Sound Track of the Latest Mickey Mouse and Silly Symphony Films

As the result of a contract recently completed between Walt Disney-Mickey Mouse, Ltd., and "His Master's Voice," expensive apparatus has now been installed at the "H.M.V." Recording Studios at St. John's Wood, in order to make gramophone records from the actual sound track of the latest Mickey Mouse and Silly Symphony films.

The apparatus constructed for "His Master's Voice" is believed to be the only one of its kind in the world, and incorporates intricate filters in order to obtain a constant speed and complete absence of jerkiness.

Resembles a Cinema Projector

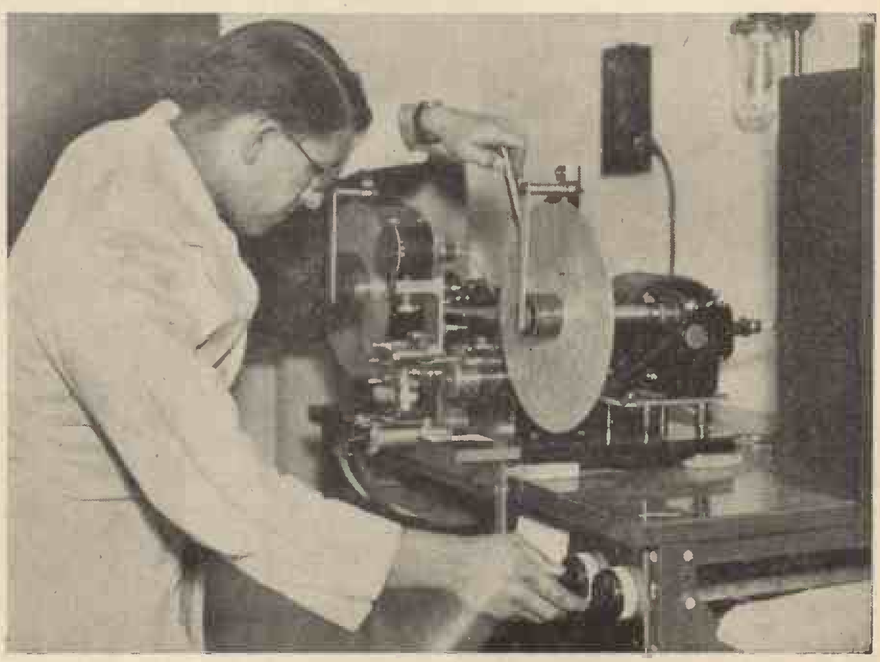
In some respects the machine resembles a cinema projector, but differs in that it only produces the sound part of the film. Nevertheless, it is essential that the film is passed through the machine at the normal projection speed in order that the sounds may be reproduced exactly as in a cinema.

The method of recording on film differs entirely from that of gramophone records. On film, sounds are represented by a strip of jagged lines, rather like a toothcomb, down the edge of the film. Light passing through the film falls on a photo-electric cell which converts the light into electric impulses. These impulses are then fed into amplifiers and afterwards to the gramophone recording machine.

Extremely Fine Quality

The transfer of film recordings to records, obtained by the "His Master's Voice" method, are of a quality hitherto not believed possible.

In order to comply with the regulations governing the storage of cinematograph film, "H.M.V." have given the apparatus a special room in which every precaution against fire has been taken in order to guard these extremely valuable Walt Disney productions.



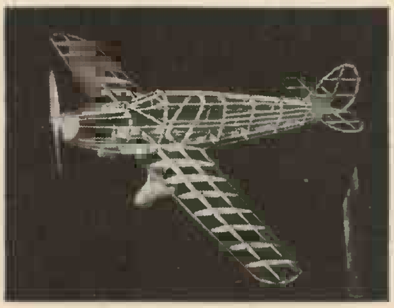
An "His Master's Voice" engineer about to start the special film recording machine which has been recently installed at the "H.M.V." studios, for the purpose of transferring the sound track from Walt Disney films to gramophone records.

● Make sure of HAPPY LANDINGS

by buying one of our kits

. THEY BUILD WELL
. THEY FLY WELL

PERCIVAL GULL



Wingspan 18 inches, length 12½ inches. Scale model of a plane which has been breaking records all over the world. The model is an excellent flyer. Fuselage built on Comet's Auto-line-up method. Quite easy to build. Complete kit with all balsa, printed and strip, carved balsa flying prop, quick-drying cements, etc. Carriage paid for **3/6**

PUSS MOTH

Wingspan 16 inches, length 12 inches. The ideal beginner's model —easy to build and a splendid flyer. Complete kit with everything needed, full-size plan, printed and strip balsa, quick-drying cements, Japanese tissue, carved balsa flying prop, hardwood wheels, etc. Carriage paid for **2/-**

HESTON PHOENIX
RETRACTABLE LANDING GEAR

Wingspan 18 inches, length 13½ inches. Your biggest thrill ever—a really workable retractable landing gear with locking control. The plan of this absolutely scale model is simply alive with information and drawings. Every detail is shown clearly in three positions on an exceptionally big plan so well laid out and illustrated that you feel you can start right in. The fuselage is built on Comet's Auto-line-up principle—the best. Kit is absolutely complete, large printed sheets of balsa, cements, bottle of green dope for touch up, very smart with silver and green tissue colour scheme, printed registration letters and all else needed. The landing gear requires some experience in modelling, but the explanations and drawings are very clear. Carriage paid for **3/6**

- If you live in a country district state your nearest Railway Station, as kits are sent by passenger train. (Carriage extra abroad, allow 2/-.)
- Send two penny stamps for aeroplane catalogue giving details of biggest range of scale model flyers in England.

P. M. SWEETEN LTD.

Send your Order *NOW* to Bank Hey St., BLACKPOOL

NORTHERN MODEL AIRCRAFT CO.

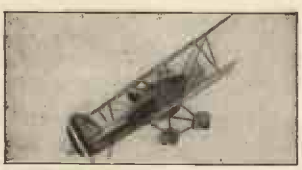
37a FOUNTAIN STREET, MANCHESTER, 2

If you want QUALITY, VALUE and SERVICE, not to mention our unrivalled EXPERIENCE, then send for your requirements to us—

THE 'MODEL AIRCRAFT ONLY' FIRM

— 'LINDBERG' SCALE MODEL KITS —

LEAD FOR FLYABILITY, AUTHENTICITY, VALUE. EVERYTHING NEEDED TO BUILD MODELS LIKE THIS HAWKER SUPER-FURY. SPAN 12" to 14". Other types: SOPWITH CAMEL; S.E.5. 1/6 carr. paid (In U.K.).



'CONDOR' HIGH-PERFORMANCE KITS

The **PROVED** Flying Models. Up-to-date design 'CONQUEROR' WAKEFIELD CUP WINNER 1933. 23/-
321 secs. R.O.G. and many others.

Other 'CONDOR' Kits: 'CLOUD' 20/-; 'CRUSADER' 9/6

'BABY CYCLONE' PETROL ENGINE

1/6th h.p. 6 c.c. Bore ¾" Stroke 13/16". Weight complete 10½ ozs. Reliable. Good starter. Real Precision job. Will fly models up to 5 lbs. weight. CARR. PAID £4 19 6, including Prop. Model Kit designed for this Engine £2 15 6.

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MODEL AIRCRAFT SUPPLIES LTD.

THE HOME OF NEW LINES

—and our latest one is

MICROFILM SOLUTION

OBTAINABLE AT OUR DEALERS THROUGHOUT THE COUNTRY

9d. *per 2-oz. Tin.*

● **Full-size drawings of British Indoor Record Holder, and how to cover it with Microfilm, 7d. post free.**

171 New Kent Rd., London, S.E.1

OUR GREEN BOOK CATALOGUE 4d. POST FREE

MODEL AERO TOPICS

By F. J CAMM

Microfilm

ULTRA-LIGHTWEIGHT models have been produced in America weighing but a fraction of an ounce. These models are, of course, intended for indoor flying, and they naturally fly at a very low speed. Whilst balsa wood enables the constructor to build a very light structure, even Japanese tissue is not sufficiently light to enable the maximum duration to be obtained. In England the S.M.A.E. has done a vast amount of work in encouraging the flying of indoor models, and it regularly holds meetings at the Albert Hall. Thus, model aircraft flying ceases to be a seasonable hobby. It is an unfortunate fact that in America the hobby is catered for by the manufacturers in a more intense way than it is over here, but matters have improved during the last three years to such an extent that many of them are supplying American goods which were formerly difficult to obtained, whilst quite a number of them are developing materials superior to the American products on their own account.

Microfilm is an ultra-light covering which was first produced in America about two years ago, and it formed the subject of an article by its inventors in an American periodical. Supplies, however, were difficult to obtain.

Ideal Covering for Indoor Models

It is with pleasure then that I record that Model Aircraft Supplies, Ltd., of 171 New Kent Road, London, S.E.1, have developed a covering for indoor models even better than that supplied in America. The ruling of the S.M.A.E. states that in all competitions under their jurisdiction at the Albert Hall no model should exceed ½ oz. in total weight, and even these may only be flown at the discretion of the judges. This entailed the use of ultra-lightweight materials, and the company to which I have referred have been trying out various solutions for making microfilm. They have at last succeeded and they have submitted a sample to me for test. I find it superior to the American product. It is made in the following way :

A clean shallow tray, such as a large developing dish or baking tin, is obtained. This must be absolutely free from any grease or soap. Warm water of a temperature of 80° F. is next poured in to a depth of about 1½ in. A hoop of stout wire or aluminium with a diameter of about ⅛ in. is next laid in the water, the two ends of this being twisted together and left sticking up vertically to form a handle. One or two drops only of the Microfilm solution are next dropped on to the top of the water. This immediately spreads, forming a very fine film. Allow the film to remain on top of the water for a minute to harden off. Next gently lift the wire hoop up under the film and with a gentle sideways movement the complete film may be lifted from the surface of the water. It will be noticed that with various amounts of solution dropped on the water, different coloured films are obtained.

The thicknesses of film range through the following shades : Cloudy Clear, Straw Brown, Blue Violet, Red Violet, Light Green, Yellow Gold, Violet Red, Blue, Apple Green Rose, Dark Green, Red Green, Red, almost colourless and too heavy. The Blue Violet will be found most suitable for tails, the Red Violet for the wings of Spar machines, the Violet Red for fuselage tails, the Apple Green for the wings of fuselage machines, and the Dark Green for covering the fuselage itself. It should be remembered that the colour depends on the amount of solution used and the area of the water upon which it is poured.

To make smaller sheets, the solution can be dropped on to one spot ; to make larger sheets, the solution should be poured in a small continuous stream.

It will be found that the lids of the special tins in which the solution is supplied may be used for pouring out the solution. Do not try to pour it from the tin itself.

The price of this solution for 2 oz. costs only 9*d*. as against the American price of 20 cents, equivalent to 10½*d*. The price of 9*d*. does not, of course, include carriage, as this solution may not be sent through the post.

Register of Model Aircraft Manufacturers

So many readers who purchase my books on model aircraft write to me for addresses of suppliers of the various parts. I append, therefore, a list of addresses of firms supplying model aircraft materials. Most of them advertise regularly in this journal and I would particularly draw your attention to their announcements in this issue. Nearly every one of them supplies complete models as well, and I would advise the aero modeller to write at once for their various catalogues (not omitting the small charge made in some cases) and to keep them on file for ready reference. These catalogues contain a large amount of useful data as well as a list of the firms' products.

As this is a Christmas Number it is appropriate to mention that a modern model aeroplane, a kit of parts for making a flying model of one of the well-known full-size aeroplanes, a miniature petrol engine, or some other accessory will make a welcome present.

Model Aircraft Manufacturers

Bond's o' Euston Road, Ltd.,
254 Euston Road,
N.W.1.

P. M. Sweeten, Ltd.,
Bank Hey Street,
Blackpool.

Northern Model Aircraft Company,
37A Fountain Street,
Manchester.

Model Aircraft Supplies, Ltd.,
171 New Kent Road,
S.E.1.

Elite Model Airplane Supplies,
45 Tamworth Avenue,
Prestwich,
Manchester.

Leicester, Lovell & Company, Ltd.,
(Casco Glue),
14-18 Nile Street,
N.1.

F. J. Mee, Esq.,
Warneford Flying Aircraft,
Greenwich Road,
S.E.10.

Model Supply Stores,
46 Derby Road,
Prestwich,
Near Manchester.

Aero Models, Ltd.,
Wellington Building,
The Strand,
Liverpool 2.

J. F. Hallam & Son,
Poole,
Dorset.

E. Gray & Son, Ltd.,
18-20 Clerkenwell Road,
E.C.1.

A. J. Holladay & Company, Ltd.,
3 Aldermanbury Avenue,
E.C.2.

Model Aircraft Stores,
127B Hankinson Road,
Bournemouth.

Premier Aeromodel Supplies,
2A Hornsey Rise,
N.19.

Aero-O-Kits (Sheffield),
Portobello Works,
127 Portobello Street,
Sheffield 1.

The Heston Phœnix, made from a kit of parts supplied by P. M. Sweeten, Ltd., Bank Hey Street, Blackpool. Wingspan 18 *in., length* 13½ *in.*

Our Model Aircraft Books

There can be few aero modellists who have not heard of *Model Aeroplanes and Airships*, which is an ideal book for the beginner, and details the construction of a number of simple, yet up-to-date models, including flapping-wing models, helicopters, kites, and a rubber-driven airship, concluding with a chapter on full-size gliding ; it costs 1*s*., by post 1*s*. 2*d*.

Power Driven Model Aircraft, which deals with the design and construction of models propelled by petrol engines, compressed-air engines, and flash-steam engines, including instructions on building the engines ; this also costs 1*s*., by post 1*s*. 2*d*.

The Model Aircraft Book, which costs 3*s*. 6*d*., by post 4*s*., and is really an advanced course in model aircraft design and construction. It includes full details with profuse illustrations in line and half-tone of a number of petrol-driven models, including those built by Capt. Bowden, and a chapter on building a full-size primary glider.

A set of these books makes a most acceptable Christmas present for those interested in this most modern of all hobbies.

Sweeten's New Kits

Messrs. P. M. Sweeten, Ltd., 38 Bank

Hey Street, Blackpool, have just produced two splendid kits of flying scale models —the Hurricane Fighter, price 4*s*. 6*d*., and the Heston Phœnix, price 3*s*. 6*d*. I have built up these two models, and found that they were very quickly erected and result in two most realistic models which are reliable and fascinating flyers. I would recommend every one of my readers to write at once for details of Messrs. Sweeten's kits, for they supply them for nearly every type of modern aeroplane. They are all reasonably priced, easily erected, nicely boxed, and the instructions and illustrations enable them to be built without previous experience. These kits make fine Christmas presents.

Indoor Flying Meetings at the Albert Hall

The following are the dates of the indoor meetings to be held at the Albert Hall, London, S.W.7. These meetings commence at 7.30 p.m., and admission is by ticket only, obtainable from Council Members and Club Secretaries.

The cost of admission is 6*d*.

December 9th, 1936.
December 22nd, 1936.
January 6th, 1937.
January 20th, 1937.

At a recent meeting of the Council of the S.M.A.E. the following records were approved :

Biplane Flight.—S. R. Crow, Blackheath. 91·2 sec., made on North Kent ground and timed by North Kent timekeepers, Messrs. P. C. Newport and C. Gibson.

Seaplane Record.—G. J. Liggett. 153·8 sec., timed by Messrs. J. C. Smith and A. A. Judge.

Fuselage Farman Pusher Record.—C. A. Rippon. 51 sec., timed by Messrs. A. Walker and J. Broome.

Spar Indoor Tractor Record.—R. Copland. 11 min. 57 sec., timed by Messrs. J. C. Smith and H. York.

New Rules for the Wakefield Competition, 1937

After considerable discussion and by eleven votes to nine, the council's number one proposition was carried, i.e. wing area 190-210 sq. in., with a total minimum weight of 8 oz. Voting amongst the London clubs appeared to be in favour of the heavier model, but the provincial clubs carried the day.

The council asked for another meeting, to be held at the earliest possible moment, to discuss the final details for the Wakefield Competition.

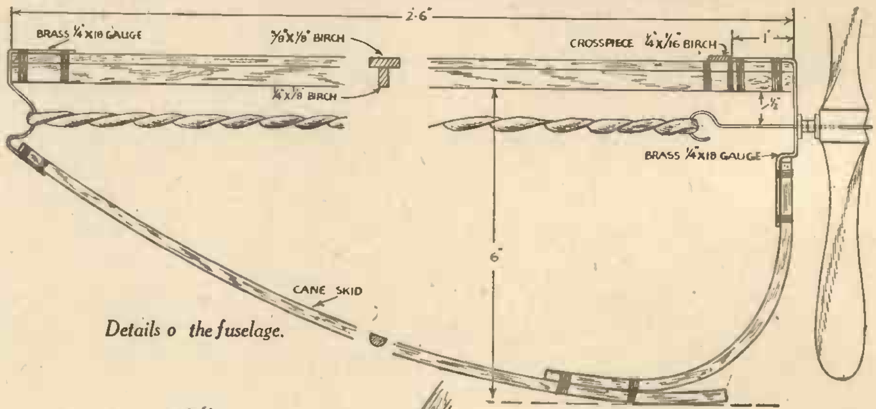
A Model Pterodactyl for Beginners

A few years ago I published a design suitable for beginners for a model Pterodactyl. As the issues are now out of print and I have received many requests for this design, I repeat it herewith.

