BUILDING YOUR OWN AEROPLANE - THE "LUTON MINOR"

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PRACTICAL MECHANICS

OCTOBER

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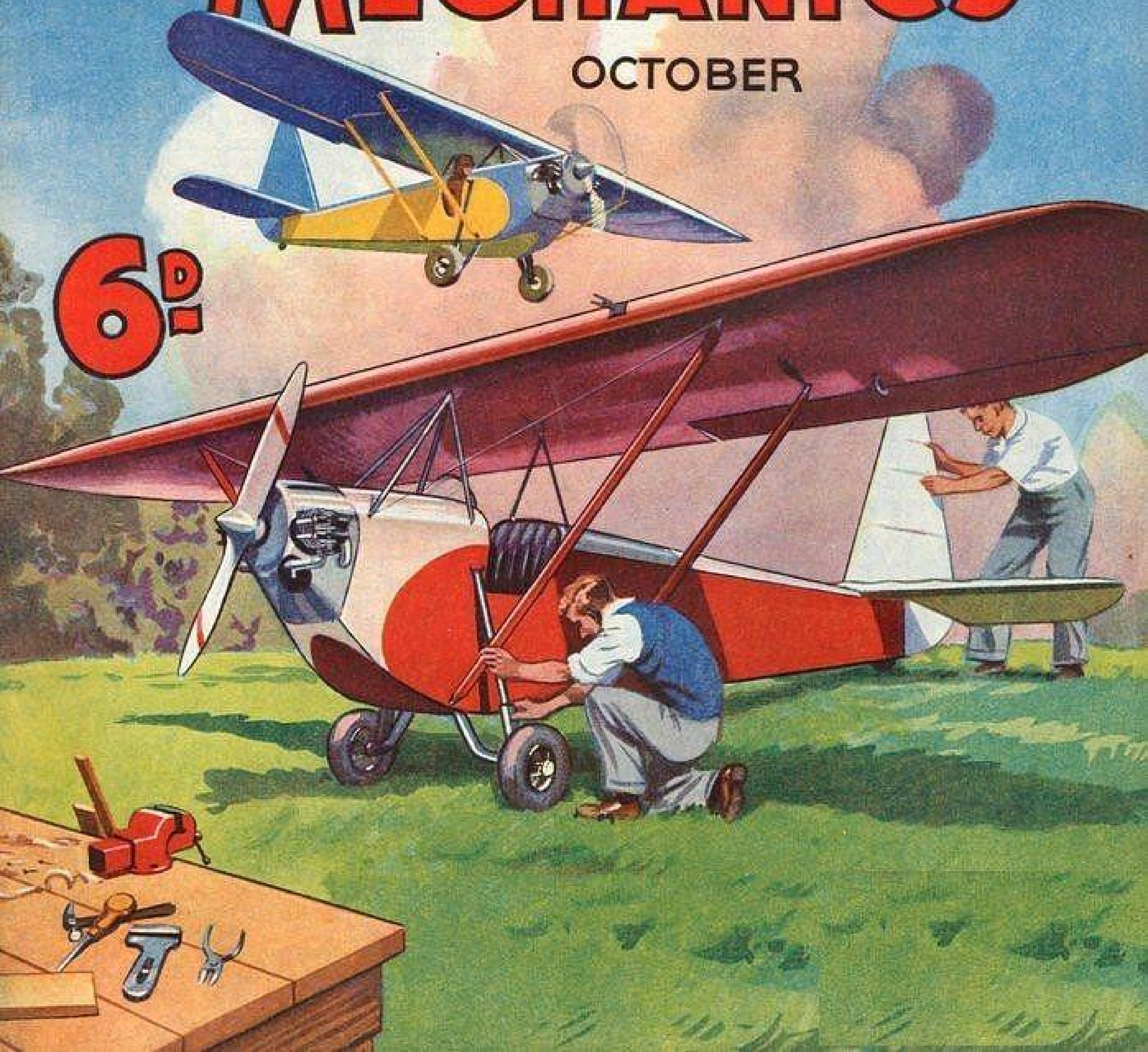

EDITED BY F. J. CAMM

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PRACTICAL MECHANICS

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Fair Comment

By The Editor

Building Your Own Aeroplane

WITHIN the brief space of 20 years aircraft has progressed from the stage where it was the expensive hobby of the moneyed few, and the interesting work of the scientific investigator, to that where it takes place as a standard method of travel, and the hobby of the multitude. You have probably noticed that in almost every industry there are the professionals and the amateurs. This is true of wireless, the gramophone, photography, stamp collecting, cycling, motoring, motor cycling, microscopy, boat building, and so on. Aircraft is no exception, for the science has advanced to the point where it is not only safe but cheap. All of the principles are well-known and have been widely disseminated; the knowledge now is general. The skilful amateur able to work in wood and metal can build his own light aeroplane; this hobby has been going strong in America for a number of years, although in this country and in Germany activity has been restricted to the construction and use of gliders and sailplanes. Mon. Mignet demonstrated with the Flying Flea that a simple aeroplane used as he intended it to be used was practicable and safe. Its unorthodox lines, however, operated somewhat against its popularity, and inspired others to produce a machine of more conventional lines which could be built and flown by amateurs. Accordingly in this month's issue I present instructions and drawings for building the Luton Minor Monoplane, which is a really practicable light aeroplane having a top speed of over 80 miles an hour, cruises at 70 miles an hour, and lands at only 30 miles an hour. The newspapers and the aeronautical press have all satisfactorily commented on it; complete and ready for flying, it costs from £180, whilst the set of prepared materials cost £40, or including engine and airscrew £97. Many of my readers will, of course, be able to reduce these prices. It is a parasol monoplane, the wings being supported by steel pylons on the fuselage, and one pair of steel tubular lift struts. Its flight range is 225 miles at 75 miles an hour, or 270 miles at 60 miles an hour. Fuel consumption varies between 1 and 1½ gallons per hour at these speeds, and constructors have a choice of 6 engines. The Luton Minor has been designed to comply with Air Ministry requirements for the acrobatic category of the Certificate of Air Worthiness and has a load factor greater than 7½. The great advantage is that sets of finished parts and partly finished parts are available for those constructors who have not the necessary equipment or experience to make them.

Further articles on the Luton Minor will appear in subsequent issues.

Readers will agree that we spare neither money nor effort in regularly presenting to them exclusive articles and information. This journal was alone in describing the construction of the Flying Flea. We have described how to make speed boats, motor cars, gliders, petrol driven models, and many other devices and pieces of apparatus upon which information has been lacking. I hope that my readers will appreciate the exclusiveness of the contents of PRACTICAL MECHANICS.

A New Gramophone

WE become so accustomed to a particular article that we cannot envisage that it will ever change. For example, 40 or 50 years ago people spent considerable sums of money on repeater watches, which upon pressing a button at the side of the case chimed out the exact time, so that you could use the watch in the dark. These watches were most expensive and intricate. Then, almost in a night, someone produced the luminous watch dial, which at once enabled the wearer to see the time in the dark, whilst those who are hard of hearing could rely upon their sight instead of upon the ear as with a repeater. The old focussing camera has gone, superseded by the modern midget camera, complete with range finder, exposure metre, colour filters, etc. Lengthy exposures are a thing of the past.

Spring driven clocks are almost a thing of the past, for the synchronous mains clock enables everyone, for a few shillings, virtually to have Greenwich Mean Time in their homes. There is no need even to rely upon the Pips nor Big Ben, for most electrical supplies are of time-controlled frequency. Electricity and wireless have been responsible for rapid development. The Gramophone, which many thought had reached finality in design, will shortly undergo a rapid change, in my opinion, and for this we must thank the cinematograph industry. All readers know that by means of a sound track on the side of a film, a photo-electric cell and an amplifier, silent films are made to "speak." It is apparent, therefore, that if an ordinary gramophone recording is made on a strip of material such as celluloid and cellophane we have at once got rid of one of the chief drawbacks of the gramophone, namely, needle scratch, and we have also got rid of the need for automatic record changers, since by making the film sufficiently long the gramophone could play the complete score of an opera without the need for changing records. Such a gramophone is now on the market, and suitable recordings which will play continuously from 9 to 90 minutes are also available. Thus, instead of having a large volume of wax discs you can store a considerable amount of music in but a tithe of the space, for an eleven-inch spool will play for 90 minutes. An ordinary wireless amplifier is used with a means for passing the strip of cellophane past a photo-electric cell.

Building the "LUTON MINOR" Light Aeroplane

The First of a Series of Articles Describing the Construction of a Really Practical and Successful Light Aeroplane, Designed to Air Ministry Standards and Requirements for the Acrobatic Category of the Certificate of Airworthiness. It may be Built and Flown by Amateurs. Simplicity and Safety are its Keynotes. It is of the Parasol Type. It has been Granted a "Permit to Fly."

Construction Described by The Designer

THERE are many amateurs who would like to build their own light aeroplane, but who refrain from doing so, since they are unable to obtain approved drawings, or to get their own designs checked for strength and airworthiness, and no one wishes to spend time and money on the construction of a machine that may never fly. There are several keen builders to-day who are struggling to make a show from sketchy designs, but most do not progress far before they "come unstuck" on account of insufficient or incomplete data.

We are, therefore, offering our readers a design which has proved its flying ability, which has been designed and produced by a competent aircraft company along recognised lines in conformance with Air Ministry standards and which has been granted a "permit to fly" by the proper authorities.

The design is the well-known Luton Minor, which has already been adopted by the National League of Airmen, after flight trials were carried out by the President of the League, Captain Norman Macmillan, M.C., A.F.C.

The "Minor" is a parasol monoplane, this arrangement having been chosen for its simplicity of construction, safe flying and structural qualities, good view in flight and the maximum aerodynamic efficiency which it offers.