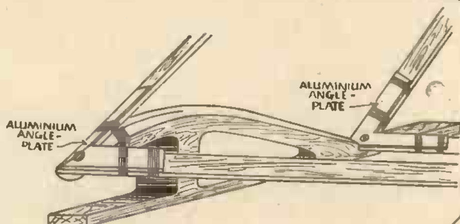
New 9 c.c. Petrol Engines

During my visit to the recent Cycle and Motor Cycle Show I observed on the stand of the Villiers Engineering Co. a sturdy 9 c.c. 2-stroke petrol engine. Knowing that this must be a new line for this old-established company, which has consistently produced 2-stroke petrol engines for motor cycles and other purposes, I asked for further details, and was informed that they had produced this new unit experimentally, and, provided that there is sufficient demand, they intend to market it for model aeroplanes and model boats. The price has not yet been fixed, but I understand that it will be competitive. The engine has a steel cylinder and the usual adjustable jet and mixing chamber, operating direct from the petrol tank. The ignition system is by coil and condenser.

It would have been interesting had the company produced a miniature flywheel magneto, for they are pioneers of this form of ignition, and must know everything there is to know about it. The smallest flywheel magneto yet made is that which I produced some years ago for a 30 c.c. horizontally opposed twin-cylinder two-stroke. The magnets were specially made for me by Darwins, the magnet people. They were expensive, but the magneto worked extremely well. Actually, however, it was no lighter than a coil and condenser, although it gave a fat spark at low crankshaft speed. I do not know whether anyone else has experimented on these lines. If so, I shall be glad to hear the results of those experiments.

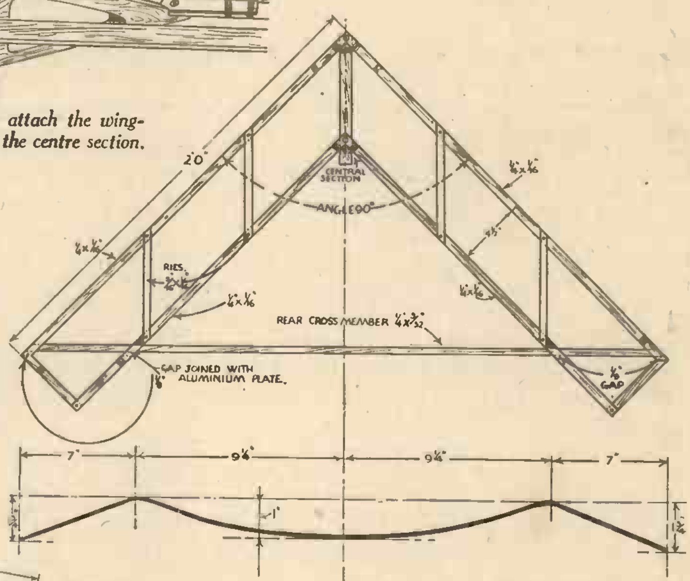


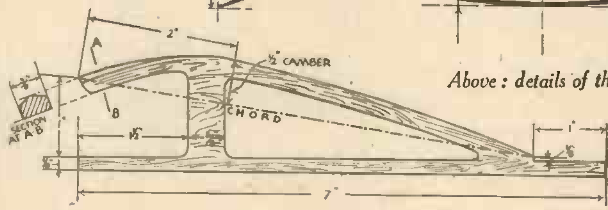
Details o the fuselage.



How to attach the wing-spars to the centre section.

A MODEL PTERODACTYL



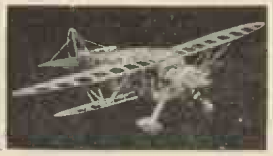


Above : details of the mainplane. Left : the centre rib.

Two views of the finished Pterodactyl.

GIVE M.S.S. VALUE KITS THIS XMAS

NOTHING WILL BE MORE APPRECIATED



Here are some outstanding examples of value:

BUNCH CADET MAJOR, span 30 ins.	Post free 9/-
BUNCH CADET JUNIOR, span 20 ins.	Post free 3/6
HI-FLYER DE LUXE, 4 models, span 25 ins. (Monocoupe mono, Stearman, Great Lakes, Voight)	Each 6/6
HI-FLYER, 20-in. kits, 23 models	Each 3/3
The wonderful FAIRCHILD 22, span 50 ins.	21/-
THE IDEAL PAIR	
"MISS AMERICA" 7 ft. Gas Model Kit	45/-
"GWIN-AERO" 6 c.c. Petrol Motor	87/6

And one for you to make over the holidays:

The Splendid MONOCOUPE 90a, span 50 ins. - 35/-

Guaranteed to fly 500 feet, it takes off from the ground within 15 feet, zooms high above the trees, and after a beautiful flight settles down to a perfect 3-point landing.

All these KITS are complete in every detail. There is nothing extra to buy.

ACCESSORIES OF EVERY DESCRIPTION

Send **2d.** *for 18-page Catalogue. Full of hints and tips. Scores of illustrations.*

MODEL SUPPLY STORES
(Dept. P), 46 Derby Road, Prestwich, Manchester

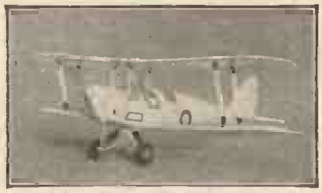
AEROMINORS

CONSTRUCTION SETS $\frac{1}{48}$th FULL SIZE

Wings, fuselage coverings, etc., are accurately designed and printed on special graded card. Internal stiffenings of balsa wood. Wheels, propeller parts, nose-pieces, etc., supplied shaped in wood. Tail planes, rudders, etc., made from thin plywood. Struts and under-carriages are made of wire with card fairings. Glue, pins, cane, thread for rigging, celluloid, plywood, balsa wood supplied. Complete with illustrated Instructions.

Hawker "Fury." Wing Span 7½ in.

No. 1 Kit. Either Hawker "Hart," "Hind," "Audax," "Demon" or "Osprey" Price 3/-

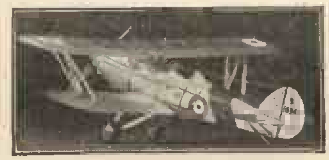


De Havilland "Tiger Moth." Wing Span 7⅞in.

No. 2 Kit. De Havilland "Tiger Moth" or "Moth Major" Price 2/6

No. 3 Kit. Hawker "Fury" or Hawker "Nimrod" Price 2/6

Postage Abroad 1/- extra.
In preparation, Percival "Vega Gull" (Winner of the King's Cup 1936, also Johannesburg Race). Ready Soon.
Send 1½d. for fully illustrated literature describing AEROMINORS, also our well-known large-scale AEROMODEL kits ($\frac{1}{24}$th Scale), etc. If you cannot obtain AEROMINORS from your local dealer send your Postal Order direct to:



Hawker "Nimrod." Wing Span 8½ in.

AEROMODELS Ltd.

No. 5, FIRST FLOOR, WELLINGTON BUILDINGS, LIVERPOOL, 2

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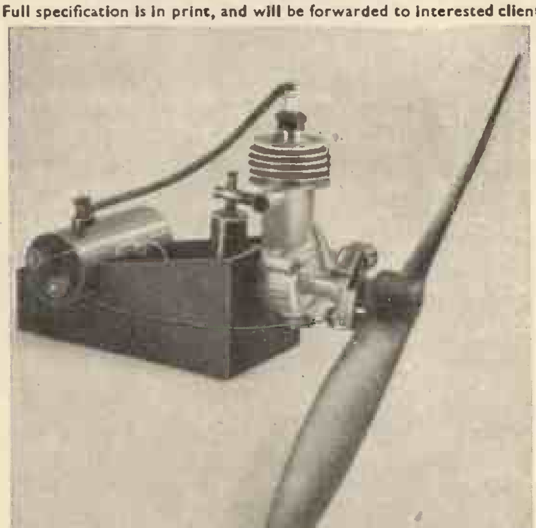
AT LAST . . . . 3·5 cc.

The GRAYSON "GNOME"

TWO-STROKE

THE IDEAL POWER PLANT FOR SMALL AIRCRAFT
SOLD COMPLETE AS ILLUSTRATED OR IN CASTINGS
Full specification is in print, and will be forwarded to interested clients



Complete engine, tank, carburettor, £3.17.6. Propeller extra, 5/6. Coil and Condenser, 2½ ozs. 14/6. Coil only, 2 ozs. 10/6. The above engine can be supplied in castings set in aluminium, complete with blueprint, 7/6. Set in electron, 10/6.

Complete Booklet P.E. for GRAYSON and GRAYSPEC ENGINES 3d. post free

E. GRAY & SON LTD., 18/20 Clerkenwell Rd., London, E.C.1

★ MEGOW'S

FAMOUS AMERICAN FLYING SCALE KITS

Wonderful Value . . . and they Fly

"GIANT" KITS.

50-in. Taylor Cub, 50-in. Monocoupe, **7/6** each.
60-in. Stinson .. **11/3**
50-in. Waco Biplane **15/-**

Always use "A-S" Rubber Lubricant - - 3d. box. Postage 1½d.

12–15-in. span. 28 types, including Puss Moth, S.E.5, Taylor Cub, Lockheed Vega, Stinson R., Fokker D7 and D8, Monocoupe, Boeing P12E, etc. **11d.** each complete. 24-in. span Kits: Curtiss Hawk, Taylor Cub, Fairchild, Corben Ace, Waco, Monocoupe, Kinner, Stinson R., etc. **2/6** complete.

Mail Orders: Add 2½d. for 11d. Kits; add 6d. all others.

All kits sold by HOBBIES LTD., and dealers everywhere or direct from

AER-O-KITS (Sheffield), Dept. XPA, 127 Portobello Street Sheffield, 1

MODEL PETROL ENGINES EASY TO MAKE FROM OUR CASTINGS AND DRAWINGS, **10/6** SET.

SEND SIXPENCE FOR ENGINE CATALOGUE

FINISHED ENGINES FROM **£3. 3. 0**

J. HALLAM & SON
POOLE - DORSET

THE WATER SOFTENER

THE perfection of the small chemical water softener has been boosted by the demand for hot water in modern office blocks and flats. Still smaller sized units make soft water available for the smallest demands. The method used in all these softeners is filtration through a bed of active sand, or zeolite. Although it is not the only method available, it is the cleanest and most convenient. In addition there are electrical treatments, but these do not soften water; they are designed merely to prevent scaling of hot-water systems.

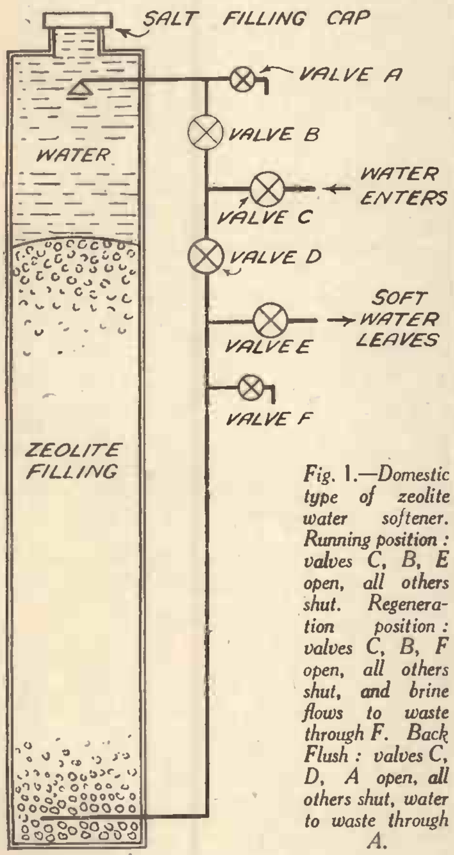


Fig. 1.—Domestic type of zeolite water softener. Running position: valves C, B, E open, all others shut. Regeneration position: valves C, B, F open, all others shut, and brine flows to waste through F. Back Flush: valves C, D, A open, all others shut, water to waste through A.

Hardness in Water

Hardness in water arises from the presence of small quantities of lime and magnesia which have been dissolved from limestone and chalk rocks through which the water percolates in its passage from rain-catching hillsides to reservoirs. Lime and magnesia in water form with soap insoluble curds, and before a lather can be obtained all the lime and magnesia have to be removed in this way. Then and only then will the water lather. This reluctance to lathering gives the water a hard feeling, and the chemist, borrowing from practical experience, still uses the expressions "hard water" and "hardness of water."

Chemists, indeed, use a soap test to measure the hardness of water. A special soap solution is added drop by drop to the water. At first, while the soap is removing the hardness, no lather is formed. As soon as this has happened addition of more soap produces a copious lather. From the amount of solution added the hardness of the water is obtained and is expressed in degrees of hardness. One degree of hardness as an actual quantity is one grain of hardness by weight per gallon of water. The terms degree and grains of hardness thus mean the same thing. London water has about 16 degrees of hardness, *i.e.*, 16 grains of hardness per gallon of water. Waters in chalky districts run up to 20, 30, or even 50 degrees or grains of hardness.

Scaling

A good deal of the hardness in water is due to the bicarbonates of lime and magnesia. These bicarbonates are chemically decomposed when the water is boiled, or even in some cases merely heated. Bicarbonate hardness is therefore referred to as temporary hardness. The products of the decomposition are a precipitate of the simple carbonate and carbon dioxide gas. You have probably noticed that hard water when boiled goes cloudy, due to the formation of the precipitate and effervescence due to the carbon dioxide. The accumulation of carbonate precipitates causes the formation of a hard scale usually called "fur" in kettles and water-heating boilers.

London water has about 10 degrees of temporary hardness out of its total of 16 and at this figure does not give appreciable scaling in boilers which run at a temperature of 120–140° F., which is the temperature of ordinary domestic hot-water systems. But if the temporary hardness runs much above 10 degrees and in addition the principal hardness constituent is magnesia, scaling is bad at any temperature above 100° F. It is in such cases as this that water softeners in conjunction with hot-water systems become almost a necessity.

Water Treatments

The easiest and cheapest way of softening water is to add lime and soda to it in carefully calculated quantities. But this method requires a type of plant which is not suitable for household use, although it would not be difficult to devise a suitable small-scale plant if the more convenient and cleaner method of zeolite softening were not available. All small household softeners work on the zeolite system. That is, water is brought in through a bed of active zeolite sand which removes the hardness from the water. The system is also variously called permutit, base-exchange softening, or is referred to by the trade name of the type of zeolite used in the softener.

Zeolites

There exist in nature certain active sands called greensands, or zeolites. In appearance they resemble coarse-grained gunpowder of very dark green colour, and they consist of aluminous quartz charged with soda. Their peculiar activity lies in the readiness with which they exchange their soda content for the lime and magnesia present in hard water. The exchange is complete, and the water is naturally completely softened because soda rather assists than hinders the lathering of soap.

Besides the natural zeolites, there are artificial zeolites made in various ways, such as by the combination of aluminate of soda with water-glass or in another case by roasting, acid washing, and soaking fuller's earth in water-glass. The artificial zeolites are on the whole rather better for small water softeners than the natural sand, because they are more active and have a larger-size grain, which in the softener does not offer so much back pressure to the water supply.

Softening Capacity

A given weight of a zeolite holds a limited and exact amount of soda. It is not therefore surprising that a given weight of zeolite will remove a definite and fixed number of grains of hardness. This fixed softening capacity is referred to as the exchange value of the zeolite. Most zeolites have an exchange value of about 6,000–10,000 grains of hardness per 100 lb. of zeolite. As a

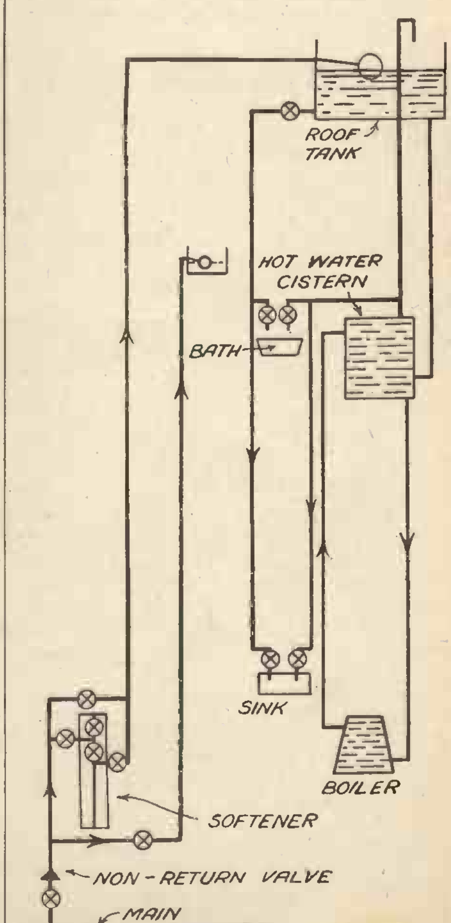


Fig. 2.—Installation layout for a water softener.

cubic foot of zeolite weighs practically 100 lb. the exchange value can be run out very easily from the dimensions of a softener.

Note carefully that the exchange value is expressed in grains of hardness; it has nothing to do with the volume of water which the softener will treat. Thus, if a water of 10 degrees of hardness, *i.e.*, 10 grains of hardness per gallon, is to be treated by a softener with an exchange value of 6,000 grains, simple arithmetic shows that it will treat 600 gallons of water before the softening capacity is exhausted. But if the water is 20 degrees hard, then it will treat only 300 gallons, and so forth. Two things then need to be known in installing a softener: the first is the hardness of the water and the second is the consumption between regenerations.

Regeneration

When the softening capacity of the softener is exhausted, it can be restored by a process known as regeneration. It is carried out by a short soaking in strong brine of common salt, or sodium chloride. This is an exact reversal of the softening process in which the former preference of the zeolite for lime and magnesia is reversed by the presentation of a sodium salt in high concentration. Just as the softening process follows exact relations as to quantity, so too does the regeneration process. The amount of salt is approximately one pound of salt for every 1,000 grains of exchange value of the softener.

Operation

Both softening and regeneration processes take place very quickly, and are quite simply effected. In softening, the hard water enters at the top of the zeolite, filters through the sand bed, and leaves at the bottom in a completely softened state. As soon as the exchange value of the softener has become exhausted hard water starts to pass. A hardness test with soap solution shows this. Regeneration is then carried out by opening a cap in the top, inserting the proper weight of salt, and then again passing the water in at the top and out at the bottom to a bypass cock, which leads it to waste. As soon as the water ceases to taste strongly of brine, it can be taken that the softener is regenerated, the brine cock is shut and the soft water outlet cock again opened to put the softener back on the line.

One other operation is required from time to time, known as back washing. The zeolite acts as a filter bed for the water and naturally any foreign suspended matter in the water supply gets caught and held on the top of the softener bed. In time this sets up a heavy back-pressure, which prevents free flow of the water supply. When this is indicated the cocks on the softener are reversed, so that water flows in at the bottom and out at the top to a special waste cock. Brisk upward flow of the water in this way shakes up the bed and washes out dirt.

The straightforward arrangement of cocks for operation and the schedule of operations are given in Fig. 1. But in modern softeners by use of two-way cocks the number of cocks can be cut down to two and operation becomes correspondingly simplified.

Fitting a Water Softener

The size of water softener suitable for a house depends on the hardness of the water to be treated and the amount of water to be used. The hardness is out of your control, but the quantity and therefore the size and cost of the unit and cost of running can be cut down by considering the plumbing layout of the water system. Soft water is really only needed for the hot-water system and perhaps for the cold taps in bathroom and kitchen. It is not needed for flushing cisterns, and a good many people prefer hard water in the kitchen for tea and coffee making and drinking. In addition softened water should not be used for cooking with aluminium ware, for the soda introduced in the softening process attacks aluminium.

The ideal plumbing layout, then, provides a supply of hard water to one kitchen tap and to flushing cisterns. The softener then goes into the rising main to the roof tank, which in turn provides soft-water supplies to the hot-water system and to the normal cold taps of the house. This layout should always be used where a softener is installed. It will be found that it cuts down the water consumption to about fifty gallons per day for the average household, and on this basis a softener becomes a very reasonable addition to the modern house.

CALOR GAS

Town Conveniences for a Million Rural Homes

CALOR gas is a butane mixture, prepared to the calor gas formula and butane is an aliphatic hydrocarbon of the paraffin series with the formula C_4H_{10}. The isomer is isobutane.

That is technically speaking. Translated into every-day language calor gas is a product which will bring every advantage of town gas to rural homes, however far they may be from gas mains.

Strange as it may appear, there are to-day throughout the British Isles nearly a million homes for which there is no gas or electricity supply available. The exceedingly heavy cost of the grid network makes it extremely unlikely that these homes will be supplied with electricity for some time to come. The extension of gas mains to isolated homes or hamlets would be an uneconomic procedure.

In Steel Containers

But calor gas is brought to any home, wherever it is, in small steel containers, and it functions in standard gas appliances that have undergone very minor adaptions. It is equally satisfactory for a small boiling ring or for the lighting, cooking and heating of a country mansion. Actually, it is already functioning in some thousands of homes in Great Britain; after three years, in half a million houses on the Continent; whilst in the United States it has been in use for nearly twenty years. It is, therefore, a product the value of which has been more than amply proved.

The calor gas container measures only 13 in. by 16 in. and weighs about 50 pounds when full. It is linked up to a cooker and any number of lights, fires, water-heaters and other appliances by a simple system of piping. A steady and constant pressure at the burner is maintained by a specially designed pressure regulator attached to the container. When used merely with a boiling ring or a cooker, a short flexible tube is the only connection necessary to the container which holds sufficient gas to last the average household, for all its needs, some three to five weeks.

Wireless, motor-transport, telephones have robbed the countryside of much of its loneliness. But in many thousands of homes there still goes on to-day the carting of coal and ashes and the removal of soot; the filling up of oil reservoirs, the trimming of wicks, the pricking of burners, and all the consequent unnecessary drudgery submitted to by the country housewife.

Odourless

Calor gas does everything that town gas will do. It burns without odour, it soots neither pots, pans nor ceilings, it is non-toxic.

But it has not merely a domestic application. It is not applicable only to the country home, the country inn, church, village hall or store. For the rural forge or workshop it provides intense, *controllable* heat. The farmer is using it for his incubators and for sterilising his milk bottles.

It has already been installed in hundreds of yachts at sea and in caravans on the roads. There are already calor gas street lighting systems in villages and rural street bollards are now in operation. There is a calor gas lit lighthouse. Railway restaurant cars have used it for months. In fact, one has only to think of the many hundreds of uses of town gas and this new product can be used for all of those purposes where town gas is not available, and in many cases it is never likely to be available.

Small Pressure

Unlike ordinary gas cylinders, the weight is light and the pressure small. Containers have been tested to a pressure of 700 lbs. per square inch and yet the pressure in a full container is only 23 lbs. to the square inch, an enormous margin of safety.

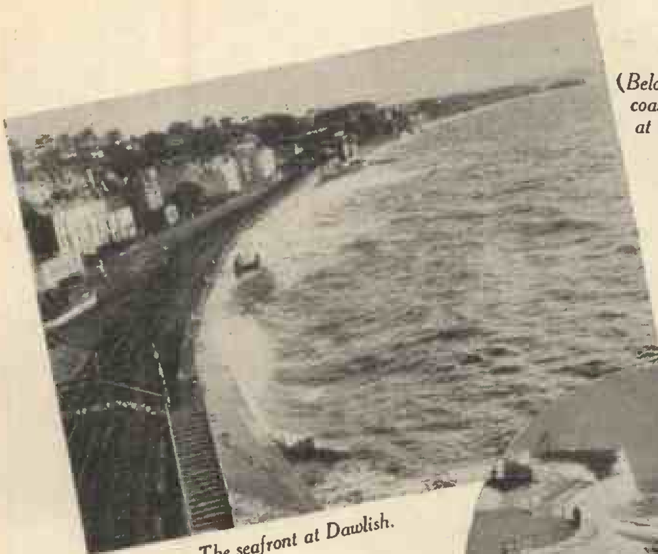
National distribution is being rapidly pushed forward and within a month or two there will be an official fitter and stockist in every area of 25 miles square throughout the country. Consumers will, usually be supplied with two containers. When one is empty a post card to the nearest stockist will bring a full one in replacement. In the meantime a couple of minutes suffices to disconnect the empty one and connect up the full one. Practically everywhere simple hire or hire purchase terms will be available.

Disadvantages of Country Life

A distinguished north country engineer said recently that this gas would effect a revolution in the countryside. That may have sounded like an exaggeration at the time; but that it will remove one of the chief remaining disadvantages of country life is evident. And, what is most important, the cost compares favourably with those fuels that are in present use.

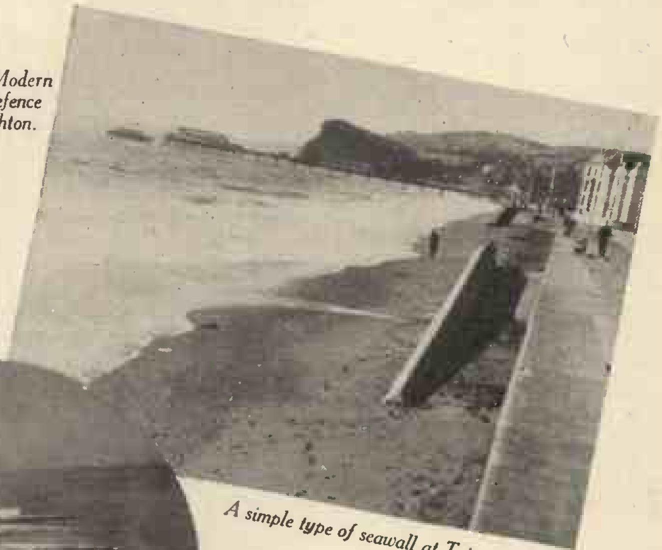
To those interested in more technical details, it may be added that each container of calor gas holds a charge of 28 lbs. of liquid butane mixture, which on vaporisation gives approximately 186·33 cu. ft. of gas, of a total value of between 600,000 and 700,000 B.T.U.'s. It is claimed that, owing to the scientifically balanced construction of calor gas burning appliances—they are tested to the calor gas standard of efficiency—each B.T.U. gives a much greater value than a B.T.U. of ordinary gas. The general construction of appliances is the same as in standard practice, but the gas orifice is much smaller and the air ratio much larger—about 30 to 1. Calor gas is a 100 per cent. British product.

OUR VANISHING COASTLINE



The seafront at Dawlish.

(*Below*) *Modern coast defence at Brighton.*



A simple type of seawall at Teignmouth.

Coast Erosion, and How it is Fought

IN these unsettled times, National Defence is a matter of paramount importance to our Government. Our Navy, Army, and Air Force are being strengthened, and every effort is being made to ensure that if we should be attacked we shall be strong enough to defend our shores.

But there is one powerful enemy who is attacking us *now*, and the battle has been proceeding for thousands of years. His advance is continuous and relentless, overwhelming towns and villages and even sweeping away mighty cliffs. That enemy is the *sea*.

When a Royal Commission was appointed a few years before the War, to enquire into the problem of coast erosion, some startling evidence was produced. In a paper read by E. R. Matthews, a distinguished engineer and scientist, the following figures were quoted.

66,000 Acres Lost

"One million nine hundred thousand tons of *cliff* are washed away every year, and the total amount of erosion round our coasts is estimated at three million tons. Supposing, as is likely, that the rate has been the same during the last two thousand years, we have lost 66,000 acres since the Roman invasion. The present rate of erosion on the Holderness coast is 11 ft. per annum, and if this has been continuous since the Romans landed in 55 B.C. more than three and a half miles of coast have been swallowed up by the advance of the waves."

Mr. Matthews was speaking of the gradual advance all along the coast, but there have been a number of instances where the enemy has made a big push, and captured a mighty salient—as we said in the War.

The most striking victory was before written history began, when this country was still joined to France. The waves broke through and now twenty-one miles of rough sea separate us from the mainland of Europe. The ocean had another victory in more recent times, which was due to the treachery of one of our own defenders. I refer to the famous Goodwin Sands. Before "1066 and all that" this formed part of the estates of the mighty Earl Godwin, the most powerful of the Saxon nobles, whose son King Harold died bravely fighting for his country.

Even in those early times it was understood that only vigilant watch and careful protection could hold these lands intact against the fury of the waves. The threatened population did their part, and collected a quantity of stones and timber to repair the sea walls, but the Abbot of St. Augustine's seized them, and used them to build Tenterden steeple.

Drowned Cities

Another, and more probable account declares that an annual tax was paid by the people for the maintenance of the sea-wall, but the money was diverted by the Bishop of Rochester, and used to build and endow the church at Tenterden. This story was quoted by the saintly Bishop Latimer (the greatest preacher of his day) in one of his famous sermons before King Henry VIII.

The sea walls being neglected, the sea broke through and swallowed up the land. Old tradition avers that the ruins of Earl Godwin's Castle could be seen under water for some years after the incursion of the waves.

There are many other places around our coasts where drowned cities lie far out to sea. The Cathedral and town of Selsey were overwhelmed about four hundred years after the church was built, and half the peninsula of Selsey has vanished since

Lulworth Cove is an instance where erosion has beautified the coast.

the Norman Conquest. If we look out to sea at Bognor at dead low water, we can observe a line of rocks, which tradition avers was once a range of cliffs facing the sea.

The Eastern Shores

Coast erosion is more serious on our eastern shores owing to the soft and friable nature of the cliffs. Twenty years ago the ruined church of Dunwich could be seen standing at the edge of the Suffolk cliffs, but when I visited the place last year only a few stones on the beach remained, and the church had vanished. This was an important seaport in Roman times, and was far greater in the mediæval period. During the winter of 1328 the sea broke in, destroyed four hundred houses, and demolished the harbour. Two hundred years later four churches were swept away, two town gates were destroyed, and many houses were overwhelmed.

The rest of the ancient town was swept away in 1740 and two hills, each over 40 ft. high, were levelled. To-day no vestige of the place remains.

Sea-walls

Every seaside visitor knows that all our larger coast towns are protected by sea-walls, which usually form the foundation of the sea front. Even in summer tremendous waves can be seen hurling themselves against the wall at high tide, and in great gales the spray is flung a hundred feet in the air.

The sea front at Bridlington, and the new marine parade at Scarborough are northern examples of this, while Splash Point at Eastbourne, White Rock at Hastings, and the sea-wall at Dawlish, are well-known places on our southern coast where magnificent wave effects can be seen.

Few landsmen realise the stupendous force of wave action. At Dunbar a pressure of three and a half *tons* to the *square foot* has been recorded, and there is no doubt that this tremendous figure is often exceeded where the waves roll in across a great width of ocean. Thus on the Cornish Coast—the "next parish to America"—the great breakers rush in from a two-thousand-mile stretch of ocean, and speeds of over sixty miles an hour have been observed. This is one of the stormiest coasts in the world. The first Eddystone Lighthouse was swept into the sea by a mighty wave, together with its architect, and the keepers. When the Wolf Lighthouse was built, only thirty-eight *hours* work was possible in the *first year*—owing to gales.

When Cherbourg breakwater was built, concrete blocks weighing twelve tons were displaced by the waves, and turned upside-down, while at Wick (Scotland) two great masses of concrete weighing 1,350 and 2,500 tons respectively were hurled from their position.

The Force of Winter Gales

Seaside town councils know to their cost how tremendous is the force of winter gales. Recently the sea front at Sidmouth was breached, and some thirty years ago the old Beaconsfield sea-wall at Bridlington was demolished, and blocks weighing twenty tons were scattered along the beach.

How then can these mighty forces be frustrated ? There are two methods, which are often used in combination—sea-walling, and groyning.

The sea-wall is, of course, a solid structure of stone or concrete, built along the front of the town, and usually projecting in a bold curve at points where wave action is most dreaded.

Much has been learned by engineers during the last few years about sea-walls.

The cheapest form is a vertical wall, but this is liable to be undermined and brought down by the scour of the receding waves, which carries away the beach from its foundations. An apron of stone or concrete, therefore, has to be added, which protects the beach immediately under the wall, and the cost of this usually offsets the cheapness of a vertical wall.

The best modern type has a stepped face, that is the wall is widest at the base, and recedes in steps as it rises, each row of blocks being set back behind the row below. The set back also diminishes as the wall rises, 12 in., 9 in., and 6 in. being a common arrangement. The steps break up the receding wave, and prevent scour by the undertow.

Stone or concrete blocks are better than solid masses of concrete, which are liable to be disintegrated by wave action.

The Use of Groynes

Sometimes extensive damage is done by masses of spray falling on the roadway, after the wave has been flung high in the air, and this is counteracted to some extent by fitting a projecting cornice at the top of the wall which checks the uplift.

Before we explain the use of groynes, it is necessary to speak of the coastwise sweep of sand and shingle. Millions of tons of cliff and shore are torn from our country every year: what becomes of it ?

The rock is broken up into shingle, and is carried by the waves along the coast, and the same process operates with mud and sand. On our southern coast the sweep is from *west to east*, on our eastern shore it runs from *north to south*. If some obstacle juts out into the sea to check the movement, the sand and shingle is piled up against it, and a raised beach begins to be formed. The same process occurs when two currents meet, and each deposits its load of detritus at the point of contact.

Here erosion is reversed, and new land is formed. The most remarkable example of a *natural groyne* to be found around our coasts is the Chesil Bank.

It is 18 miles in length, and 40 ft. high at the eastern end, where it connects the former island of Portland to the mainland, and forms a splendid causeway two miles long with the sea on each side. The fury of the waves here is often tremendous, and a large ship was once carried right across this lofty beach.

Groynes are long walls of timber, stone, or concrete, which jut into the sea at right angles to the coast line, and collect the shingle, thus forming a raised beach.

A rock pillar left by erosion at Portland.

Breakwaters and groynes, West Bay, Bridport.

When Currents Meet

When two currents meet, and each deposits the sand or shingle which it carries, a curious spit or hook is formed, and such are quite common around our coasts.

The spits at Calshot and Hurst Castle have not changed during historic times, but the great triangular deposit at Dungeness is growing steadily, as it has done for twenty centuries, and is believed now to contain three times the area which it possessed in Roman times.

Some of these spits are very long, as, for example, Spurn Head, athwart the Humber, and the tongue of shingle which turns the Suffolk river Alde southwards at its mouth.