It is recommended that, where possible, two or three constructors should work in collaboration, and when the aircraft is completed, if no aerodrome is available in the immediate vicinity, constructors may get together for the formation of local clubs and by finding a reasonably large, flat field they may found what may one day prove to be a network of aerodromes covering the whole country which should be of inestimable value in the development and defence of these lands.

Choice of Engines

The "Minor" may be powered with any engine of from 25 to 40 h.p. Thirty horsepower gives a top speed of 80 m.p.h., whilst a speed of 100 m.p.h. is obtainable with 40 h.p. The higher powered engine, however, provides a better take-off and gives a reserve of power that may on occasion be desirable. It should be noted that a high top speed has not been aimed at in the "Minor" design—it is a quality easily obtained by decreasing the wing area, but is accompanied by a rise in the landing speed, and it is a low value of this latter, together with a quick take-off, that were sought in the design.

The following table gives brief particulars of engines available, though there are other suitable units not included in this list.

The Luton Anzani is a re-designed version of the inverted "V" twin, the re-design having been based on extensive experience with this engine both in "Minors" and other aircraft. It is also the cheapest engine available. The "Sprite" is a well-made little engine, a horizontally opposed twin, but the power is rather low. Two-stroke enthusiasts may prefer the Scott, a two-cylinder in-line engine, though it cannot be regarded as having been thoroughly tried out on the Luton Minor as yet, whilst its power also falls short of 30 h.p.

The Carden engine offers the advantage of four cylinders, but against this must be set the complications of water cooling and the total weight of about 150 lb., or roughly half as much again as the other engines mentioned.

Provision is made in the "Minor" design for alternative petrol tank locations. The standard position is in the fuselage top, just behind the engine, but in the case of the Carden engine the petrol has to be placed inside the wing on account of the excessive engine weight at the nose. The wing tank becomes necessary also where

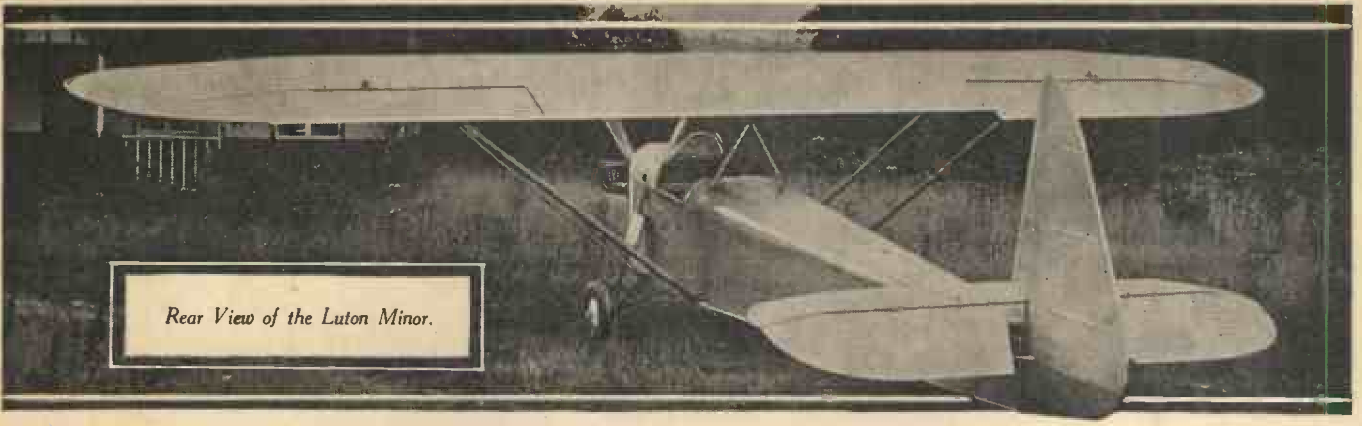
This photograph shows the attractive lines and sound design and construction of the Luton Minor.

POWER UNITS

Anzani	34 h.p.
Sprite II	25 h.p.
Scott Flying Squirrel	28 h.p.
Carden-Ford	30 h.p. (water cooled)

ENGINE PRICES

Luton Anzani, 34 h.p. improved model	£52 10 0
dual ignition and impulse starter	£62 10 0
Sprite II, 25 h.p., with impulse starter	£58 0 0
dual ignition and impulse starter	£65 0 0
Carden-Ford, 30 h.p., 4-cylinder, radiator, etc.	£55 0 0
with dual ignition	£63 10 0
Scott, 28 h.p., 2-stroke	£53 0 0



Rear View of the Luton Minor.

the carburettor is too high to allow a gravity feed from the fuselage tank, unless a petrol pump is fitted.

The "Minor" was designed from the outset to provide the easiest possible construction for amateur building. There are no complicated box or "I" section spars to make, and all machined metal parts have been avoided. The woodwork and bent up sheet metal fittings are of the simplest kind. The amount of welding has been kept down to a minimum, and no difficulty should be experienced in getting this done by a proficient welder.

The Main Plane

The wing is normally made in one component, of 25 ft. span, but for those who are unable to accommodate the full span in their workshops, an alternative design has been prepared whereby the wing is built in two halves and joined together for assembly. The wing building will be described for the single unit, and the necessary modifications for halving the wing will be explained later.

Ribs

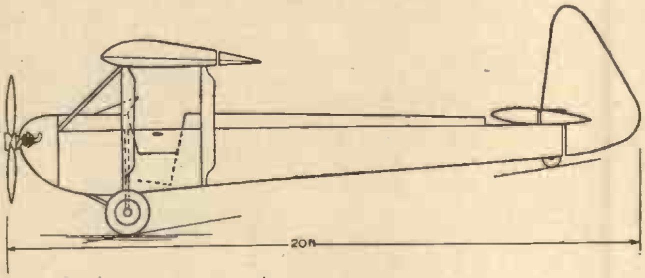
The rib arrangement is shown in the sketches and consists of ½ in. × $\frac{3}{16}$ in. flanges, with verticals and diagonals of the same section, all of which are set with the larger dimension perpendicular to the plane of the figure, or parallel to the wing span. The ply nose web and the remaining web pieces are all cut from $\frac{1}{16}$ in. plywood, with a circular lightening hole cut in the nose web. Slots are cut in the leading-edge, ½ in. deep × ⅜ in. for the later accommodation of the leading-edge member, which will be pinned and glued to the small vertical member ⅜ in. × ½ in. near the front of each rib. The lower flange is cut short at the rear and the top flange is shaped to take the trailing-edge member.

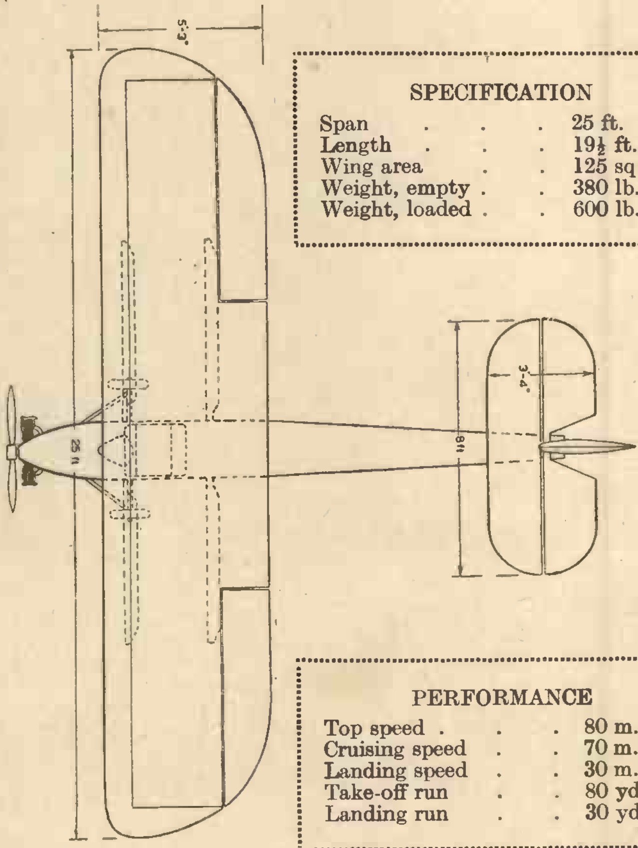
Except for the end three ribs at each wing tip, all the ribs are similar, and it is recommended that a jig should be made up for these standard ribs.

Making the Rib Jig

First obtain a straight board of deal or other wood, about ⅝ in. thick and 65 in. long × 12 in. deep, and on one face of this set out the shape of the rib in pencil, from the ordinates given in the table. Next mark out the positions of the front and rear spars and the aileron spar, leaving a 1-in. gap for the aileron hinges. The front spar

Illustrations by our own Artists and Draughtsmen



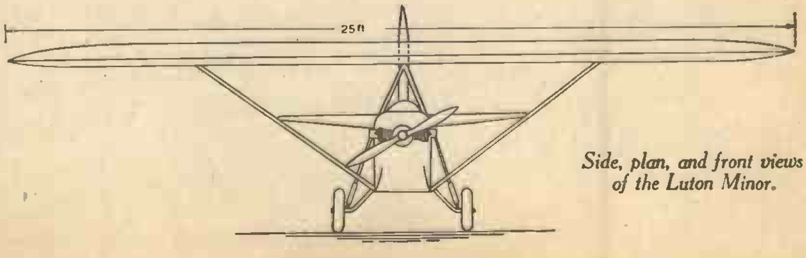


SPECIFICATION

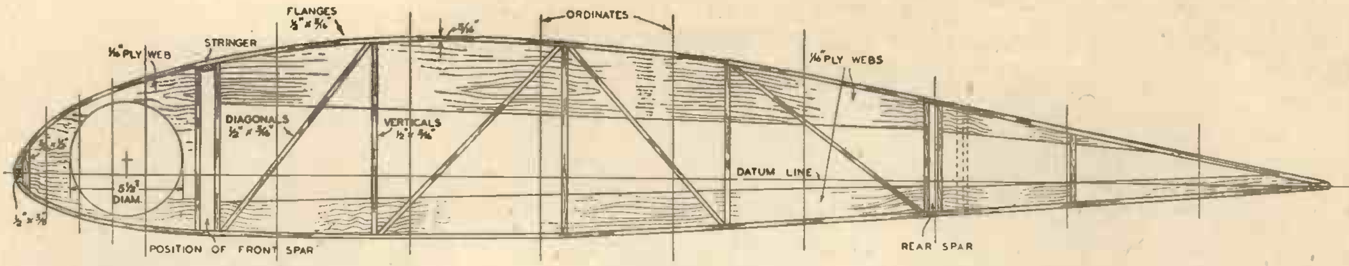
Span . . .	25 ft.
Length . . .	19½ ft.
Wing area . .	125 sq. ft.
Weight, empty . .	380 lb.
Weight, loaded . .	600 lb.