We have spoken of erosion as an enemy which must be fought, but the same power which has swept away farms and engulfed cities, has carved out the graceful sweep of many a noble bay, and has created charming coves and creeks.

BOOKS worth READING

"Duration Flying Models," by Frank Ellis. Price 6/- net, 72 large pages, numerous full-size folded plates, half-tone, and line illustrations. John Hamilton Ltd., Publishers, London.

THIS book, written by a Canadian who was one of the pre-War pilots and served in the R.F.C. and R.A.F. during the War, contains a number of designs for stick models of the super-duration type. They all appear to be satisfactory fliers, and many of them hold records. The instructions are very thoroughly prepared and include lists of materials and numerous explanatory diagrams and photographs. The folding full-size plates are valuable in that they can be used as templates in construction. Every aero modeller interested in duration models should purchase this book.

"Boat-building Materials and Methods," by A. H. Lindley Jones. Price 5/-, 181 pages, 157 illustrations. Published by Percival Marshall & Co. Ltd., London.

THE eight chapters in this book deal with the timer, methods of storing and working, the selection and use of fastenings, the methods of preserving, caulking, and waterproofing, paints, varnishes, metals, wires, ropes, chains, and other fittings required in the construction of modern boats. The author has dealt fully with the different types of timber which may be used and explained their main features and working facilities. Every phase of the craft is dealt with, and the constructor should not find that any point has been overlooked in the production of this interesting text book.

"How to Buy Timber," by R. R. Rivers. Price 3/6, 121 pages. Published by Sir Isaac Pitman & Sons, Ltd., London.

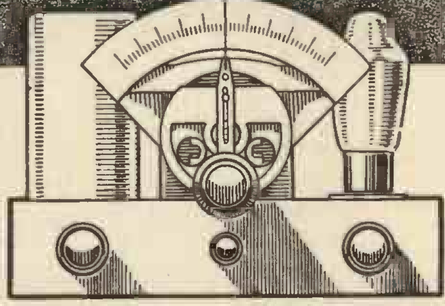
THIS is a popular guide for builders, architects, carpenters, cabinet makers, motor-body builders, and all others whose craft necessitates the purchase of timber in any quantity. The book is divided into three parts, the first dealing with the purchase of various types of timber, and the second with the selection of timber. The third part deals with the type of timber to use for different purposes. In this section will be found hints on secret nailing, wood for dance floors, fireproof woods, etc., and the book concludes with some useful tables showing the number of feet in a Petrograd standard, superficial measurements, table of relative prices, and so on.

"A First Course in Wireless," by "Decibel." Price 4/-, 214 pages, 93 illustrations. Published by Sir Isaac Pitman & Sons, Ltd., London.

THE twenty-one chapters in this book are devoted to the complete study of modern wireless practice, from a simple exposition of the term "electricity" up to the explanation of the modern circuit refinements such as automatic volume control, superhet. receivers, and so on. The main features of modern circuits are adequately dealt with, and cover the single-valve receiver, H.F. and L.F. amplifiers, selectivity, decoupling, and all the other incidentals of a good up-to-date wireless

(*Continued on page* 185)

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



THE increased interest in short-wave reception, created, no doubt, by the present television programmes, has resulted in a demand for an efficient receiver which will enable the short waves to be received in addition to the broadcast programmes. A separate receiver is not essential for this purpose, and in view of the tremendous popularity of the all-wave receivers which have been described in our companion paper, *Practical and Amateur Wireless*, we are giving here details of a similar type of receiver for battery operation.

F. J. CAMM'S RECORD ALL-WAVE THREE

A simple-to-build battery operated three-valve receiver covering the ultra-short and the short waves in addition to the normal broadcast wave-lengths.

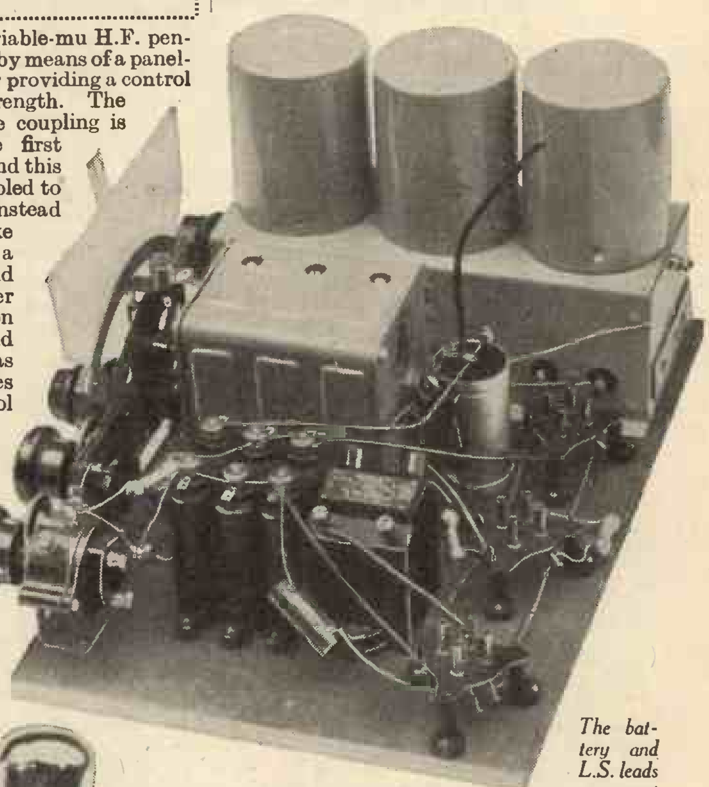
The Circuit

The circuit is reproduced on page 175, and it will be seen that although a "straight three" arrangement is employed there are one or two points of interest. Firstly, in regard to the coils, it will be noted that the short-wave and normal broadcast units are separated, a complete changeover being effected by the self-contained switch. This arrangement is, of course, preferable to the method where all coils are connected in series, and gives much better results. A further point of interest regarding the tuned circuits is that in the detector grid circuit a small capacity tuning condenser is employed on short waves, and the standard capacity on the broadcast wave-bands. This is carried out by using a three-gang condenser in which two of the sections have a maximum capacity of ·00025 mfd. and one of ·0005 mfd. The two smaller sections are wired to contacts on the switch element so that on the broadcast bands the two sections are in parallel, but on short waves only one section is in use, and this is connected in parallel in the usual way with the short-wave coil. In the aerial circuit, where the tuning is not so critical on short waves, the addition of a ·00005-mfd. trimmer attached to the tuning dial enables the tuning to be satisfactorily adjusted, and the inductances of the coils are arranged so that the correct wave-band is covered with the ·0005-mfd. condenser.

The first valve is a variable-mu H.F. pentode, adjustment of bias by means of a panel-controlled potentiometer providing a control of volume or signal strength. The parallel-fed tuned anode coupling is employed between the first valve and the detector, and this valve is transformer coupled to the output pentode. Instead of using an H.F. choke for reaction purposes, a resistor is employed, and this gives a much smoother control of reaction on the short waves, and the value which has been selected ensures good reaction control on the remaining wavebands. It will be noted also that the reaction winding is adjusted for the separate wave ranges, the switch for this being ganged with the remaining wave-change switch elements. The L.F. transformer is direct fed, and the H.T. supply for the detector valve, as well as for the screen of the H.F. valve, is arranged with a separate lead so that the optimum working conditions may be found under all circumstances.

The Layout

In order to cater for the beginner, this particular receiver has been assembled on a flat baseboard, and the components chosen are provided with terminal connecting points, to which the battery and loudspeaker leads are joined. This avoids the necessity of separate terminals and saves expense. Furthermore, all of the components are provided with ordinary screw holes, so that

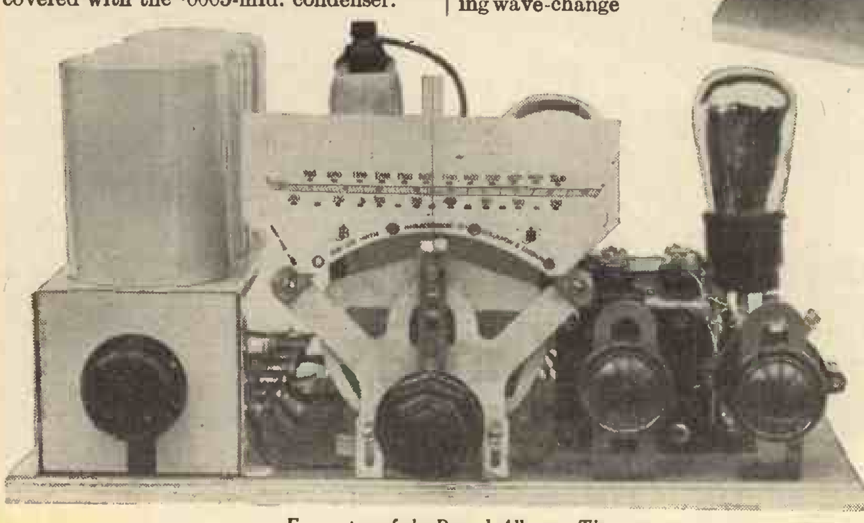


The battery and L.S. leads are not shown in this illustration in order to avoid confusion.

they may be attached to the baseboard in the simplest possible manner, and no drilling or other labour is involved. The layout provides for short and efficient wiring, and the only point to be emphasised is that each part must be placed on the baseboard in a definite order, otherwise it will be found difficult, if not impossible, to place in position certain of the connecting wires. This order will be explained in the wiring instructions which follow.

Building the Receiver

To build the receiver, therefore, the following procedure should be adhered to.



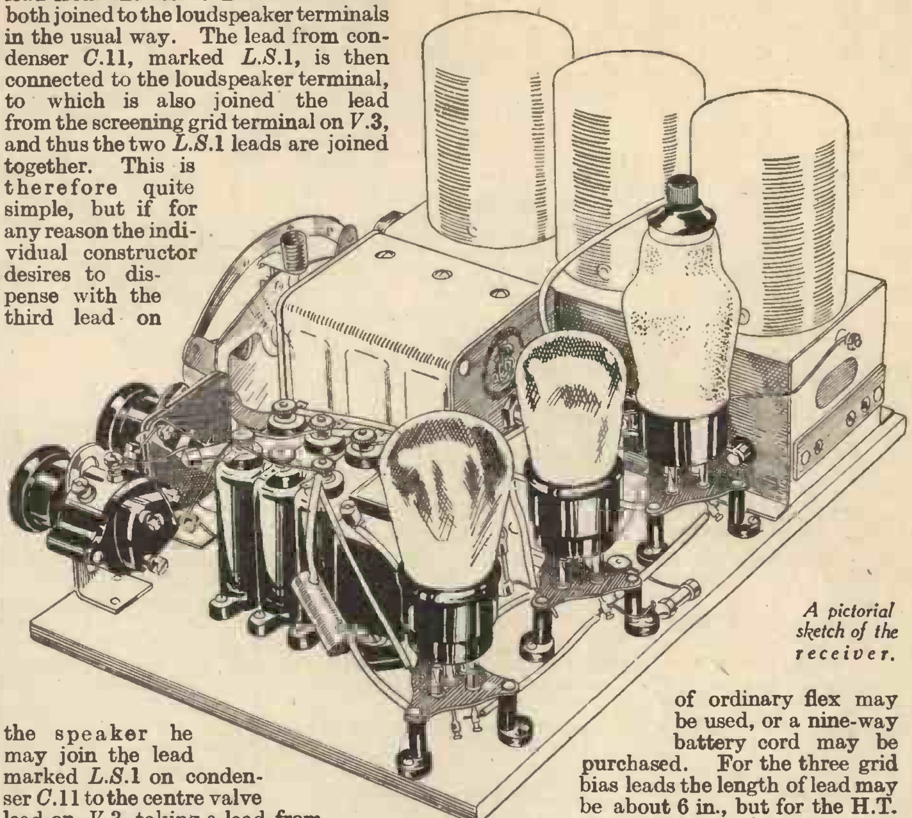
Front view of the Record All-wave Three

Firstly, obtain a piece of plywood 12 in. by 8 in., with a thickness of about $\frac{3}{8}$ in. This may be obtained with the kit of parts from Messrs. Peto Scott or purchased locally, and will cost only a few pence. Firstly, screw in position the three valveholders, loosening the screws attached to the lower portion of the valve legs before doing so. Make quite certain that they are in the correct order and arranged in the correct position so far as concerns the grid and anode sockets. Now cut off a length of the connecting wire sufficient to pass from the first to the third valve, and cut off two short lengths of insulated sleeving which will just reach from the filament socket on the centre valveholder to the valveholders on each side, and then thread the wire through the centre valveholder filament terminal, slip over the two pieces of sleeving (one on each side) and anchor the ends in the end filament sockets. Carry out the same procedure on the other side of the valveholders, and the filament circuits will be completed.

Next screw down the grid condenser, and proceed with the wiring and mounting of the components, following the circuit shown below. If you cannot wire from this diagram, a Blueprint, No. P.W. 69, may be obtained from this Office, price 1/-.

The Flexible Leads

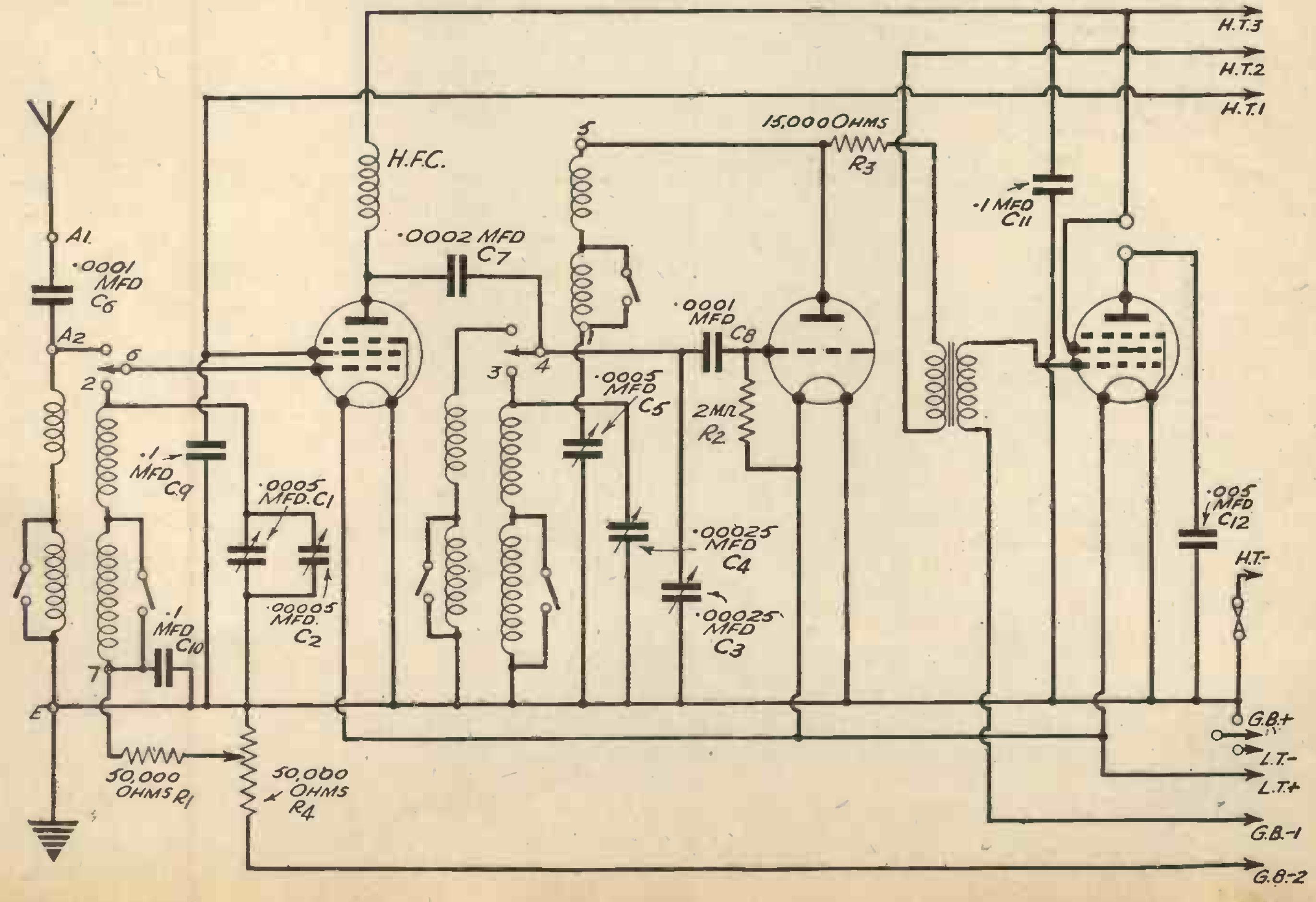
It will be seen from the diagram that three loudspeaker leads are required in this particular design in order to simplify the general receiver wiring. In addition to the usual anode and H.T. positive lead to the speaker, the additional lead is employed in order to convey to the screen of the output pentode the necessary H.T. positive potential. No confusion should arise from this scheme, however, as in the blueprint the lead from the screening terminal on the output valveholder is marked *L.S.*1 and the lead from the anode *L.S.*2. These are both joined to the loudspeaker terminals in the usual way. The lead from condenser *C.*11, marked *L.S.*1, is then connected to the loudspeaker terminal, to which is also joined the lead from the screening grid terminal on *V.*3, and thus the two *L.S.*1 leads are joined together. This is therefore quite simple, but if for any reason the individual constructor desires to dispense with the third lead on the speaker he may join the lead marked *L.S.*1 on condenser *C.*11 to the centre valve lead on *V.*3, taking a lead from this point for connection to the loudspeaker.