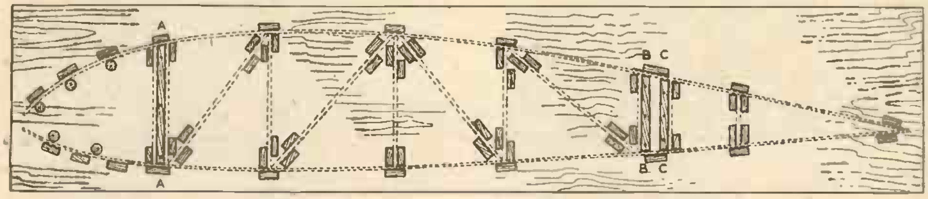
PERFORMANCE

Top speed . . .	80 m.p.h.
Cruising speed . .	70 m.p.h.
Landing speed . .	30 m.p.h.
Take-off run . .	80 yds.
Landing run . .	30 yds.



Side, plan, and front views of the Luton Minor.

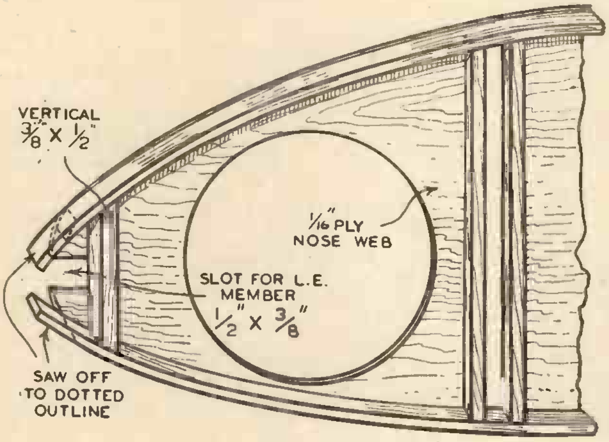




Diagrams showing rib construction and jig for assembling the ribs.

centre is 9·45 in. from the L.E. and the rear spar is 34·65 in. from the former. Cut lengths of wood to represent the spars on the jig, of width ⅝ in., ½ in., and 5/16 in. (the spar width) and about ¾ in. deep. Screw these to the jig face in the spar positions AA, BB, and CC, so that they protrude ¾ in. from the face. Next cut a number of small blocks, roughly 1 in. × ½ in. × ¼ in., which will be required to hold the rib members in position.

Tack these blocks in pairs at each end of all vertical and diagonal members, as shown in the sketch, so that the 3/16-in. strip of spruce may be laid in position between the blocks. Further blocks are then tacked on externally to the rib outline for positioning the flanges. Inside the flange, position over the more cambered leading-edge portion; half-a-dozen eccentric buttons may be screwed on to assist in getting the flanges to the required curvature over this part.



Leading edge of rib.

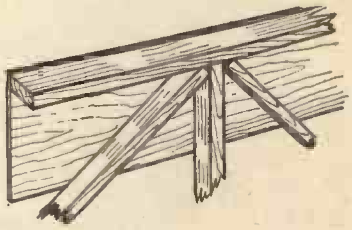
Building the Main Ribs

Material required: 500 ft. of ½ in. × 3/16 in. spruce, and 72 sq. ft. of 1½ m.m. plywood. Place two lengths of prepared flange strip in the jig, first steaming the front portions if necessary to assist in obtaining the curvature. Cut verticals of the required lengths and slip into position; also the diagonals. Spread glue (cold water casein cement) over the faces to which the ply-wood webs are to be attached. Place the webs in position and fix with brass gimp pins—⅜ in. × 20 gauge—or wire staples; leave for a few hours to dry and then ease gently from the jig with the aid of a chisel, having first released the eccentric buttons. Make good any damage or loosening caused in extracting from jig. The nose and tail of the rib are left for cleaning and shaping when all is quite set, and also the outer edges of the ply webs are cleaned down with the aid of a spokeshave, and finally sandpapered.

Notice that web gap at the rear spar is larger for the ribs over the aileron portion of the wing, shown dotted. The ten main ribs over the central part of the wing have a ½ in. spar gap, the remainder being $1\frac{3}{16}$ in.

In making up the end ribs, the same procedure may be followed, but since two only of each pattern are required, the jig may be simplified by using headless nails in place of the wood blocks. The end, or tip rib, has a solid plywood web, and this may be marked out, cut to shape, and used in place of a jig, by simply attaching the spruce flanges in position.

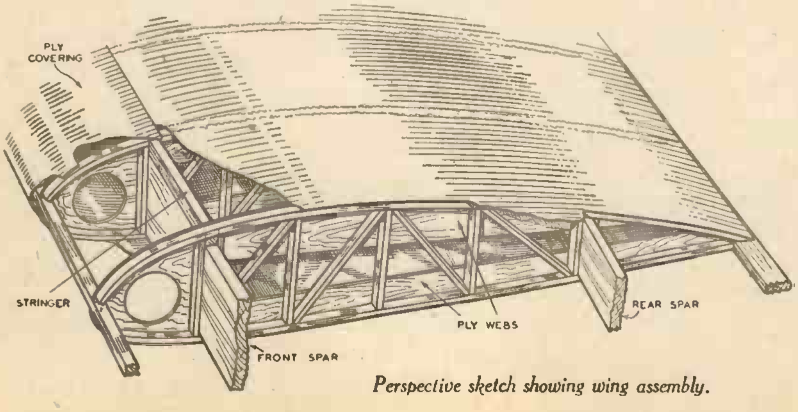
Trailing edge of rib.



Typical rib joint.

Wing Spars

The front spar consists of a 25 ft. length of spruce, ⅝ in. thick and 6 in. deep. This should be prepared from aero quality Grade A spruce, should be straight grained and free from knots, resin pockets, shakes, etc. The most important portion of the



Perspective sketch showing wing assembly.

LUTON MINOR

PRICE LIST OF COMPLETED PARTS

Main plane, covered and doped	£50	0	0
Fuselage, painted	£36	0	0
Tail unit	£17	10	0
Undercarriage, with wheels and shock absorbers	£14	0	0
Controls	£2	10	0
Tanks	£3	10	0
Wing pylons and fittings	£1	0	0
Lift struts (streamline steel tube) and bracing	£6	10	0

PRICE LIST OF COMPONENT PARTS, READY FOR ASSEMBLY

Set main plane ribs	£7	10	0
Main plane and aileron spars	£6	4	0
Fuselage sides made up (cost extra to materials)	£3	0	0
Fuselage made up, complete with decking (extra)	£24	0	0
Complete set fittings and controls made up	£20	0	0

spar is that in the vicinity of the left strut attachment, say a 5 ft. length, running inboard from a point 4 ft. from each tip. The spar remains parallel over the central length of 17 ft., leaving the last 4 ft. at each end to be shaped in accordance with the sketch.

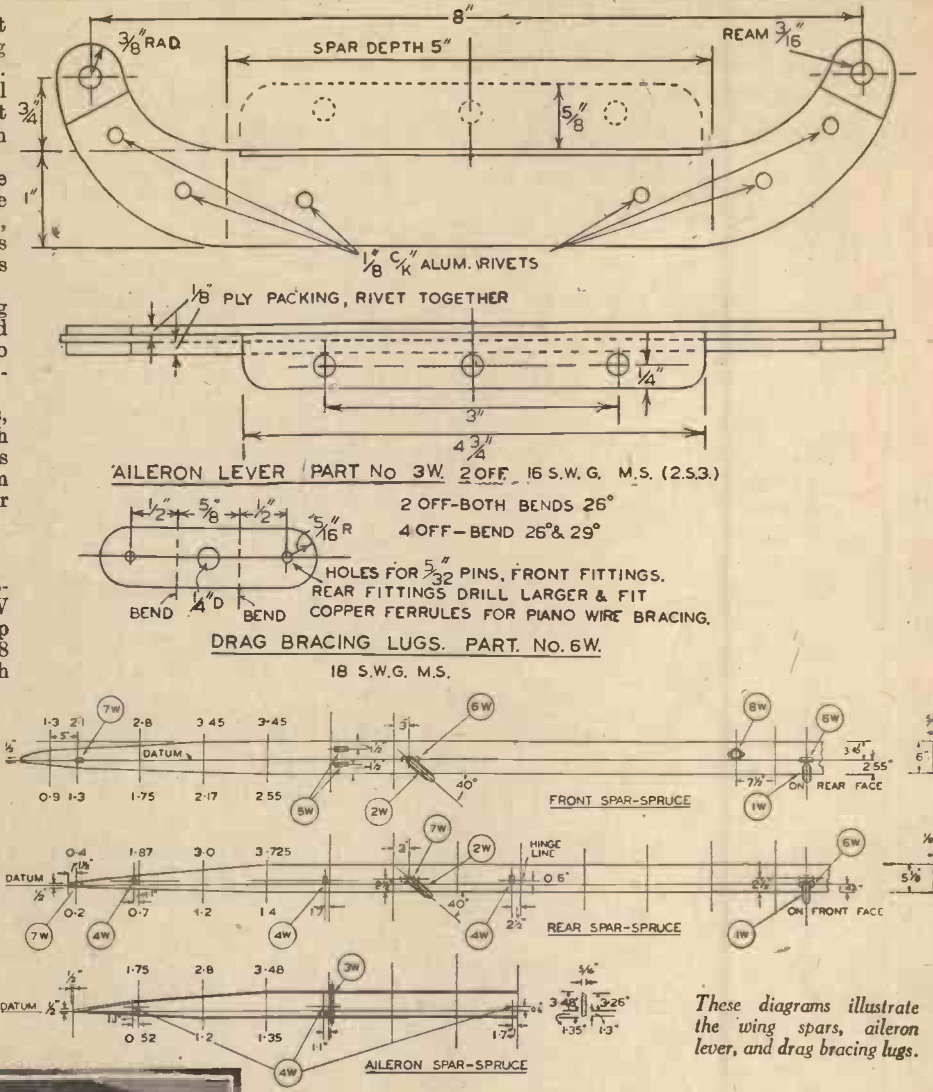
Mark in the datum line 2·55 in. from the base, mark all rib positions and set off the distances 3·45 in., 2·8 in., 2·17 in., 1·75 in., etc., above and below the datum line, as shown. Saw and plane the tapering ends accordingly.

Repeat for the rear spar, the section being 5⅛ in. × ½ in., again using carefully selected spruce and paying particular attention to the region adjacent to the left strut attachment.

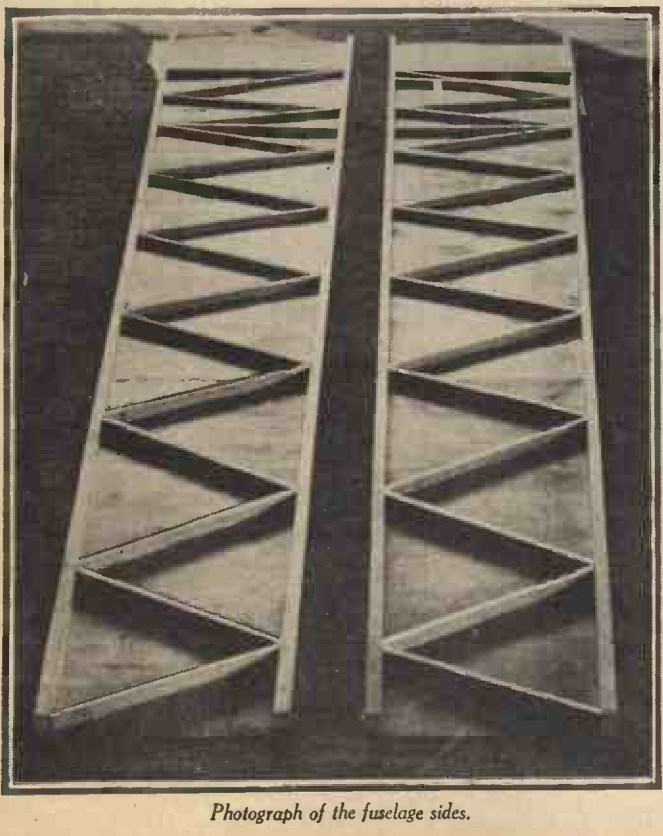
Next comes the pair of aileron spars, made from $\frac{5}{16}$ in. spruce, 4·83 in. deep, each spar being 7 ft. long. The procedure is as before, but in this case the top and bottom edges take the shape of the wing contour and are therefore bevelled as shown.

Wing Fittings

The sketches on pages 9 and 10 show the fittings required for the wing assembly, Nos. 1W to 8W. They are all simple fittings, bent up from sheet mild steel (Specification 2S3 28 ton steel) of 18, 16, and 14 S.W.G. Each fitting should be carefully marked out in the flat by means of a scriber, dividers, and straight edge, cut roughly to shape, taking care that the cuts do not touch the marked lines, and finally filed carefully to the correct shape. All centre lines and positions of holes should be marked, and in most cases the main centre line should be used as datum from which all other measurements are taken. Scribed lines should not be pressed deeply into the metal but should only lightly scratch the surface, or film. Scribe on the *inside* of all bends to prevent the start of cracks when bending takes place. This is best done by marking out on the side to which flanges are



These diagrams illustrate the wing spars, aileron lever, and drag bracing lugs.

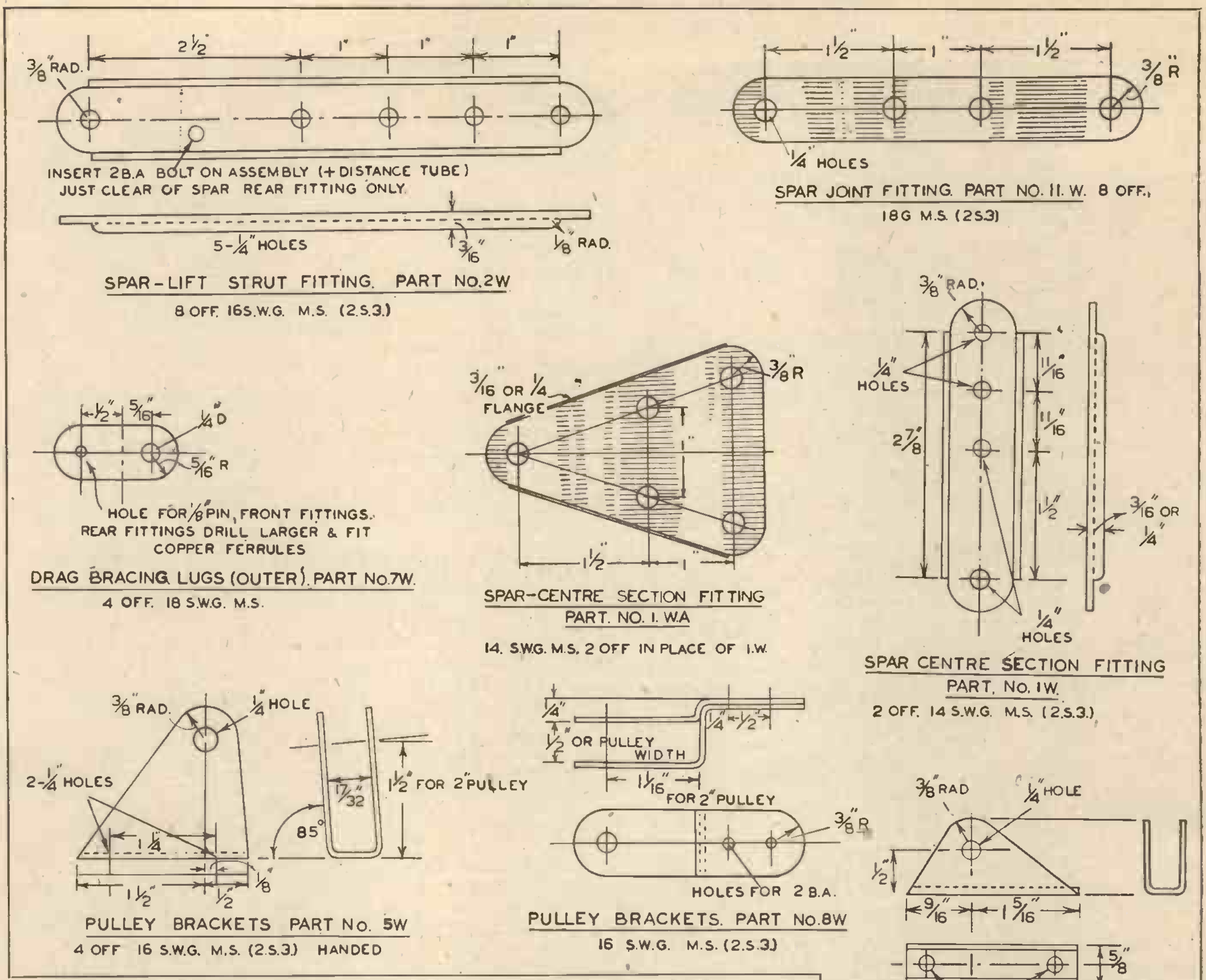


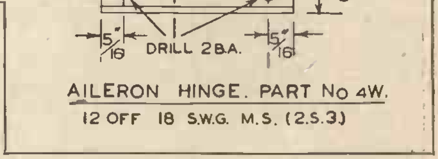
Photograph of the fuselage sides.

TABLE OF RIB ORDINATES

The ordinates for the main plane ribs are given below, the dimensions being the distances of the upper and lower surfaces from a horizontal datum line.

Distance from L.E.	Main Rib.		Rib 1.		Rib 2.		Rib 3.	
Inches.	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.
3	3·15	2·21	2·85	1·73	2·25	1·67	2·05	1·32
6	4·2	2·65	4·0	2·2	3·38	1·9	2·85	1·47
9	5·42	2·85	4·7	2·41	4·18	1·98	3·23	1·58
12	6·3	2·97	5·2	2·5	4·35	2·06	3·68	1·58
18	7·15	2·97	5·52	2·52	4·97	2·06	3·6	1·41
24	7·15	2·84	5·5	2·52	4·35	1·90	2·87	1·23
30	6·05	2·6	5·12	2·13	3·43	1·67	1·93	0·88
36	5·3	2·27	4·32	1·84	3·07	1·37	0·95	0·49
42	4·23	1·90	3·3	1·45	2·16	0·97	—	—
48	3·1	1·39	2·2	1·05	1·1	0·66	—	—
54	1·83	0·95	1·01	0·55	—	—	—	—
60	0·5	0·44	—	—	—	—	—	—
Chord	63		60		51		42	
L.E. radius	1·2		0·96		0·72		0·48	





to be turned. Notice that the spacing of the pulley bracket flanges in 5W and 8W should be made to suit the pulley depth.