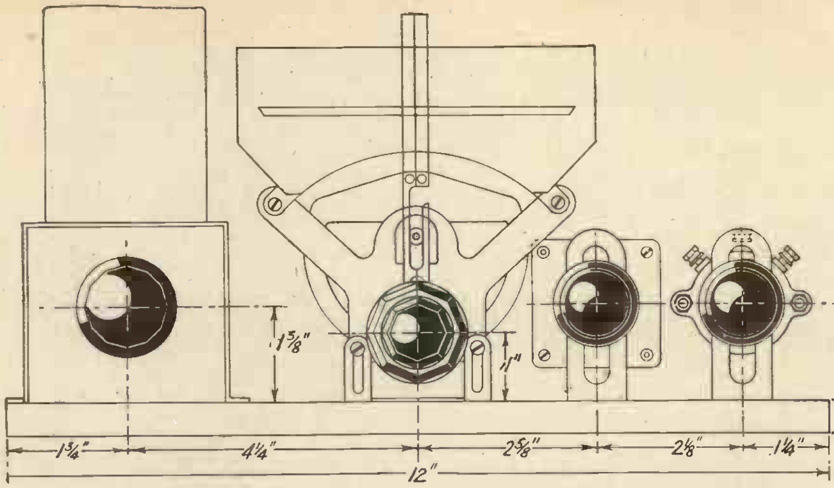


A pictorial sketch of the receiver.

The Battery Leads

There are nine battery leads, and lengths of ordinary flex may be used, or a nine-way battery cord may be purchased. For the three grid bias leads the length of lead may be about 6 in., but for the H.T. and L.T. a length of about 12 in. will be required. Bare a distance of half an inch at each end of these leads and attach to one end of each one of the Bowspring wander-plugs or spades. The lead marked L.T. + should be joined





This diagram will enable you to drill the front of the cabinet accurately.

to the filament socket on *V*.3 farthest from the panel, and L.T. — to one of the switch contacts on the combined volume-control and on/off switch. To the remaining empty terminal on this switch the G.B. + lead is attached. To the empty side terminal on the control the G.B. — 2 lead is attached, and G.B. — 1 is attached to the terminal on the L.F. transformer, which is marked G.B. H.T. — lead is joined to the right-hand terminal on *C*.9, and H.T. + 3 is joined to the left-hand terminal on *C*.11, the remaining two leads being joined to the L.F. transformer and condenser *C*.9, the latter H.T. + 1 and the transformer lead H.T. + 2.

The receiver is now ready for test, and before plugging in the valves the wiring should be very carefully checked by the blue print. If you have a meter it is advisable to make a voltage test to ensure that the valves will not be burnt out due to a mistaken connection. For this purpose the H.T. and L.T. batteries should be connected up as described in the next section and the switch placed to the "on" position. The voltmeter should then be applied to the filament sockets on the valveholders and the reading should not be greater than 2 volts.

Preliminary Adjustments

If this is in order the valves may be inserted, the H.F. valve being plugged into the holder next to the coil unit, the detector valve in the centre holder and the pentode in the remaining holder. A short flexible lead should now be joined to the anode terminal on *V*.1 and taken down and connected to the terminal on the H.F. choke to which is connected condenser *C*.7 (·0002 mfd.). Connect the L.T. negative and positive spades to the negative and positive terminals on the accumulator and insert the G.B. positive plug into the positive socket on the G.B. battery. G.B. — 2 should be inserted into the other end of the G.B. battery at — 9 volts, and G.B. — 1 into the 4·5-volt socket. The latter voltage may be modified subsequently when the receiver has been put into correct working order. H.T.1 should be inserted into the 84-volt socket on the H.T. battery, H.T.2 into the 60-volt socket, and H.T.3 into the 120-volt socket. Again, it may be found subsequently that H.T.1 and H.T.2 may be modified in order to provide the maximum operating conditions.

Connect the earth lead to the socket marked *E* on the rear of the coil unit and the aerial lead into the socket next to it, *A*.2. Turn the reaction condenser to its maximum position in an anti-clockwise direction and set the control knob on the wavechange switch so that the orange-coloured spot is on top. This sets the coils to the medium-wave band from 200 to 550 metres. Turn the right-hand control slowly to its maximum position and the receiver will then be in its most sensitive position and the local station should be heard. Turn the main tuning control until the signal is picked up, or until any signal is heard, and in the case of a listener situated in the London district, for instance, the London National should be heard at a setting about one-third of the way from the lower end of the tuning dial. To ensure that the minimum wave-length of 200 metres is tunable, the trimmers on the three-gang condenser must be correctly set.

Adjusting Minimum Wavelength

The trimmer on the section farthest from the panel should be unscrewed to its minimum setting, and that on the next section should be set as near the minimum position as can be obtained, and this will be ascertained by the spread covered by the concentric trimmer on the slow-motion drive. When a station has been tuned, therefore, adjust the trimmers as near to the minimum setting as possible and swing the trimmer to make certain that no further improvement are obtained. Then turn to a position at the opposite end of the tuning scale and again swing the trimmer to make certain that the correct band is covered.

The Short Waves

The reaction control should, of course, be adjusted to strengthen those stations which are not normally sufficiently powerful to provide adequate loudspeaker signals. The change from one waveband to another is carried out by means of the wavechange switch mounted on the coil unit, the colour of the spot which is uppermost showing the actual setting which is in use. The green spot signifies the lowest waveband from approximately 14 to 30 metres, the red spot the next short-wave band from 27 to 60 metres, the orange spot the medium waves as above-mentioned, and the blue spot, the long waves, from 850 to 2,100 metres. These ranges are, of course, only approximate, and will be modified according to the setting of the trimmers and to the aerial with which the receiver is employed.

Alternative Aerial Connections

The modification of the aerial lead, by inserting it into either socket *A*.1 or *A*.2, will also modify the range and, furthermore, will be found essential to obtain smooth reaction on the short waves. The selectivity is best when terminal *A*.1 is in use, but naturally a slight loss in signal strength is then obtained. When transferred to *A*.2 the selectivity will be poorer, but better signal strength will be obtained. The adjustment of the volume control will also be found to modify slightly the selectivity as well as the sensitivity, and thus it will be necessary in some cases to make use of the transfer aerial tapping, the volume control, and the reaction condenser in order to obtain a signal free from interference. For instance, it may be found at some parts on the dial that a station may be heard at full volume with reaction at zero and with the volume control in its maximum position. But there may be a background from some other more powerful station on an adjacent wave-length.

LIST OF COMPONENTS FOR F. J. CAMM'S RECORD ALL-WAVE THREE

One All-wave Coil Unit (B.T.S.), 25*s*.
One Three-gang Condenser, Type K (·00025 + ·00025 + ·0005 mfd.) (C1, C3, C4) (J.B.), 15*s*.
One Slow-motion Drive (type 2135) including ·00005 mfd. trimmer (C2) (J.B.), 6*s*. 6*d*.
One ·0005 mfd. Reaction Condenser (C5) (Graham Farish), 2*s*.
Six Fixed Condensers:
  Three ·1 mfd. type B.B. (C9, C10, C11) (Dubilier), 5*s*. 6*d*.
  One ·005 mfd. type 4421/E (C12) (Dubilier), 1*s*.
  One ·0001 mfd. type 670 (C8) (Dubilier), 1*s*.
  One ·0002 mfd. type 670 (C7) (Dubilier), 1*s*.
Three Half-watt Resistors:
  One 15,000 (R.3) (Bulgin), 6*d*.
  One 50,000 (R.1) (Bulgin), 6*d*.
  One 2 megohm (R.2) (Bulgin), 6*d*.
One Volume-control Potentiometer with switch, 50,000 ohms type VM.36 (R.4) (Bulgin), 5*s*. 6*d*.
One All-wave H.F. Choke, type H.F.15 (Bulgin), 5*s*.
One L.F. Transformer, ratio 3·5 to 1, type Niclet (Varley), 7*s*. 6*d*.
Two Component-mounting Brackets (Peto-Scott), 8*d*.
Three Baseboard-mounting Short-Wave Valveholders, two 4-pin and one 5-pin (type V.8) (Clix,) 5*s*. 6*d*.
Seven Master Wander-plugs:
  H.T. — H.T.1, H.T.2, H.T.3, G.B. +, G.B. —1, G.B. — 2 (Clix).
2 Spades, L.T. + and L.T. — (Clix).

One wooden baseboard, 12 in. by 8 in. (Metaplex).
Twenty-three No. 3 ¾ in. round-head screws.
Eight No. 3 ½ in. round-head screws.
Two No. 4 ½ in. round-head screws.
  Two lengths insulated sleeving.
Quantity of tinned copper wire or insulated connecting wire.

ACCESSORIES

Three valves, VP215, H210, and Y220 (Hivac).
One W.B. Stentorian Speaker (Whiteley Electrical).
One 120 volt Drydex Super-Life H.T. battery (Drydex).
One 9 volt G.B. battery, Type H.1001 (Drydex).
One 2 volt L.T. accumulator, Type DMG-C (Exide).
One "Record" Cabinet (Peto-Scott).

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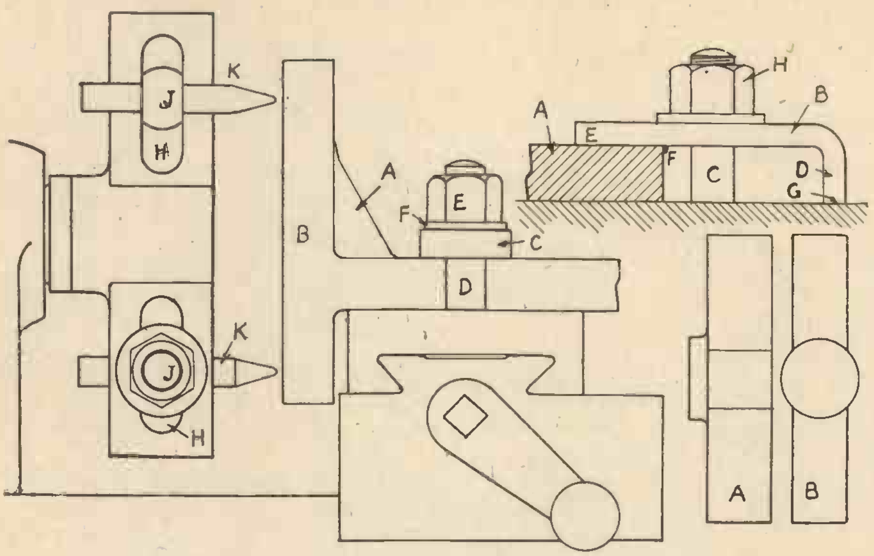
Advertiser	Page No.	Information Required

Attach sheet of paper, with particulars, and your name and address (written in **BLOCK** *letters) with date, to this announcement.*

SURFACING IN THE LATHE

Surfacing Jobs Which Are Not of a Shape Which Allows Them to be Rigged Up on the Face Plate.



Figs. 1 to 3.—(Left to right) A suitable arrangement; using a bent bar when only one stud hole is required and a simple wooden pattern.

MOST mechanics have had experience of using the lathe for surfacing, in which operation the work is bolted to the face plate and the tool traversed by the cross slide and fed up to the work by the top slide of the compound slide rest.

This method gives good results on such work as can be bolted to the face plate on the lathe mandrel. But in many cases jobs require surfacing which are not of a shape which allows of them being rigged up on the face plate, and a method of tackling such jobs may prove of interest. It will also prove a time and money saver if several parts have to be machined, and is always available once rigged up.

Where we have a cast-iron standard (such as the side standards for a small vertical engine) the bottom and the top surfaces require machining in a true plane. They could not be mounted on the face plate.

A Suitable Arrangement

The arrangement shown in Fig. 1 makes the job easy. The work is bolted down on the top of the cross slide, the top slide having been removed and the stud holding the latter being used (perhaps with an additional stud and a cross bar) to hold the work down. Sometimes the shape of the work allows it to be bolted down by the stud (which holds the top slide normally) alone. The tools for surfacing are mounted in a tool holder which screws on the lathe mandrel nose.

In Fig. 1, *A* is a pillar, the base *B* of which requires machining or surfacing. It is bolted down by a strap *C* and a pair of studs and nuts and washers *D, E, F*. Sometimes the shape of the work is such that only one stud is required, and it may screw into the stud hole in the bottom slide which holds down the top slide.

This may be done by using a bent bar as at Fig. 2, which saves the necessity, where the shape of the job allows its use, of drilling and tapping a hole in the slide top for a second stud for use in this method of surfacing.

Here the work is at *A*. *B* is a bent bar of iron with a hole through it to take the stud *C*. The bend down end *D* of the bar should be very slightly longer than the thickness of the work to be held down so that the bar holds firmly at *E* rather than at *F*. Where the bent-down part is not long enough any metal (not wood) packing can be put under the end at *G*. Screwing down the nut *H* will hold the work firmly.

Other Shapes

For other shapes other fastenings may be improvised and the use of a second stud hole will always be found of utility when tackling awkward jobs.

The tool holder shown in position, relative to the work, in Fig. 1, is made of cast iron: a simple wooden pattern shown at Fig. 3 being required, *A* being a side view and *B* a front view. It is bored out and screwed to suit the lathe mandrel and slots are cut in it by drilling and filing as shown at *HH* in Figs. 1 and 4. These slots should be ½ in. wide. They are to take the turned eye studs *JJ* (Figs. 1 and 4), and should be about ¾ in. wide.

The eye studs are turned from the bar and their shape is shown at Fig. 6 where *A* is an end view, *B* is a side view and *C* a perspective view. At the end they are turned to ¾ in. diameter and then filed down to the shape shown and ½ in. wide, and fit in the slots in the tool holder. They have ½-in. shanks turned and screwed ½-in. Whitworth, and through the head, from flat to flat, is drilled a ⅜-in. hole *D*, which takes the ⅜-in. round steel cutter.

In Fig. 4 is shown how the nut and washer at the end draws the eye bolt *J* through and clamps the cutter K against the face of the cutter holder, shown also in Fig. 1.

It will be noticed that the cutters are adjustable along the slots and can be brought near the centre for narrow work to prevent too much "cutting the air" and further out to cover wider areas.

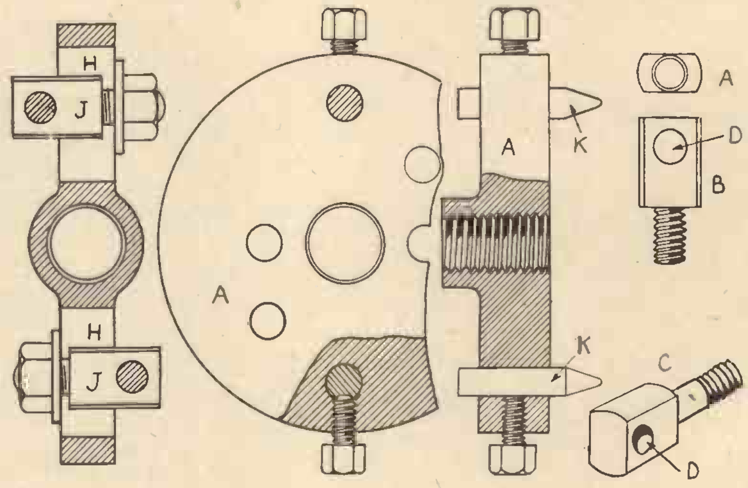
A Simple Cutter

A simpler form of cutter holder is shown at Fig. 5. Here a wide disc *A* is turned with a shoulder to fit the lathe mandrel nose. The front view shows how the holes (which should be opposite each other in pairs) can be staggered so that cutters can be inserted in pairs to take the maximum diameter to cover the job without leaving too much of the surface to be machined. Here the holes are ⅜ in. diameter square with the face and holes are drilled into them from the edge of the plate and ¼-in. Whitworth tapping size. These holes take ¼-in. set screws, which should be case hardened at the end. They pinch the ⅜-in. round cutters.

In use, the lathe should be put into back gear with the belt on the largest cone of the pulley, so that the mandrel rotates at the lowest speed. The work is traversed across in front of the cutters by the cross slide screw and handle, and the feed for depth of cut is made by engaging the nut on the saddle with the lead screw, and having a big change wheel on the end of the latter and using this to feed the saddle up to the work to increase the depth of cut.