Modifications for Two-piece Wing

Two additional main ribs are required. The spars are identically as before but each is made up in two equal lengths, so as to make a good, close butt joint at the centre.

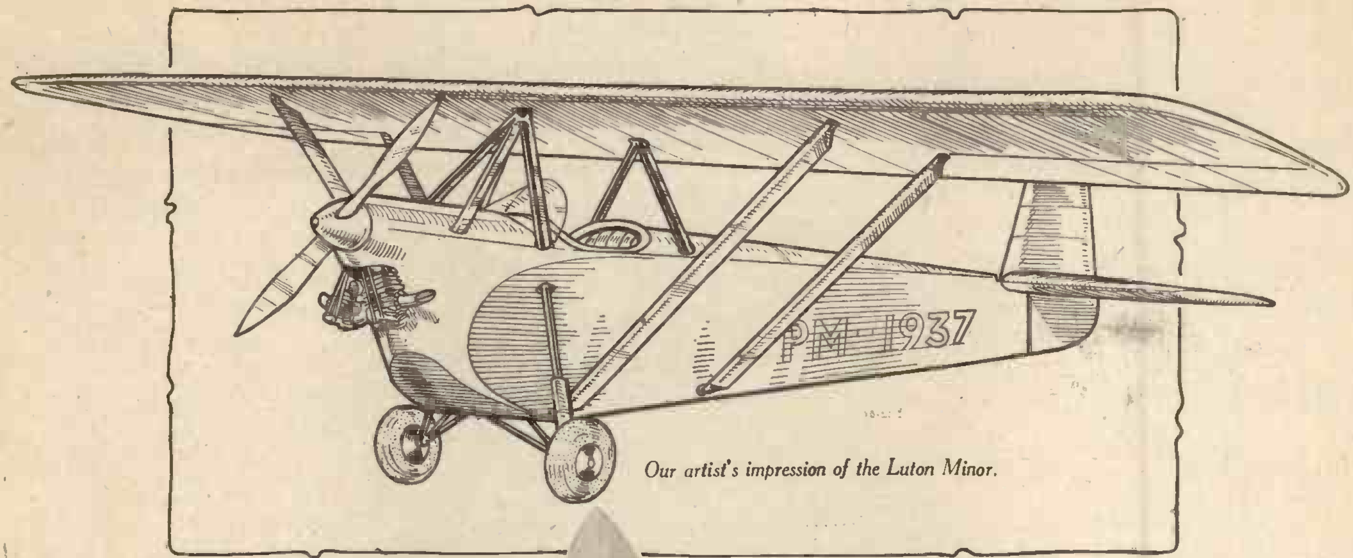
Fitting IW is not required, but is replaced by IWA, two of these being required. Eight additional fittings 11W are necessary for connecting the half spars together finally, and 4 fittings 7W are needed in place of the 2 fittings 6W (26°).

We are now ready to commence the assembly of the wing.

The "Minor" may be obtained, ready to fly, from the manufacturers, Messrs. Luton Aircraft Ltd., of Phœnix Works, Gerrards Cross, Bucks., the price varying from £180 upwards, according to the engine fitted. Messrs. Luton Aircraft also supply semi-manufactured sets of parts at £75 and complete sets of materials required for construction at £40, or the parts and materials may be obtained in component lots, i.e. wing, tail unit, fuselage, etc., for those who do not wish to put down the total cost initially. Messrs. Luton Aircraft have consented to reply to any queries, provided a stamped addressed envelope is enclosed, and to supply any materials, or small parts, and to carry out any welding that may be required. Furthermore they undertake to supply all types of engine and to allow a reduction to those who purchase both the sets of parts, or materials, together with the engine unit from them.

Those readers who desire to obtain a full

The pilot's cockpit.



Our artist's impression of the Luton Minor.

The tail and rudder.

mand that only the very best material should be purchased. Do not, therefore, be tempted to save a few shillings by using green, unseasoned, knotty, or "shaky" timber. The grain must be straight and the various scantlings free from warps and twists.

It is also necessary to follow the drawings very accurately. Every detail will be illustrated and the construction fully described. We cannot, for obvious reasons, supply this information in advance of publication, although we shall be glad to answer any questions or problems which the text of these articles does not make clear. The best plan is to study the drawings and the accompanying text as carefully as possible before attempting construction, for in this way you will ensure that you do not scrap material and make expensive mistakes. Collect the complete material for each unit first, and carefully examine it.

set of blue prints, showing all parts drawn out to larger scale than is possible here, should write to Messrs. Luton Aircraft, Ltd., at Gerrards Cross. Five pounds is the cost of the complete set.

Additional Materials Required

Besides the spars, ribs and fittings, the following material is required:

Spruce:
- 1 length, 23½ ft. × ½ in. × ⅜ in. for leading edge.
- 1 length, 17 ft. × 1 in. × ¼ in. for trailing edge.
- 1 length, 24½ ft. × ½ in. × ⅜ in., for supporting ply nose above front spar.
- 2 lengths, 24 ft. × ½ in. × 1/16 in., for ply packing strip at front spar.
- About 60 ft., 1/16 in. × ¼ in. packing strip, rear spar and aileron.
- 1 length, 13 ft. × ⅞ in. × ⅞ in., for compression struts.
- 7 lengths, 7½ ft. × ⅜ in. × 1/16 in., for wing and aileron tip bends.

Ash: 1 length, 12 ft. × ⅜ in. × 1/16 in., for wing tip bends.

1/16 *in. Plywood:* 5 sheets, 4 ft. × 4 ft., or say 80 sq. ft. in all, for wing nosing and wing tip covering.

Piano Wire: 16 S.W.G., 52 ft., or say 1 lb.

Turnbuckles: 5 cwt., eight required.

It is most essential that the correct materials, as here specified, be used. Inferior wood will not do, for the factor of safety and Air Ministry requirements de-

The Luton Minor in Flight.

Photo-micrographs with-

How to Make Clear and Well-defined Microscope

A reflex camera fitted with a 2-ft. long extension for the purpose of photo-micrography as explained in this article.

IT is usually considered necessary to have a high-class microscope to produce serviceable photo-micrographs. Whilst, of course, for the production of photo-micrographs of very high degrees of magnification, a good microscope is essential for the production of pictures of more moderate magnification up to, say, fifty or sixty times enlargement, a microscope may be dispensed with. The pictures taken without a microscope at these moderate degrees of magnification will, in some cases, be found to be clearer than similar ones made with the microscope.

Focussing Camera Required

To take microscope photographs without the aid of a microscope as, for example, photo-micrographs similar to the ones with which this article is illustrated, it is necessary to have merely a camera and a lens. The camera must be a focussing one and it must be equipped with a focussing screen. The lens should be one of short focal length, the shorter being the focal length of the lens, the higher, other factors being equal, being the degree of magnification of the pictures produced. We shall, however, deal with the best type of lens to use later on in this article.

In order to produce microscope photographs with the aid of an ordinary focussing camera as mentioned above, it is necessary to provide a "long extension" for the instrument. This "long extension" may be anything between eighteen inches and five or six feet in length and, with a given lens, the longer the extension, the greater will be the degree of magnification obtained in the photographs.

Making the Extension

The "extension" takes the form of a sort of rectangular cross-sectioned tunnel, made in wood, plywood, or even in cardboard, which fits into the camera-front at one end and carries the lens at the opposite end. This "extension" must be painted a dull-black inside to obviate light-reflections. If suitable non-shiny paint is not available, ordinary black (not blue-black) ink is a good substitute.

If the long extension is going to be used a good deal, it is best to make it soundly

A common flea.

from good quality whitewood. If, however, a mere experimental form of extension is desired, thick cardboard will suffice for the purpose, provided, of course, that all its joints are made perfectly light-proof.

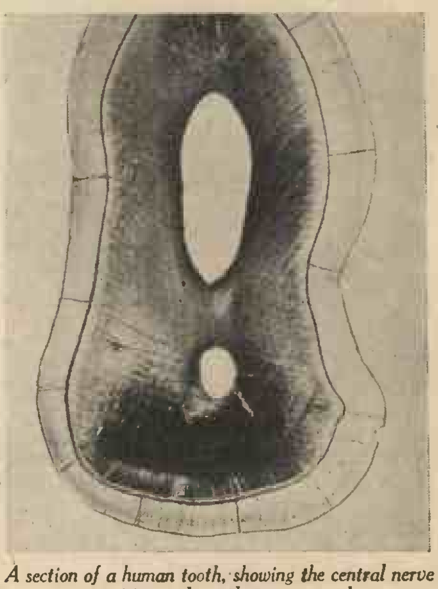
A good average length to make this extension is somewhere around three feet. This allows a fair degree of magnification to be obtained with a short-focus lens, whilst, at the same time, the photographic installation does not become too unwieldy in use. If, however, the amateur aims at taking pictures of greater magnification, the length of this extension may be increased as required.

The Lens

Now regarding the type o lens to use. In the first place, let it be said that an expensive anastigmatic lens is not at all called for. All we require is a good single or R.R. lens of about three inches focal length. As previously mentioned, the shorter the focal length of the lens, the greater the magnification obtained with a given extension. If, however, we use a lens of shorter focal length than about three inches, focussing becomes extremely critical and difficult to carry out. It is better to obtain a great degree of enlargement by making the camera extension longer than by employing a lens of focal length shorter than, say, two inches. The lens selected must be capable of being stopped down to about f/32, since such a small aperture will usually be necessary to produce a picture which is well defined in all parts.

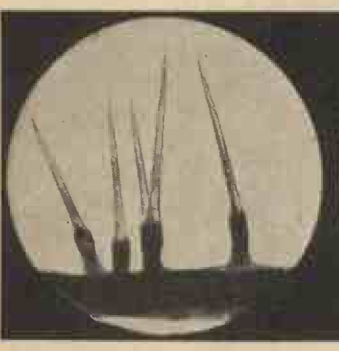
Making the Exposures

Having provided a suitable camera extension and fitted it with the necessary short-focus lens, we are at once in a position to commence our really enthralling task of

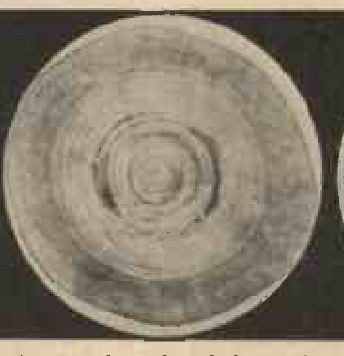


A section of a human tooth, showing the central nerve cavities, pulp and outer enamel.

home photo-micrography. It is best, if possible, to begin operations with one of



Taken with a 4-ft. camera extension. Stinging hairs on the leaf of a nettle.



A section of a real pearl, showing the annular structure.

Flaws in a section of thin cast metal rod.

The sting of a wasp.

out a Microscope

Pictures with the Very Simplest of Apparatus

the glass-mounted microscope objects which can be purchased from opticians and other similar shops. This is because such objects are almost perfectly flat, are semi-transparent and are usually attractively set out. If, however, a professionally-mounted microscope object is not available, some other object should be selected and carefully mounted upon a sheet of clear glass by means of a drop of cement placed on its underside. There is almost an infinitude of objects which may be employed for this purpose. Dead insects, portions of leaves, hair, skin, fragments of bone,

A match head.

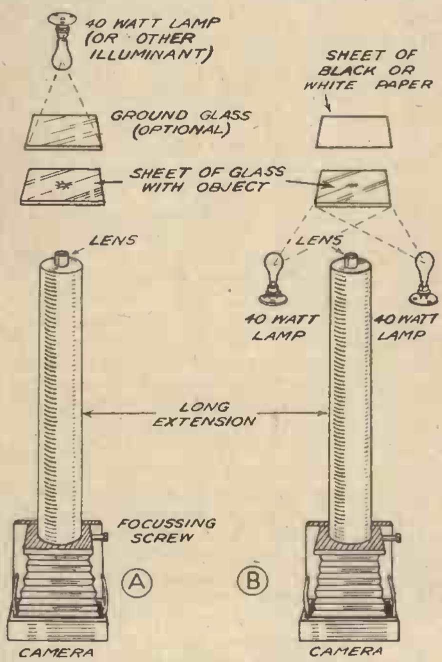
minerals, fabrics, paper, dust, foodstuffs and so on. Stick the glass sheet bearing the object into a flat-bottomed cake of soap and see that the glass stands quite vertically.

Now place the glass and its soap support in front of the lens on the camera extension and, if the object is a transparent one, as, for example, a fly's wing, place the source of illumination behind the glass and about a foot away from it. If a sheet of ground-glass is placed between the illuminant and the glass sheet bearing the object, the illumination will be more equalised but lessened in intensity, thereby necessitating a considerably longer exposure.

The Illuminant

If the object is an opaque one, as, for example, a small beetle or a piece of fabric, the illuminant will have to be placed in front of it and slightly to one side. Sometimes, in such instances, it will be found advantageous to have two illuminating sources placed in front of the object and at opposite sides of it. For backgrounds, a sheet of white (or black) paper may be placed just behind the glass sheet bearing the object, or, still better (if the opaque object is intended to be photographed on a white background) a third source of illumination may be placed some distance behind the glass sheet.

Electricity, of course, forms the best and the most easily adapted source of illumination for work of this nature, a 40-watt lamp providing a good illuminating unit. However, where electricity is not available, incandescent gas illumination may be used, or, alternatively a good oil lamp will serve the purpose quite efficiently. Even a steady-burning candle will suffice in some instances.



Showing the arrangement of apparatus for making microscopic photographs with a microscope. (A) for use with transmitted light (Transparent objects). (B) For use with reflected light (Opaque objects).

Time of Exposure

It is absolutely impossible to give an indication of the length of exposure which will be necessary when using a home-made photo-micrographic apparatus of the type described in this article. Such exposure times depend upon the intensity of the light, the length of camera extension, the aperture and focal length of the lens, the type of object being photographed and, of course, upon the speed and nature of the plate in use. Practical trial, therefore, is indispensible in order to ascertain the exposures required.

A chased "cock" from an old verge watch (original ¾-in. in length).

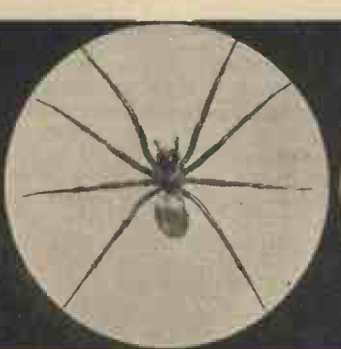
In this connection, however, it should be noted that panchromatic plates are much faster to all forms of artificial light than are ordinary plates and with one of the modern "soft-gradation" pan. plates used with a camera-extension of three feet and a lens of three inches focal length with 40-watt electric lamp illumination on an average subject, an exposure of about 7-8 seconds will be ample. Non-panchromatic plates for the same subject will require up to 30 seconds exposure.

Always stop the lens down to its smallest aperture before photographing. Exposure times, will, of course, be lengthened, but this is of little consequence. Be sure, also, that the whole apparatus is perfectly free from vibration during the period of exposure. Place a wineglass full of water upon some convenient part of the apparatus and watch the surface of the liquid carefully during the period of exposure. If the slightest tremor of the apparatus is set up, it will at once be noticed upon the water surface.

Plates or films used for home photo-micrography, be they panchromatic (red-sensitive) or otherwise, should be at least

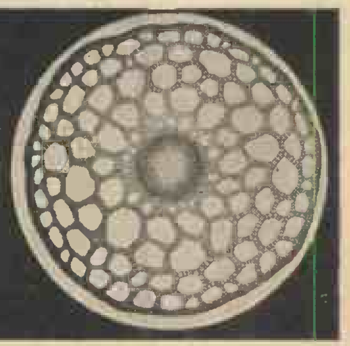
(Continued on page 61)

Moth grubs at work on a piece of fabric.



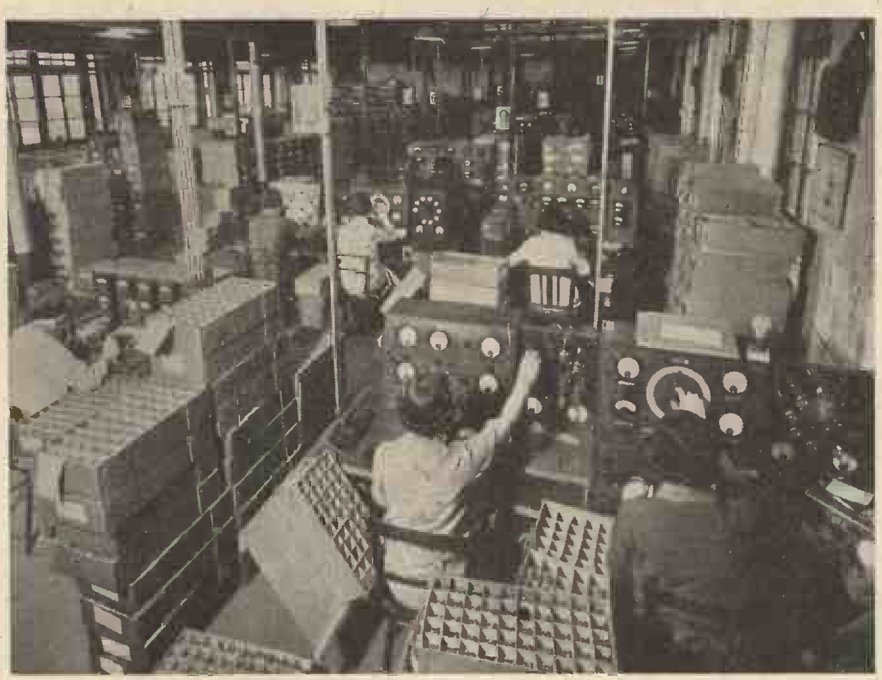
A garden spider.

The common gnat.



A section of a grass stem.

HOW WIRELESS VALVES ARE MADE


Part of the final test section of the Osram factory

BY OUR SPECIAL CORRESPONDENT.

The Wireless Valve that you Casually Plug into Your Set looks, at first sight, a simple affair, but in reality it Incorporates some of the most Ingenious Craftsmanship of Modern Science.

A VISIT to the Osram Works of the General Electric Co., has convinced me that you need to see a valve made to realise the amazing workmanship it represents. What to me is perhaps the most striking exhibit in the whole works has nothing to do with any of the processes of making a valve at all. It consists of three show cases containing 700 to 800 types of valves. No two of them are the same—each one represents some step in the evolution of the highly efficient valves with which we are blessed to-day. This evolution dates back to 1917, when the works made its first valve. So greatly has the technique improved, I was told, that most of the early valves would be absolutely useless in a modern receiving set.