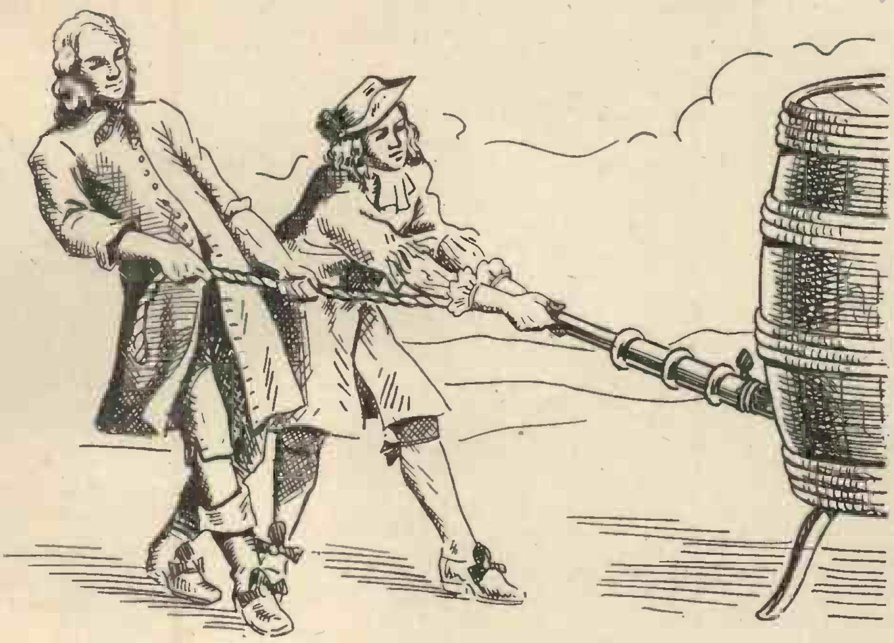
Where a lathe is fitted with a shaft for surfacing—a shaft which automatically operates the cross slide—this may be used. Most small lathes, however, are not so fitted.

Figs. 4 to 6.—(Left to right) How a nut and washer at the end draw the eye bolt through; a simple form of cutter, and the shape of the eye studs.



Masters of Mechanics—No. 16

The Honourable Robert Boyle and the Foundations of Mechanical Power



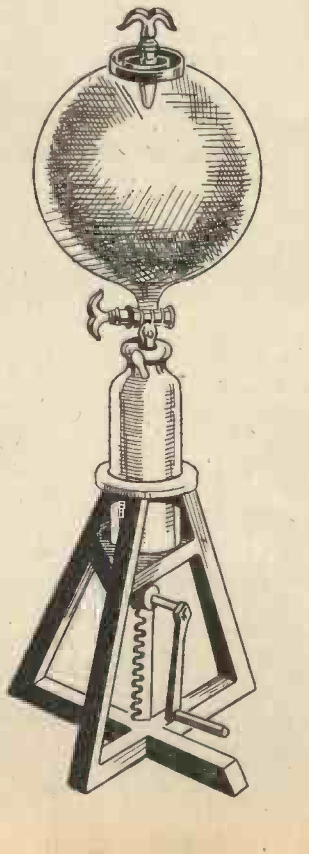
An early air-pump experiment to remove air from a sealed barrel by means of a crude type of pump.

NEARLY every schoolboy who has passed through an elementary science course considers himself to have made more than sufficient acquaintance with " Boyle's Law " and its vagaries. For Boyle's Law, that well-known generalisation concerning the relationship existing between the pressure of a gas and its volume, is one of the most fundamental concepts of modern science. Upon Boyle's Law, physics has built up an enduring structure of solid fact. No wonder, therefore, is it that the youthful aspirant to the systematic study of science is, more often than not, made to form acquaintance with this celebrated Law without delay.

Law of Gaseous Compression

In spite of the fact that the famous Law of Gaseous Compression to which he gave his name is so well known, the curious career of Boyle has, to a certain extent, been allowed to sink into obscurity. There is no doubt of the fact, however, that this shy, retiring, semi-ascetic and altogether strange and queer individual, the Honourable Robert Boyle, effected during his lifetime scientific discoveries of the utmost importance. Boyle, indeed, made his lasting mark, not only upon the infantile and immature physics and mechanics of his day, but also upon the embryo science of chemistry which he assisted in freeing from the age-old superstitions and charlatanism of alchemy and would-be magic.

One of the reasons why the early pioneers of steam-motive power experienced so much difficulty and so many disappointments over the working of their crude mechanisms is that they failed to realise the fact that steam behaves as if it were a true gas and, therefore, that, within reasonable limits, it is subject to the laws which govern the properties of gases. The early steam pioneers hardly realised the tremendous power inherent in expanding steam. Steam, to them, was merely a useful vacuum-producing agent. You admitted steam to the under-side of a piston and the vacuum produced when the steam condensed was sufficient to allow the forcible descent of the piston under the pressure of the atmosphere on its upper side.



Boyle's original air-pump, the first mechanical air-pump to be made in this country.

That, in brief, was the working principle of all the early steam engines. Had, however, inventors given closer ear to the principles of physics and mechanics which Boyle laid down, and thereby utilised the *expanding* force of steam to drive a piston downwards within a closed cylinder, steam power might have been made practicable a century or more before it actually came into prominence.

Theoretical Investigations

Boyle, it is true, never constructed a steam engine. In point of fact, the actual working mechanisms which he did actually make are very few and far between. It is to Robert Boyle as a theoretical mechanician and physicist rather than as a practical inventor that lasting fame and honour, and inclusion in the long line of engineering and mechanical pioneers is due, for, without a doubt, Boyle, by his theoretical investigations, researches which, owing to the nature of the times in which they were carried out, were arduous and difficult, laid down, with Newton and a handful of other investigators, principles which ultimately proved of the greatest help to later inventors.

The personal history of Robert Boyle was uneventful. Born at Lismore, Ireland, in 1626, Boyle was the fourteenth child of Richard Boyle, a Herefordshire man who went to Ireland early in his lifetime, married a rich wife and ultimately became Baron of Youghall, Viscount of Dungarvan and Earl of Cork. The famous Robert Boyle, therefore, in consequence of his birth, bore the title " Honourable."

Robert Boyle was cast by Nature in a delicate frame. As a youth, his health was bad, a circumstance which was not by any means improved by his highly studious habits. At the age of eleven, young Robert was taken for a protracted tour around Europe. At Florence, Boyle became acquainted with the works of Galileo. From that time he appears to have given his mind over completely to the study of natural science. In his later youth, Boyle developed strong religious tendencies and at one time contemplated taking Orders. Feeling, however, that he possessed no real vocation for such a life, he relinquished all hankerings after the Ministry and retired to Oxford and then to London, in which two cities he assiduously and, at times, very secretly devoted the whole of his abundant time to the pursuit of scientific knowledge.

A Religious Man

Boyle was one of the original members of the Royal Society. He was elected President of the Royal Society, but he refused to take that office upon himself because the Charter of the Society laid down the taking of an oath by a newly installed President, and Boyle, in consequence of his extreme religious views, interpreted to the letter the New Testament exhortation not to swear "neither by heaven, nor by earth, nor by any other oath." Such was the character of the man.

Perhaps the work of Boyle which has most benefited the modern world is that on the physical characteristics of air and gases. Air, stated Boyle, has a "spring" in it. When you heat air (or any other gas, for that matter) its "springiness" increases and, conversely, when air is cooled, this peculiar buoyancy departs from it.

In other words, Boyle, in his quaint phraseology, was trying to acquaint his contemporaries with the fact that gases expand when they are heated and contract when they are cooled.

Now comes a most significant part of Boyle's work. He showed that an expanding gas exerted a truly enormous and an almost irresistible force upon its surroundings. Subsequently, he suggested that air and gases, in expanding, might be compelled to do *useful work*.

Here we have the first germ of the future steam engine, of the turbine and of the various forms of internal combustion engines. All such prime movers operate in virtue of the almost irresistible expansion of a heated gas (for steam, in expanding, behaves very much as if it were a true gas). Were it not, therefore, for this characteristic "springiness," as Boyle puts it, this expansive force of gases, many of our present-day engines would not only be unknown but also unknowable.

A Vacuum Pump

Boyle was one of the first to construct an efficiently working vacuum pump. Such an instrument he termed a "wind pump." With this pump he made a large number of experiments upon the physical nature and properties of air. He showed that a candle flame is extinguishable in a vacuum, that animals cannot live in one and, moreover, he came very near to the discovery of oxygen by suggesting that air contained within itself some vital principle whereby animal and human life was sustained and combustion made possible.

Unfortunately, however, Boyle missed the real significance of flame and combustion. Had he been able to elucidate its real nature, the twin sciences of physics and chemistry might have made much more rapid strides than they did at that period.

The best-known contribution of Boyle to physical and mechanical science is his well-known "Law," which states that the volume of a gas varies inversely as the pressure which is placed upon it, the temperature of the gas being maintained constant. Boyle, in determining this law, worked with bent glass tubes containing air and mercury. He poured mercury into a tube containing a known quantity of air. The mercury rose in the tube and compressed the air in front of it. By increasing the "head" of mercury, Boyle increased the degree of pressure on the air in the tube.

Nowadays, we know that, whilst Boyle's Law serves for many practical purposes, it is by no means strictly accurate. Gases throughout a long range of temperature and pressure do not always obey Boyle's Law. Some of them, even when subjected to only moderate pressures, condense and turn into liquids. Others, after they have been compressed to a certain maximum degree, seem to turn round, as it were, and strenuously oppose further compression.

The Air Compressor

Boyle, in addition to constructing the first vacuum pump made in England, also devised a machine which would act in the opposite manner and, instead of removing air from an enclosed space, would strongly compress it into confined surroundings. In other words, Boyle now appears before us as the inventor of the air compressor.

Boyle's air compressor was, naturally enough, a very crude affair. At first Boyle tried to compress air within a barrel, but, finding that, when he attempted that feat, the compressed air speedily decompressed itself again through every chink and crevice of the barrel, he used a metal globe with more successful results.

It is interesting to note that Boyle, in his construction of his "wind pumps," employed the very same means as those which are now used, to wit the piston and the cylinder, both of which devices had previously been invented by mechanicians on the Continent. It was during his manipulation of his air compressor that Boyle noticed the power of compressed air to force a piston up a cylinder and thus to do useful work. From this observation came the pregnant remark of Boyle's which we have already noted—that expanding air might be made to do useful work.

Delicate Health

Owing, no doubt, to his delicate health, which remained with him throughout his lifetime, to his retiring disposition and to his ample financial resources which he inherited from his father, Boyle, as his life progressed, became more and more of a recluse. He disliked the ordinary affairs of life. No wife ever shared the interests of his life and with mechanics and science he mixed, seemingly at his mere fancy, the deepest theological matters and curious religious speculations.

It is on record that Boyle, when engaged in the laboratory and workroom of his residence, would hang up outside the door of his apartment a little card bearing the following handwritten inscription:

Mr. Boyle is not to be spoken with to-day.

In many respects, the above legend summed up the characteristics of Boyle's curious and genius-like personality. Having no liking for the ordinary engagements of the world, he shut himself away from them and lived wholly for Science, almost his sole acquaintances being a handful of kindred spirits who, with him, assisted in the formation of the Royal Society.

Boyle stands a curious and an almost solitary figure in the history of early mechanical, physical and chemical science. Behind him, the path of science is almost indiscernable, for it leads back into a veritable quagmire of superstitious nonsense. In front of him, however, the track is clearly defined and quite plain, and it leads directly to our own times.

Out of Boyle's strange and queer lifetime came a new spirit of science, a spirit which, so far as practical mechanics and engineering is concerned, ultimately fructified in the construction of the steam engine and in the development of mechanical power.

His "Works" Collected

Boyle died in London on December 23rd, 1691. His *Works* were afterwards collected, edited and published in six folio volumes. They are seldom if ever, read nowadays, except by historians of science, for Boyle's style of writing, in common with that of others of his Age, was prolix, long-winded and rambling in nature. Nevertheless, in those six folio volumes which represent a lifetime of scientific research, the modern enquirer may, if he cares to, trace at will the first conception and the beginnings not of one or two modern mechanical principles and devices but of a whole array of them.

Some mechanicians invent. Others, by their work, make it possible for inventions to be made. The Honourable Robert Boyle is to be included in the latter class of original minds and as long as the early records of mechanical and physical science persist his name will stand out prominently as that of a pioneer scientific worker of the very first repute.

FLYING DOCTORS OF AUSTRALIA

THE commercial aeroplane has achieved many triumphs, but none has been more remarkable than the aerial medical service of Australia. Populated areas in Australia are confined to the eastern and southern districts. Over the remainder of the country—an area larger than Western Europe—are dotted settlers whose nearest neighbours are often 100 miles away, and whose nearest doctor or hospital may be 200 miles or more distant. The only transport in much of this vast territory is by car over bush tracks, and in the wet season such tracks often become quagmires. It was in 1912 that a special mission was founded to provide medical aid for the remote bush districts. Nursing homes were established at various centres, and even in those pre-war days the Rev. John Flynn, who had been placed in charge of this work, foresaw the possibilities of aeroplane and wireless.

A Special Wireless Transmitter

It was not, however, until after the war that plans in this direction began to take shape. A first medical air base, with a D.H. 50 air ambulance, and a flying doctor in the person of Mr. St. Vincent Welch, began its work at Cloncurry in 1927. At the same time a special wireless transmitter was evolved for maintaining communication between remote "outback" stations and the flying doctor's headquarters. In this form of transmitter a dynamo is operated by bicycle pedals, and Morse signals are tapped out on an automatic keyboard operated like a typewriter. A wireless base station was put into operation at Cloncurry in 1928, and soon afterwards the first pedal wireless sets were installed at some of the "outback" stations, enabling them to call up Cloncurry when the services of the flying doctor were required. At the present time over thirty pedal-operated sets are working in conjunction with the Cloncurry base.

The work of the flying doctors in Australia has been enlarged greatly during recent years. The first base at Cloncurry was soon followed by another at Wyndham. Now there are additional bases at Port Hedland, Kalgoorlie, and Broken Hill.

AROUND THE TRADE

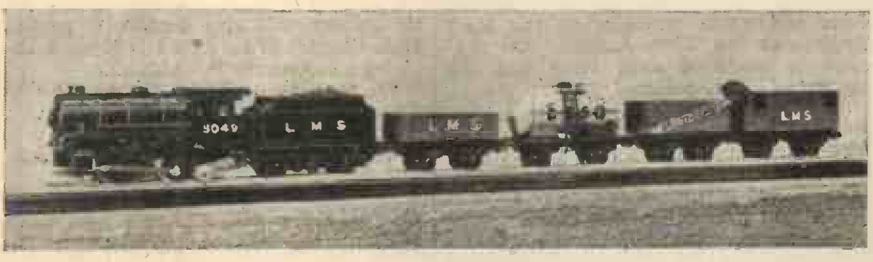
New Lines Introduced by the Manufacturers

Lionel Trains

MODELS of all the latest streamlined trains are introduced by Lionel Trains in their Christmas stock. Also of interest is a distant control passenger train with whistle. The outfit consists of one No. 265E distant control locomotive, one No. 265W streamlined coal tender, one No. 65 whistle and reversing controller, one No. 600 illuminated Pullman car, one No. 601 illuminated observation car, one No. 602 illuminated baggage car, eight O.C. curved track, four O.S. straight track and one O.T.C. lock-on connection. The cars are finished in a modern colour combination, have four-wheel bogies, removable roofs and measure 9 in. in length. The entire trains is 48½ in. long, and the track supplied forms an oval 50 in. × 30 in. The model complete costs 6 guineas. This is only one of the many interesting models listed in their latest catalogue, which is obtainable on request from Lionel Service Dept., 35/6 Aldermanbury, London, E.C.2. A complete range of accessories are also listed.

Chemistry for Christmas

READERS interested in chemistry should write to A. N. Beck & Sons, 60 High Street, Stoke Newington, London, N.16, for their latest catalogue in which is listed chemicals and accessories of all descriptions. Sets of chemical apparatus only are obtainable for 2*s*. 6*d*., 5*s*. 6*d*., 10*s*. 6*d*., £1 1*s*. and £2 2*s*. Sets of chemicals only are also obtainable, as well as sets of chemicals and apparatus combined.



The new Trix Goods Train.

Models Driven from the Mains

F. C. HEAYBERD & CO., 10 Finsbury Street, London, E.C.2, have recently introduced a new all-metal rectifier which incorporates three liberal outputs: 6, 8, 10 and 12 volts 4-5 amps D.C.; 3½ volts 3-4 amps A.C.; 20 volts 1 amp A.C. The rectifier unit will be found ideal for operating model railways, etc., from the mains. The 4-5 amp D.C. supply is sufficient for running three average trains; the 3½-volt lighting supply will illuminate twelve or more small lamps; and the 20-volt 1 amp output is suitable for point work or supplying current to small A.C. motors. All three outputs can be operated *at the same time*. The unit costs 87*s*. 6*d*.

Skybirds at Selfridge's

A SKYBIRD Aeronautical model department was recently officially opened at Selfridge's by Sir Harry Brittain and Mr. C. W. A. Scott. The exhibit comprises Military and Civil aerodromes and a series of model aeroplanes from the period of the Great War to the latest modern machines. A special feature is a complete model layout of the most modern Civil Airport, Gatwick, made with Skybird models, with its unique Martello Air Station. This layout is complete with the hangars and the Southern Railway Station.

The Trix Twin Railway

JUST imagine two electrically-driven trains travelling on the same line, at different speeds, in the same or opposite direction, backward or forward, fast or very slow; you can do all this from two simple controls with the Trix Twin Railway. The special resistance controller with safety cut-out gives perfect control for starting, stopping and reversing, it's just as easy as pressing a button. You'll be fascinated too, with the automatic couplings fitted on all T.T.R. stock. With these you can marshall Goods and Passenger Trains—just like the real thing. You can have the most elaborate railway system in only a quarter of the space usually needed, and you'll have twice as many thrills.