Metal Components

The metal components of the valves are made with astounding speed and accuracy. The machines which cut out nickel "shields," for instance, use 250 yards of nickel strip per hour, cutting out between 7,000 and 8,000 pieces.

Machines known as pinch-making machines are next used to seal the leading-in wires into the central supporting tube. In these machines the glass is made plastic, and a metal "pincher" moulds it round the leading-in wires to the shape required. Through successive processes the valve arrives at the exhaust stage, where air is withdrawn by machine pumps working to extremely low pressure. When the air is exhausted as far as possible by mechanical means, an ingenious process is used to perfect the vacuum before final sealing of the envelope. This consists of "firing" a deposit of magnesium, or other approved material, on to the internal surface of the bulb, so as to render the residual gases innocuous. A valve containing even minute traces of gas will cease to function very quickly.

Three Tests

In addition to the many examinations in the process of manufacture, three different and very rigorous tests are applied to the valve in the completed form, and any valve falling outside the prescribed limits for any feature or characteristic, is immediately rejected. In addition to this, all valves are subjected to both "static" and "chassis" tests outside the manufacturing department.

When production of a new type of valve is put in hand, a considerable amount of technical and productive effort is applied to secure manufacture on a reasonable basis.

The method of testing for mechanical faults and parasitic noises is very ingenious indeed. The valve is inserted into a "chassis" to simulate the conditions it will have to meet in use on the market, and is then tapped hard with a rubber-topped hammer. By means of a sensitive amplifier any fault is immediately discovered.

It has been found that valves, like wine, are better for maturing, and every valve before leaving the factory is subjected to a "stewing" or "loading" for two or three hours to achieve this effect.

Ingenious Jigs

The use of ingenious jigs into which the electrodes are inserted enables the girls engaged on the construction of valves to work with great speed and accuracy.

The process by which the cathode of a valve is coated with a powder consisting of a mixture of barium and strontium carbonate is typical of many others calling for great precision. The cathode, which weighs in the neighbourhood of 250 milligrammes, is first weighed, then sprayed with a thin film of coating, and then weighed again to check the accuracy of spraying.

A particularly interesting type of valve is the Y.63, otherwise known as the "Magic Eye." This type employs some of the principles of the cathode-ray tube as used for television purposes. The valve has a cup or disc coated with fluorescent powder which glows and registers accuracy of set tuning.

The ordinary valve which you and I so casually buy for a few shillings, contains an amazing number of parts. In the case of the triode hexode, for example, there are 78 parts, 17 different elements being used.

But the types referred to are by no means the only valves that are constructed by the Osram Works at Hammersmith. There are valves that you and I have never seen at all. The smallest of all is the "Acorn," which is hardly bigger than the top of one's little finger.

At the other end of the scale is a valve which stands 3 ft. 6 in. high, and of which the copper anode alone weighs 66 lbs. This is known as the C.A.T. 14, and is referred to as a 500 K.W. valve. "CAT" does not, as one might at first imagine, stand for "cathode," but for "cooled anode transmitter," from which you will gather that it is a valve used for transmitting purposes.

Special "prams" are used to wheel valves of this type from one place to another.

BOOK RECEIVED

"Thermionic Valves In Modern Radio Receivers," By Alfred T. Witts, A.M.I.E.E. 192 pages, 114 diagrams, 8s. 6d. net. Sir Isaac Pitman & Sons, Ltd., London.

THIS up-to-date book is by the same author as other semi-text books on wireless subjects. It deals fully with the principles of the modern wireless valve, explaining characteristic curves, and their meaning besides explaining the requirements of valves for different parts of the circuit. Being well illustrated with circuit diagrams, it is easy to read, although being of a technical, as opposed to a popular, nature. Formulae are given where necessary, but the non-mathematical reader can find interest and assistance even if these are "skipped."

The book is primarily suitable for students and those service engineers who are anxious to keep abreast of technical developments and thoroughly understand the "whys and wherefores."

Transmitting Matter through Space

By J. F. Stirling

Some Fascinating Problems Concerning Material Transference and other matters which a Future Generation may Solve.

EVER since mankind appeared upon the face of the earth the individual, when he wishes to get from one place to another, has been constrained to make he journey either by the walking power of his body or else by taking advantage of some type of animal or mechanically-driven vehicle. True it is that some religious mystics seem to have been possessed of the power of *bilocation*, whereby they have been enabled to be in two places many miles distant from each other at the same time and, also, that certain Indian fakirs and similar individuals have apparently been able to project themselves, as it were, out of their bodies and to perform certain ceremonies in distant localities. All such instances, however, represent entirely abnormal phenomena and there is little doubt that for nearly every member of the human race the time-honoured method of making a journey, either on foot or by some other means of physical locomotion, will remain an unchallenged one until the end of things.

In the case of non-animate objects, however, the above statement does not necessarily apply. At the present day, of course, if we wish to take coals to Newcastle we have to carry them there or else avail ourselves of the services of mechanical means of transport by land, water or air to effect their conveyance. One cannot, for instance, transmit a pound of salt by radio, although, as we shall see later, one could, if expense were no object, transmit a pound of copper a mile or two by electro-chemical means alone.

Radio Transmission of Power

One of the problems of the immediate future after the coming of world-wide television is said to be that of the radio transmission of power. Actually, it is, even at the present day, possible to transmit small amounts of energy by wireless means. The problem of wireless power-transmission, important as it may be to a future generation, fades into comparative insignificance when it is contrasted with the problem of actually transporting matter by electrical influences.

Fantastic as the problem may seem to the present-day reader, there is really no reason why, at some future age, it should not be solved. Could we, for instance, take a bar of copper and, placing it in the container of some hypothetical apparatus situated in London, transmit it by electrical means, either by wire or wireless, to a similar receiving instrument located, say, at Glasgow, then a very important advance in Man's mastery over Nature would have taken place.

Dematerialisation

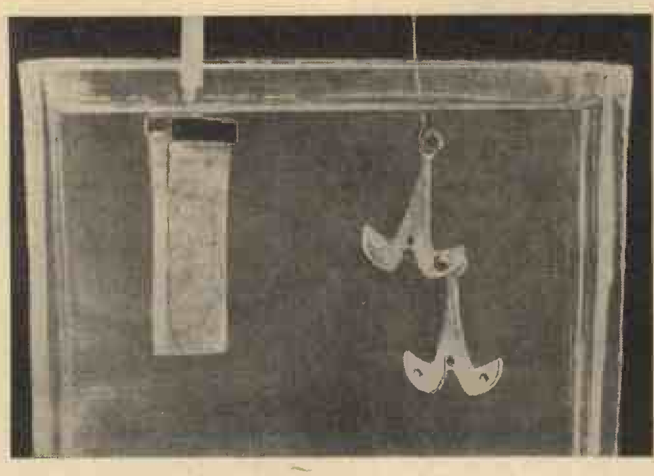
So far as one can possibly see, the only manner in which the above transmission of a heavy solid could be effected would be through some application of the yet-to-be-discovered principle of the dematerialisation of matter. Matter, we are all aware, exists in three well-known forms—solid, liquid, and gaseous, which are fairly readily interchangeable into one another. There is good reason, however, to suppose that matter can and, indeed, actually does exist in other and more tenuous forms than the gaseous one. The luminous tail of a comet, for instance, contains matter in a sort of ultra-gaseous condition, whilst surrounding the sun during the period of its total eclipse by the moon is seen the wonderful pearly, shimmering *corona* which again, it is considered, is made up partly of matter in an extremely nebulous form.

An actual photograph taken through a giant telescope of a region many light years out in the depths of space. In a region such as this, matter is very probably dematerialised and rematerialised by powerful electrical influence which surround it.

We may, therefore, refer to the material comprising the tail of a comet and that in the more distant portions of the sun's corona as dematerialised matter. There is nothing like it on earth, for a comet's tail is not merely a semi-vacuous space, but, rather, an assembly of matter in what we may term an ultra-gaseous or dematerialised condition.

Atomic Destruction

On earth it has been found possible by the employment of electrical energy to disrupt the atom and to split it up into its constituent particles to a very limited extent. This, however, constitutes the actual destruction rather than the problematical dematerialisation of matter. Matter, properly dematerialised, would be converted into an extremely subtle, super-gaseous form. In that condition, however, it would retain, at least in latent fashion, all its characteristics. Dematerialised soda, for instance, would not be anything else other than soda and when, by a reversal of the process of dematerialisation, it was



(Left) In every electrolytical bath a limited form of solids transmission takes place with the travelling of the metallic particles through the solution.

returned into its original form, the soda would be indistinguishable from similar material which had not been so treated.

Exactly how matter is to be so dematerialised is as yet beyond the bounds of definite conjecture. Some process of physical extension under electrical influence will undoubtedly be required, but whether such a process, even assuming that it is ultimately devised, could be adopted commercially without the expenditure of vast and utterly uneconomical amounts of electrical energy is a problem which only futurity can solve.

One thing seems certain and that is that matter in its dematerialised condition should be amenable to electrical treatment for its transmission from one place to another. By the use of a specially-devised cable, even, perhaps, by wireless alone, dematerialised matter may ultimately be found to be transmittable much in the same manner as electric waves and pulsations are capable of transmission.

(Right) The tail of a comet is so thin and rarified that the matter comprising it has been considered to be in a special ultra-gaseous and even dematerialised condition.

Transmission of Solids through Space

In such a manner it is probable that a future age of scientists may devise means of transmitting material objects from one place to another. The material or substance to be transmitted will be inserted into a "dematerialiser" attached to the transmitting instruments and, after having undergone electrical dematerialisation, will be transmitted to the distant receiver, either by cable or wireless. There it will be received and "rematerialised." The transmission will, of course, like all electrical impulse-travels, take place practically instantaneously, thus effecting a revolutionary speeding-up in methods of conveyance.