The patent rails are beautifully mounted on bakelite bases making them strong, rigid and impossible to bend. They are fixed and unfixed in an instant. The trains are electrically driven by means of a universal motor and a special controller. The trains may be operated off either alternating or direct current. In the case of A.C. the railway is operated direct from the mains through a T.T.R. transformer with 14 volts output; for D.C.—accumulators with a 12-volt output are needed, or a converter may be used where it is desired to run from D.C. mains. The Instruction Book supplied with each train or obtainable separately (price 3*d*.) gives complete information in every respect. This railway is on sale at stores and toy dealers, and manufactured by Trix, Ltd., 45 Clerkenwell Rd., London, E.C.1.

Successful Tuition Guaranteed

SO sure are The British Institute of Engineering Technology, 17/19 Stratford Place, London, W.1, of the efficiency of their courses, that they guarantee to coach the student until he has passed the actual examination. Irrespective of the number of attempts he may have to make, no extra fee is charged. More important still, if a student should fail to pass his examination after his first attempt, then they are prepared to return his full fee, if he does not wish to make a further attempt. Having completed his course, however, the student should hae no difficulty in passing at his first sitting.

As a further tribute to this organisation, the firm of Philco Radio and Television corporation have officially advised their dealers, and their dealers' service men to study the technical side of their work under the guidance of the B.I.E.T.

Portable Lighting and Heating

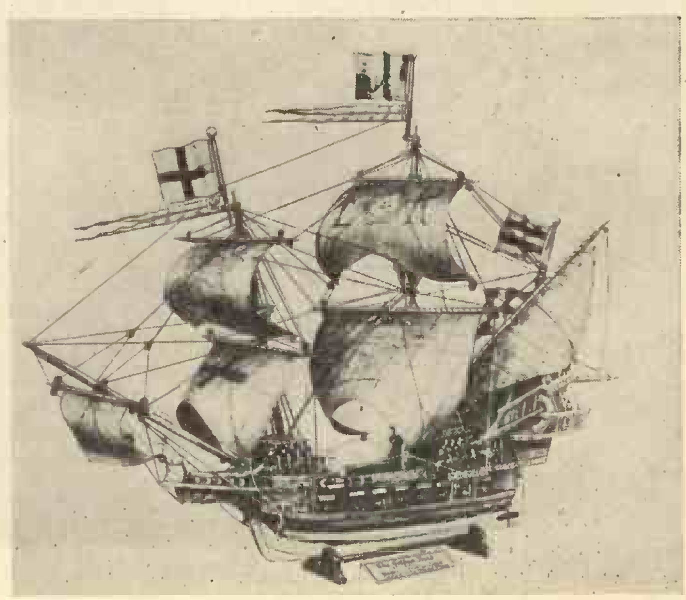
TO those with workshops, garages, etc., the Tilley storm lantern can be especially recommended as it can be carried easily and safely from place to place. It burns ordinary paraffin under pressure and will give a brilliant steady light of 300 c.p. at the small cost of 1*d*. for six hours. It is unaffected by the weather, however severe, so that it is useful for out of doors just as well as inside. Strongly made of stout brass with no parts to rust, corrode or get out of order. Among its numerous potential uses are those in connection with the work of mechanics, owners of small garages, observatories, etc.

How often during the day, both in winter and summer, temporary heating is wanted without the work involved in lighting a fire. The Tilley radiator quickly provides pleasant warmth and being portable can be used in workshop, garage, office, etc., as well as in every room in the home. In short the Tilley radiator can be used in half a dozen places in the course of a day, which other methods of heating do not possess. It is self contained and therefore requires no connections for fixing. Burns ordinary paraffin at the low cost mentioned above and works precisely on the same principle as the Tilley lantern. Oil container is made of solid brass and the reflector of highly-polished copper.

Model Galleons

STUDIETTE Galleon Kits are an original production of Studiette Handcrafts, Kent Street, Birmingham. It is well-known that a model galleon forms a very popular decorative item in the modern British home, and has been used even more since the use of pictures and other ornaments has perhaps fallen a little into disuse.

A model galleon is always an attractive feature in the home and is a constant centre of interest to family and friends alike. Perhaps it is the fact that the British nation has such a glorious naval history to relate or because every Britisher has that tang of sea-salt in his blood which gives the appeal. The fact remains, however, that whether one possesses a model galleon or not, there is hardly a soul who would but agree that these beautiful little reminders of Britain's brilliant sea fights in all their stately glory are objects of justifiable pride.



A model of the Golden Hind. The kit for making this model is supplied by Studiette Handcrafts.

Studiette model galleon construction kits have been produced by experts who have spent many hours in constant research work in connection with each individual model which has been produced. The rule is that the kit of parts, which incidentally is entirely British, contains every single component necessary, and every detail of instruction including interesting handbooks and full diagrams for the construction of a model galleon which is at once beautiful and true. Dimensions, heraldry, colouring, armament, rigging, and in fact every point concerned is as correct as it is possible to be on models of this scale so far as historical detail is available, such detail having been searched for not only in this country, but wherever the ships of Britain have touched port and left record in those bygone days.

"Modern Building Practice"

IF you are connected with the Building Trades, or are an Architect or an Architectural Student, you will be intensely interested in *Modern Building Practice*, a valuable new weekly part publication which is now on sale at all newsagents and bookstalls.

Complete in about forty weekly parts, this work contains the very latest methods in all branches of building practice, from the initial planning and designing to the work of construction and the provision of the final equipment. Celebrated architects and building authorities contribute to its pages and there will be over 2,000 practical illustrations, plans, elevations, photographs, diagrams and tables. Each weekly issue throughout will also contain a practical Date Chart. With Part I is given a Data Chart on Concrete Foundatons.

Be sure to ask for *Modern Building Practice* at your newsagents. It costs 1*s*. per part. It is worth pounds to every live man in the building and allied industries.

A New Bicycle Speedometer

S. SMITH & SONS (Motor Accessories), Ltd., Cricklewood Works, London, N.W.2, are producing a very sensitive cycle speedometer made with the same finish and exactitude as the marine, auto and aircraft instruments for which they are famed all over the world. The delights of cycling are greatly enhanced by the addition of a speedometer, especially one incorporating a mileage recorder, as Smith's does, to your mount. You are able to keep a close check on your speed, your averages, and on your time and distances for various routes. It only takes a few minutes to fit the instrument, and it is bracketed to the handlebars so that the

The Smith cycle speedometer.

dial is flush with them and so does not interfere with any controls or other equipment. The dial of the instrument is black with a white scale, and is 2½ in. in diameter, surrounded by a chromium bezel and a black enamel case. The driving sprocket is attached to the spokes on the right-hand side of the front wheel, so that it is positioned round the hub. To keep the drive shaft into position a rubber clip is supplied.

Smith's speedometer costs 19*s.* 6*d.* complete, and it carries a full guarantee, which includes service at their depots.

Model Aircraft

THE MODEL AIRCRAFT STORES have now moved to new and larger premises at 127B Hankinson Road, Bournemouth, due to the rapid general increase in their business, especially so regarding petrol engine models which are becoming very popular.

Their new premises include a large floor area which will be devoted to a permanent Model Aero Exhibition, including petrol engines, petrol engined complete models, all the latest rubber models, and everything possible to interest aeromodellers.

Mr. A. E. Brooks, the well-known designer of the 18 c.c. "Comet" engine, has joined the staff in order that his expert knowledge of petrol engines and petrol models shall be available to their customers.

Facilities have been arranged for demonstrating petrol models in the air, and intending customers are encouraged to take advantage of these demonstrations.

Their new service department undertakes repairs to any make of engine at very reasonable charges, no job being too difficult for them. Their works are fitted up with lathes and all the necessary machines and equipment for quick and efficient service. Some of the leading figures in the petrol-model world have already availed themselves of this service, with which they have expressed great satisfaction.

In addition to the manufacture of the "Comet" engine, which has been tested by an uninterested authority to develop ½ h.p., and fly a model weighing 13½ lb., their technical staff is now engaged on the final details of the "Spitfire," a real baby engine at a very modest price, which they hope to have on the market by Christmas. The "Spitfire" can be used on a 4 ft. span model, and should prove a boon to those modellists who must consider price and portability.

The rubber models are not being neglected, and the Model Aircraft Stores stock all the best and newest designs.

Anyone interested in the hobby will be welcomed at their new premises, and should find their visit well worth while.

Model Ship Catalogue

MESSRS. P. M. SWEETEN of 38, Bank Hey Street, Blackpool, have just issued an interesting catalogue of Model Ships, for which they are supplying kits of parts. The models listed are the clipper ship "Flying Cloud," which costs 2*s.*; the "S.S. Leviathan," which costs 6*s.* 6*d.*; the "Constitution," at 10*s.*; the "U.S.S. Texas," at 6*s.* 6*d.*; the destroyer "Preston" at 2*s.*; the three-masted "Constitution," at 2*s.* (smaller size than the previous model of the "Constitution" mentioned); the submarine "Chaser" at 2*s.*; and two models of the "Queen Mary," at 7*s.* 6*d.* and 3*s.* respectively. The Yankee "Clipper" costs 7*s.* 6*d.* All these prices are carriage paid. The models themselves are most realistic and vary in length from 19 in. down to 12 in. They make splendid ornaments, and each of the kit contains everything needed, including wood, dowling, spars, masts, yard arms, cement, coloured lacquers, and materials for making the stand. The kits offer a varied choice from Spanish galleons to model battleships.

TRANSPARENT MYSTERIES

(*Continued from page* 130)

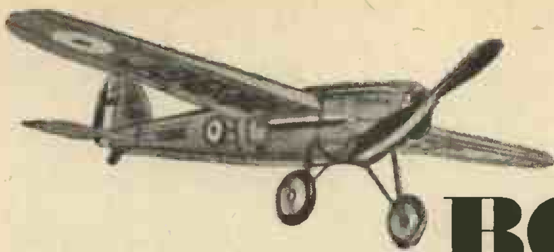
while water is poured into the glass and out again. The liquid will not be in the glass long enough to leak through and the disc can then be disposed of in the drying-cloth as before.

The Vanishing Stick

In Fig. 10 yet another method of vanishing is shown. A short stick is covered with a cloth and dropped into a glass vase, from which it vanishes.

At the outset the stick is covered with a length of thin glass tube. The stick itself is allowed to slide out of the glass tube as soon as the covering handkerchief is thrown over, and disposed of in a bag behind the table (Fig. 11). The glass tube when dropped into the vase gives a sound sufficiently similar to that of the stick striking the glass to maintain the illusion that the stick is there, but when the cloth is removed, the transparent nature of vase and glass tube renders the tube invisible; an illusion that is helped by the pattern on the glass. Another method is to fill the glass with water, which, by breaking up the lines of the tube, makes it quite impossible to detect its presence.

This ability of one transparent object to conceal another may also be used to vanish a glass of water. The glass, a small one, is filled from a cut-glass jug. A paper serviette is pressed round the glass, which is then secretly slid behind the jug. The water in the jug masks the presence of the tumbler, and the paper, retaining the shape of it, gives the impression that the glass is still under the serviette. The serviette is carried carefully into the midst of the audience and suddenly crumpled into a ball. A very surprising vanish, as the glass seems to melt away under the very noses of the spectators.



BOOKS
for
AERO - MODELLERS

MR. F. J. CAMM, Editor of *Practical Mechanics*, writes: "I can recommend no hobby with more enthusiasm to the modern handyman or his son than Model Aeroplane Building, for there is no other hobby which can be followed at such small cost, and with such a minimum of tool equipment. It is the only practical hobby which combines the fascination of a scientific indoor recreation with the benefits of healthy outdoor exercise. It is possible to reproduce in miniature all of the evolutions of a full-size machine. You may use elastic, steam, or tiny petrol engines as motive power. I, myself, have devoted many thousands of pleasurable hours to the building and flying of model aircraft. There is the additional advantage that it will provide the magic key to the door of opportunity in the aircraft profession, where skilled labour is short and urgently required. Profitable jobs await those with technical knowledge. You cannot obtain this in any better or more rapid way than by building and flying models."

THE MODEL AIRCRAFT BOOK

By F. J. CAMM. Here is a book which the author himself describes as a second course in advanced model aircraft construction. It follows upon the success of his two earlier books—"Model Aeroplanes and Airships" and "Power-driven Model Aircraft"—and is necessitated by the very rapid development of aero-modelling in the last few months. The book gives full constructional details for really expert modellers and is intended for the use of the expert or really ambitious novice, although the actual wording of the text can be followed by a mere tyro, and the lavish illustrations on each page would enable anyone with a reasonable flair for handicrafts to proceed right away to the construction and assembly of a workmanlike scale model reproducing in its evolutions and appearance the latest types of British and foreign aircraft. The book contains 10 extensive and detailed chapters.—A Petrol-driven Model Monoplane. A Petrol-driven Model Biplane. Power Units for Model Aircraft. The 1935 Wakefield Cup Winner. A Fuselage Model Biplane. A Light-weight Duration Monoplane. A Flapping-wing Model. Model Aeroplane Stability. Building Scale Models. Building a Primary Glider. This volume is handsomely bound and printed on strong art paper. It is as attractive to look at as a gift book as it is useful in the modern handyman's workshop.

3/6 net, or 4/- post free.

MODEL AEROPLANES and AIRSHIPS

By F. J. CAMM. The Standard Work for the Beginner. With Special Chapters on Gliders, Helicopters, Wing-flapping Models, Kites and Full-size Gliding. Everything the novice or expert wants to know clearly and lucidly set down by a man who is not only a theorist of repute but who has actually himself made and flown many thousands of models, and whose designs are known by model experts everywhere. The book traces the history of aero-modelling, deals with the first principles of flight, materials, and designs and passes on to the actual construction, from the cutting of the air-screws to the final assembling of the fuselage and mounting of the "engine." Stunt as well as straight models are dealt with—Helicopters and Wing-flapping machines. There are also valuable chapters on important accessories, such as apparatus for winding elastic motors. The book has also an introductory chapter on full-size gliding and includes ample notes on the actual flying of all models. A complete index makes it an immediate and handy reference for every handyman's workshop. With over 120 illustrations, including photographs and diagrams.

A Newnes Home Mechanic Book. 1/- net, or 1/2 post free.

POWER-DRIVEN MODEL AIRCRAFT

By F. J. CAMM. The growing interest in model aircraft propelled by some form of engine, such as compressed air, steam, or petrol, has induced Mr. Camm to produce this volume, which is supplementary to his "Model Aeroplanes and Airships." He deals extensively with the older-fashioned rubber-driven type, and although pointing out the disadvantages of this method of propulsion gives ample instructions for the construction of models employing it. He is, however, more interested in the compressed air, steam, and midget petrol engines which have been produced in recent years. These units are thoroughly reliable and simple to make, and capable of propelling a model weighing up to 6 lbs. (the record stands at over 15 minutes' flight, until, in fact, the petrol ran out). In every case he amplifies his carefully detailed text with constructional diagrams, and where possible with photographs of models constructed by himself, on the workshop bench and in flight. The book consists of 96 pages, fully packed with up-to-date information for all aero-modellers and including over 130 illustrations.

A Newnes Home Mechanic Book. 1/- net, or 1/2 post free.

The Perfect Winter Time Hobby!

Obtainable from all booksellers or at post free rates direct from :

GEORGE NEWNES LIMITED
8-11 Southampton St., Strand, W.C.2

NEWNES LONDON

BOOKS WORTH READING

(*Continued from page 171*)

receiver. The beginner should find this book of inestimable value in understanding the present-day requirements in receiver design, and it explains clearly how to read a circuit diagram.

"Accumulator Charging Maintenance and Repair," by W. S. Ibbetson, B.Sc., A.M.I.E.E., M.I.Mar.E. Price 3/6, 147 pages, 41 illustrations. Published by Sir Isaac Pitman & Sons, Ltd., London.

MR. IBBETSON has written this book for the use of all who are interested in the charging and upkeep of accumulators. This covers, of course, those who are interested in modern wireless reception, country-house lighting, or even the supply of voltage for motor-cars and motor-cycles. The book is essentially practical and gives all the essential information to enable anyone to keep the accumulator in its best condition. Various methods of charging are given and tests for cell condition are also explained. The book commences, of course, with an explanation of the electrical circuit, a definition of electrical power, and proceeds to the more practical side.

"The Alternating Current Circuit," by Philip Kemp, M.Sc., M.I.E.E., A.I.Mech.E., Mem.A.I.E.E. Price 2/6, 102 pages, 57 illustrations. Published by Sir Isaac Pitman & Sons, Ltd., London.

THIS book is intended for the use of electrical engineering students when they first begin the study of alternating currents. It aims at giving a clear but simple explanation of the various phenomena exhibited by the A.C. circuit. It does not attempt to deal with the various types of A.C. machinery or apparatus. Questions of wave-form have not been dealt with, as the author feels that a preliminary study of the subject is best made on the assumption of sine waves, and he has endeavoured to strip the mathematical bogy of its terrors. He has succeeded in including in this little book all the essential features.

"The Modern Book of Lighthouses, Lightships, and Life-boats," by W. H. McCormick. Price 5/-, 142 pages. Published by A. & C. Black Ltd., London.

THIS book tells the story of the lighthouse, from the Pharos of Alexandria to the lights of to-day. It describes the building of the famous lighthouses such as the Eddystone, Bishop Rock, Fastnet, Bell Rock, Skerryvore, etc., and draws a fascinating picture of the heroic labours of the men who carried out the dangerous task. It includes also details of the great lighthouses round the coast of the United States of America and of the lightships that are used when a lighthouse cannot be erected. It concludes with a thrilling account of the life-boat service and some of the desperate fights which have been made to save the lives of shipwrecked men. The book is splendidly illustrated by 16 photogravure plates.

"The Modern Book of Aeroplanes," by W. H. McCormick. Price 5/-, 142 pages. Published by A. & C. Black Ltd., London.

THIS book is a partner to the one just mentioned, and deals with the development of aviation in a similar manner. It describes in simple language the manner in which an aeroplane flies and how it is controlled. Famous flights are dealt with, as well as the thrills of air racing and record breaking. The book concludes with an account of the wireless control of aircraft and the method in which the modern liner receives weather reports and other communications to enable it to fly safely from one port to another.

"Marvels of the Air," by T. Stanhope Sprigg. Price 3/6, 152 pages, over 150 illustrations. Published by George Newnes.

THIS book deals with the various types of aircraft and important events in aviation. Planes of the War days are described and there are 16 illustrations of these, accompanied by an interesting description of aerial combat. The title aptly describes the material covered in this interesting book, and the illustrations alone will form a valuable picture gallery to be stored and kept as a matter of interest. The latest machines which are illustrated and described may be compared with the early craft, and as time goes on it will be even more interesting to trace the developments in this branch of transport.

"Speed of the Wind," by Capt. G. E. T. Eyston. Price 3/6, 142 pages. Published by George Newnes.

THIS is a comprehensive and romantic story of speedmen in every sphere, on the road, in the air, on the water, and on land. It describes speedmen of the iron way, and describes our railways as they may be years from now. It tells the story of the Rolls-Royce, and describes the tragedy of Sir Henry Segrave. Motor kings are both illustrated and described, and many interesting accounts are given of the fight for records in all fields of sport. The air receives a chapter, and famous air races are described. There are dozens of interesting illustrations showing well-known speedmen in all branches of sport, and of record-breaking air craft, cars, trains, etc.

BUILD YOUR OWN PERIVALE MAINS CLOCK

(*Continued from page 126*)

correct any inaccuracy in alignment, move the small (hour) hand.

Next fit the two studs (36) into the tapped bosses provided for them on the back of the clock base plate (6). Fit, and secure the dust cover (37) by the two nuts (38), fit the hand-setting knob (39), and the clock is complete.

Connect to the mains, start, and set the hands to the correct time by the B.B.C. time signal, and you have an accurate and attractive timepiece that should last a lifetime. After the clock has been running for a few days, it should be quite silent, as by that time bearings and gears should have bedded down, and any initial roughness will have worn off. Care should be taken to keep iron filings away from the clock during assembly, as when the current is connected the rotor and pole pieces become magnetised and will attract any of these filings, causing the clock to make a crackling sound when running.

Do not use force in assembly, as every part is designed to fit accurately, and see that all revolving parts are quite free before passing on to the next operation.

The manufacturers guarantee that when assembled with reasonable care and as per instructions, this clock will be an accurate and reliable timepiece for a period of years. If, however, a purchaser should meet with any unexpected difficulty, the clock may be returned to them for adjustment. The clock must be accompanied by a postal order value 1*s*., to cover cost of handling and return postage.

PRACTICAL MECHANICS Replies to Queries and 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 191. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8-11 Southampton Street, Strand, London, W.C.2.

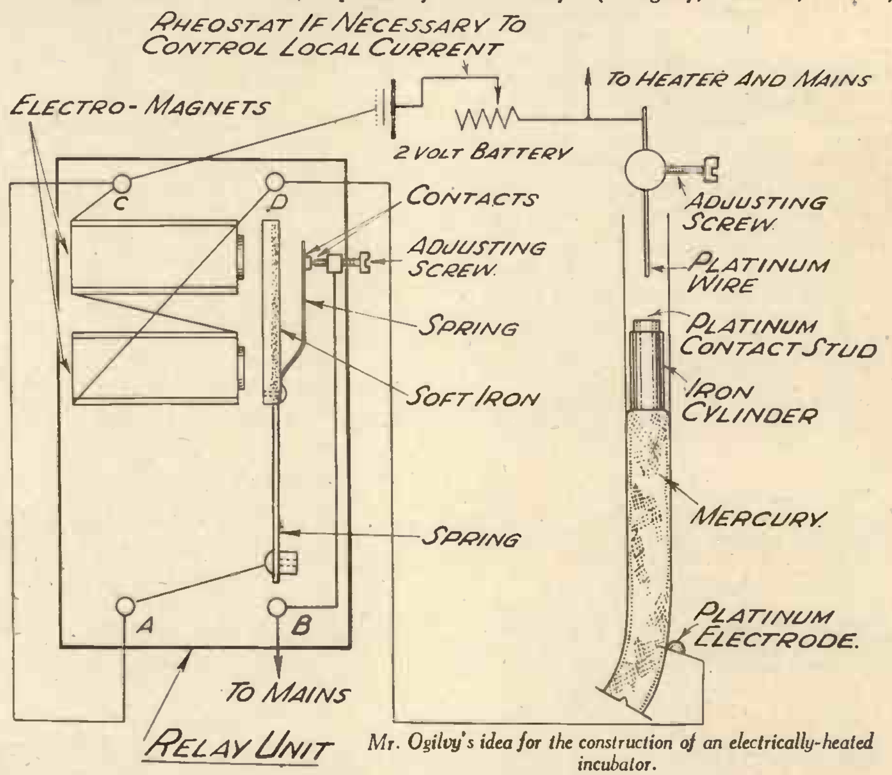
AN ELECTRICALLY-HEATED INCUBATOR

"A SHORT time ago I had occasion to seek your advice with reference to an electrically-heated incubator for bacteriological work, the temperature being controlled by means of a thermostat. You kindly supplied me with suggestions.

"I have myself devised and tested the enclosed thermostat (see sketch) and thought that perhaps other readers might be interested.

"I think the sketch is self-explanatory. An interesting feature is the automatic switching, whereby the accumulator supplying the current for the local circuit is 'Trickle' charged when the mains circuit is closed.

"In brief, the action is as follows: the mains circuit is closed and the heating lamp raises the temperature inside the incubator, causing the air inside the glass tube to expand and thus causing the mercury in the open limb of the U-portion of the tube to rise. On this mercury floats an iron cylinder equipped with a platinum contact stud. As the mercury rises so does this cylinder, until contact is established with the fixed platinum wire, the height of which can be adjusted according to the temperature required. Immediately contact is established the local circuit is closed, and the electro-magnets come into operation, opening the mains circuit, causing the heating lamp to be extinguished and consequently the temperature to drop. When this happens the mercury in the tube falls and the local circuit is opened, the electro-magnets release the armature and the heating circuit is once more closed. The operation is repeated indefinitely. If the thermostat is desired to operate on A.C. the trickle charging of the battery cannot take place; in this case wire C A must be disconnected and the mains connected to A and B only. (R. Ogilvy, Mortlake, S.W.14.)



Mr. Ogilvy's idea for the construction of an electrically-heated incubator.

SYMPATHETIC INK

"CAN you please tell me how to make a really good sympathetic ink (not cobalt chloride) which appears on heating gently and rapidly disappears again on cooling?" (G. Donaldson, W.C.1.)

COBALT chloride constitutes about the best heat-controlled sympathetic ink material, but since you do not wish to use this compound, you might try a mixture of equal parts of ammonium chloride and copper sulphate. In a state of dilution, this makes an ink which is invisible until the paper upon which it is written is heated. There are, of course, many sympathetic inks which are rendered visible on paper by exposure to certain fumes or by other simple chemical treatment, but heat-controlled inks are few and, apart from a cobalt chloride ink, the copper sulphate-ammonium chloride ink is the best.

Probably you will be aware of the fact that dilute sulphuric or nitric acid or even ordinary milk, when used as an ink, is rendered visible on warming, but in such instances the characters do not fade upon subsequent cooling.

GLYCEROL

"(1) CAN you give me the chemical equation for the reaction between benzene and nitric acid by which nitrobenzene (from which aniline is prepared) is formed? I understand I must add to the nitric acid a certain percentage of sulphuric acid. Can you tell me the volumes used of each acid, for an effective mixture? Are concentrated acids used? If not, can you tell me the specific gravities of acids used?

"(2) I read that glycerol is manufactured synthetically by passing a mixture of acetylene and air over a heated catalyst. I would like to perform this process, experimentally. Can you give me the names of catalysts which are used, and at which temperatures they are most effective? Does the glycerol pass on over catalyst as vapour?

"(3) How can I make an effective pyrotechnical smoke mixture? Will you give me the proportions of compounds used for same, either by volume or by weight, and indicate which.

"(4) What is the best operating temperature, using ferric oxide as catalyst, for preparing sulphur trioxide from sulphur dioxide and air. In the ordinary conditions, in what form does sulphur trioxide exist. Is sulphur trioxide deliquescent in air?" (R. W. Kendrick, W.17.)

(1) THE chemical equation which you require is as follows:

$$C_6H_6 \times HNO_3 = C_6H_5.NO_2 + H_2O$$

(Benzene) (Nitric acid) (Nitrobenzene) (Water)

To make nitrobenzene, add slowly to 10 parts (by vol.) of benzene a mixture of 12 parts of concentrated nitric acid and 16 parts concentrated sulphuric acid. During the addition of the acids, the benzene should be maintained at a temperature below 40° C., the flask containing the benzene being immersed in cold water. After the mixed acids have been added, heat the mixture on a water-bath to 80° C. for half an hour, then pour the contents into a basin of cold water. The nitrobenzene will collect at the bottom of the vessel as a yellow oil. It should be drawn off, shaken with a little weak soda solution and then distilled. Pure nitrobenzene boils at 205° C.

(2) It is not possible for you to imitate the manufacture of glycerol by the passage of air and acetylene over a heated catalyst for the reason that very high temperatures are usually required and, also, that the nature of the catalysts employed are kept secret. Remember, also, that acetylene is an explosive gas and that it is liable to detonate violently when heated under certain conditions. Bear in mind, also, that a mixture of acetylene and air forms an extremely explosive mixture.

The yield of glycerol from such catalystic processes is very small, and it is only by working with very large quantities of materials that reasonable amounts of this material are obtained.

(3) The best smoke-producing material for pyrotechnical purposes is red phosphorus. Yellow phosphorus, also, gives equally good results and is cheaper, but is dangerous to handle. A mixture of equal quantities of ammonia and hydrochloric

gases will produce dense white fumes of ammonium chloride, but this reaction is only suitable for employment on a small scale.

(4) A temperature of 400° C. (just below red heat) is the best for the catalytic preparation of sulphur trioxide by the method you describe. You would obtain a much higher yield of sulphur trioxide if you employed platinised asbestos as the catalyst. At ordinary temperatures, sulphur trioxide exists in the form of white fibrous-looking crystals, melting at 25° C. They have a strong affinity for water, combining with it to form sulphuric acid. Hence, sulphur trioxide MUST be hermetically sealed up in glass tubes, if it is to be preserved.

INFRA-RED RAYS

"I SHALL be obliged if you will kindly let me know the best way to produce infra-red rays. I understand that they can be obtained by screening an ordinary lamp with thin ebonite. Can you tell me where I can obtain this material?" (G. C., Herts.)

A GENERAL reply to this query would require the writing of a complete book. The subject is a very large one indeed, and one on which little general information has been published. In order to be of any service, it would be necessary to specify what type of infra-red radiation is required since the spectra, or range of wavelengths, embraced under the term "Infra Red" is so very wide compared with the visible spectra and entirely different methods have to be used for the production of infra-red rays according to the approximate wavelength required.

In general, the sources of infra-red rays are the sun, fires or furnaces, molten metals, and hot bodies. For laboratory and spectroscopic purposes, it is usual to use some form of electrically heated emitter such as a Nernst glower, a silica pencil, or a small electric furnace. Practically any hot body emits a proportion of infra-red rays—an electric iron, for example. The longer infra-red rays, however, overlap with the ultra-short Hertzian radiations and for the production of long-wave infra-red radiation it is necessary to adopt electromagnetic methods. It thus depends entirely on what purpose and on what intensity of radiation is required, what methods have to be adopted for their production.

MAKING GLASS

"(1) WHAT is glass made of and what is the formula?

"(2) What kind of crucible is used for making glass?

"(3) Is a gas bunsen burner satisfactory for supplying the necessary heat?

"(4) What kind of blowpipe is used for blowing glass?" (H. S. E., Birmingham.)

(1) GLASS has many different compositions. Most bottle glasses consist mainly of lime (or magnesia), sodium oxide, and silica. Other glasses, for special purposes, may contain, in addition to the above, aluminium oxide, boric acid, and other substances.

An ordinary "white flint" glass used for high quality bottle-making and other purposes has the following approximate composition:

Silica (sand), 75 per cent.
Aluminium oxide, 0·2 per cent.
Lime, 8 per cent.
Sodium oxide, 15 per cent.

the remainder being impurities.

(2) Glass-making materials are usually melted in fireclay crucibles. For special purposes, however, carbon crucibles are used or crucibles of magnesia or other refractory material.

(3) No, an ordinary bunsen burner is most decidedly insufficient for supplying the necessary heat in the making of glass. In fact, it is almost impossible to manufacture glass in the home workship or laboratory, since a very fierce heat is required for the purpose.

(4) For actually blowing molten glass into various shapes, glass-blowers have traditionally used the power of their lungs. Nowadays, however, special glass-blowing machinery has been installed in bottle-making works, such machinery being fed with a carefully controlled stream of compressed air.

ROCKET PROPULSION

"WILL you please furnish me with some reliable powder fuels for a small rocket with which I am experimenting? I require also the proportions in which the chemicals are mixed.

Also, will you please tell me the formulæ of some of the liquid fuels used in the large mail-carrying and experimental rockets, and the proportion of the components of these?

"I do not intend to use these liquids for experimental purposes." (G. P., Manor Park.)

A GOOD powder for rocket use contains the following ingredients:

Saltpetre, 4-5 parts.
Flowers of sulphur, 1·5 parts.
Powdered charcoal, 2 parts.
Fine sawdust, 0·5 part.

The above ingredients, in fine powder form, should be mixed intimately.

Greater explosive violence will be given to the powder if, in addition to the ingredients enumerated above, about half a part of finely powdered potassium chlorate is added. Note, however, that the incorporation of the potassium chlorate is not free from danger. The potassium chlorate MUST NOT be ground with the above powder. It must be ground separately and then *gently stirred* into the mixture. Any forcible grinding of the potassium chlorate with the mixture may cause an explosion.

Experimental long-distance and space-exploring rockets have been filled with powders similar to the above. They have, also, been charged with mixtures of liquid air and petrol, liquid oxygen and acetone, and liquid oxygen and benzene. Such mixtures, of course, are unprocurable by the average individual.

INFRA-RED RAYS

"COULD you tell me, besides materials and lenses which only let through infra-red rays, the actual professional method used to-day for use in conjunction with photo-electric cells (which, I suppose, would have to be of a special kind) for generating large quantities of infra-red rays to scan night scenes? This is a point which books on television never seem to mention, and as I have not the slightest idea of how such lenses, materials, infra-red ray lime-lights or whatever is used for making infra-red rays are made up, I should value any information about the subject." (J. G. S. A., London.)

THE obtaining of infra-red rays for television and other purposes is a simple matter. A box, or a projecting apparatus, containing one or more high-powered electric bulbs is "screened" by having in front of it a light-filter which permits only infra-red rays to pass. These filters are commercially obtainable from either Ilford, Ltd., Ilford, or from Kodak, Ltd., Kingsway, London, W.C.2. They consist of gelatine dyed with a dark crimson-red dye. Other screens for passing infra-red rays only comprise very thin sheets of ebonite, which also possesses the property of passing the far infra-red rays.

Photo-cells specially sensitive to infra-red rays are, as you state, employed for such purposes. Such cells usually employ for their active surfaces cæsium or rubidium hydrides or sometimes thin layers of thallium metal and thallium sulphides. Ordinary lenses are, in practice, employed for infra-red television experiments.

A sand yacht made by Mr. G. Freeman. The construction of this yacht was described in our issue for September, 1936.

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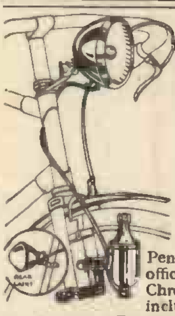

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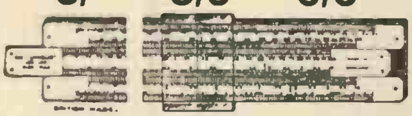

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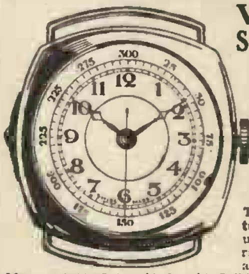

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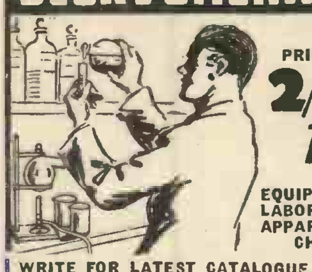

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