Inter-planetary Communication

Successful upon earth, there seems to be little reason why a sort of inter-planetary communication should not be effected by the method. Granting the practicality of the method as applied to terrestrial transmissions, we ought then, at least, to be in a position to project planet-wards an electrical beam of dematerialised matter. If, however, such transmissions were not received and materialised upon the surface of the planet to which they were directed, the dematerialised substances would presumably remain in that condition for evermore and would, very probably, continue their travels into the depths of unknown Space until their energy was absorbed by the mysterious influences which operate in those far-out regions where worlds are born.

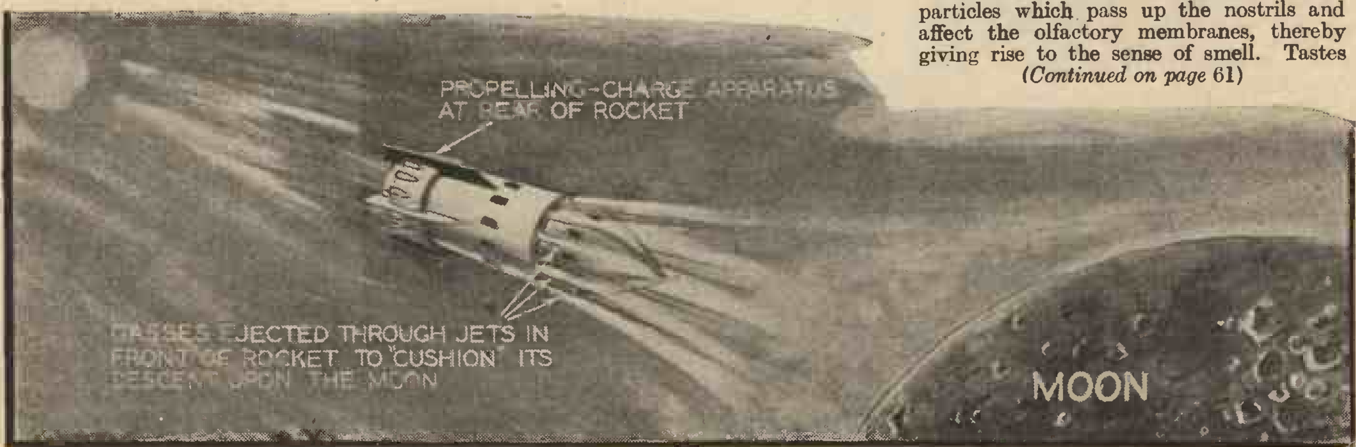
This electrical transmission of matter is not, even at the present day, so utterly impossible as it may seem. Imagine, for example, a mile-long trough containing copper sulphate solution. At one end of the trough a zinc article is immersed in the solution, a strip of copper dipping into the solution at the opposite end of the trough. An electric current is sent through the solution, the zinc article being made the negative pole and the copper strip the positive electrode. Provided the driving potential of the current was sufficient to overcome the resistance of the solution, particles of copper would flow through the solution and deposit themselves upon the zinc cathode, the solution replenishing its copper content by attacking the copper anode. In this flow of metallic particles from anode to cathode which occurs in all electrolytical operations, we have a sort of limited transmission of matter which, of course, is not capable of any serviceable application for such a purpose.

Electrical Transmission

Although by a process of dematerialisation and subsequent electrical transmission it may at some distant age be possible to transmit a variety of materials from one place to another with efficacy and speed, thus revolutionising the world's transport methods, it cannot ever be possible to apply the method to living creatures, for the reason that the process of dematerialisation would destroy life which would not be regained by subsequent rematerialisation. Man cannot, therefore, hope to transmit himself electrically with the speed of light by this yet unheard-of method.

If, however, material non-animate objects, such as salt, sugar, soda, sand, etc., could be transported electrically by the above means, there is no reason, also, why, instead of transmitting the materials themselves, it should not be possible to transmit their smells and/or tastes. In this manner the electrical or radio transmission of taste and smell, which has already been suggested by thoughtful writers, would be an accomplished fact. Odours are due to the throwing off by the odoriferous material of infinitely small particles which pass up the nostrils and affect the olfactory membranes, thereby giving rise to the sense of smell. Tastes

(Continued on page 61)



MODEL AERO TOPICS

CURRENT NEWS FROM THE WORLD OF MODEL AVIATION

BY F. J. C.

A view of some of the competitors before the start.

"Petrel" Model Aircraft Result

A FAIR number of competitors turned up at Brooklands Aerodrome on Saturday, August 14th, for the "Petrel" Contest for our £50 prize. Unfortunately, the atrocious weather did not permit of the competition being run, and after a few flights the competitors agreed that it should be postponed. The postponed contest was therefore held at Brooklands Aerodrome on Sunday afternoon, Sept. 5th, and although the entry was somewhat disappointing, nevertheless, some excellent models were on view and some good flying was witnessed. Readers will remember that only models built according to the design and specification published in this journal were eligible, and we excluded professional model makers and those engaged in the making of models for profit. Models had to be the unaided work of the competitor, who could only enter one model, and variation of design was not permitted. The competition was for time-controlled flights, points being awarded for take-off, stability, duration of flight, and landing. Thus, the models which took off quickly and had a fairly flat gliding angle obviously had a better chance than one with a long take-off and a steep drive.

In order to prevent models from flying outside the Aerodrome, competitors were asked to set the time-control switches so that the ignition was cut off at 45 seconds. The maximum points awarded were 100—60 for duration, 15 for take-off. 5 for landing, and 20 for stability. The weather was excellent.

The winner was Mr. C. R. Jefferies, of 73 Welfrod Road, Shirley, Warwickshire, whose model flew consistently well. In his first flight, his model took 3·5 seconds to get off, and landed 115·2 seconds later, although the ignition did not cut off until 49·5 seconds. In his second flight the model took 2·8 seconds to rise. There was a 47 second motor run and a duration 92·2 seconds. His third flight was somewhat shorter, and as no other competitor succeeded in putting up anything like this duration, he takes the £50 prize. The second prize winner was Mr. B. A. Payne, 100 Pinner Road, Harrow, Middlesex, whilst the third was Mr. I. Lucas, 5 Wood Mews, London, W.1, who receive 5 guineas and 3 guineas respectively. A number of consolation prizes have been awarded to other competitors. The general workmanship of the models was excellent, although most of the competitors had failed in spite of the ample time allowed to adjust their engines so that the last ounce of power was obtained. Any of the small engines such as the Spitfire, the Grayspec Gnome, or the Hallam Baby will fly and have flown the "Petrel," but naturally the engine must be properly adjusted. The model easily flies with a 6 c.c. engine. It would seem that most of the competitors relied upon frequent flooding of the carburetter, which I think is bad practice, as the engines get very rich and become temperamental. Another point which I noticed which was responsible for erratic running was the use of ordinary valve tubing as connection between the petrol tank and the jet. At high speed these tubes tend to close up under suction, and this was responsible for quite a lot of engine stopping. A heavy rubber tube should be used. Very few of the models failed structurally, and competitors were allowed to give the models a slight push in launching owing to the comparatively rough nature of the ground. I desire to express my gratitude to Mr. J. C. Smith, Mr. H. York, Mr. A. F. Houlberg, and Mr. L. J. Hawkins, for their valuable services as judges and time-keepers, and who brought to bear on the contest a vast amount of experience which they have gained in their capacities as members and officials of the S.M.A.E., under whose auspices the competition was held. My congratulations also to the winner

A further view of the competitors and their models. Mr. B. W. Best, the well-known timekeeper, is on the left.

on his skill in so accurately interpreting our instructions and producing such a consistent flyer.

Petrol Model Insurance

MR. BROOKS, of the Model Aircraft Stores, Bournemouth, sends me details of the terms of policy of a Petrol Model Insurance Scheme which he has inaugurated, and which indemnifies the assured against all sums which he or she shall become legally liable to pay in respect of claims made for compensation for bodily injury (fatal or non-fatal) to persons, or for damage to property for any accidents or accident resulting from flying petrol model aircraft. It excludes compensation for injury to any person who is engaged in the service of the assured, to the assured's own property or property in his custody, and accidents occurring outside the limits of the United Kingdom. The liability of the Underwriters is limited to £2,500 in respect of any one accident or series of accidents arising out of one event. The premium costs only 7*s.* 6*d.*, with an additional shilling for the first year.

The Wakefield Cup Result

IN last month's issue I gave the names and times of the first three competitors in the Wakefield Cup Contest. I now give the names and times of the first twelve :

		Secs.
1. E. Fillon	France	253·23
2. R. Bullock	Great Britain	194·53
3. R. T. Howse	Great Britain	193·46
4. Chabot	France	157·6
5. R. Clasens	Belgium	156·83
6. B. Anderson	Sweden	155·73
7. M. Mckinney	Belgium	155·05
8. G. Stark	Germany	151·83
9. K. Schmidtberg	Germany	147·65
10. A. Dague	America	145·1
11. D. Bodle	America	136·16
12. B. Lindn	Sweden	132·73

One of the machines in flight.

World's Records

AT a recent Council meeting of the S.M.A.E. the delegates to the F.A.I. conference made their report. They stated that they had been successful in getting passed several of the British recommendations for timing world's records. Briefly, the regulations are as follows : World's records will be acknowledged for power driven models, rubber-driven models of the fuselage type, gliders and seaplanes. In the case of rubber-driven models and gliders the wing loading must be at least 15 grammes per square decimetre, whilst all models must conform with the S.M.A.E. formula ; the tail area of models is limited to 33⅓ per cent. of the main plane area, and any area in excess of this will be counted as lifting surfaces. Records will be introduced for duration, distance, altitude, and speed.

Seaplanes must make a flotation test of 5 minutes.

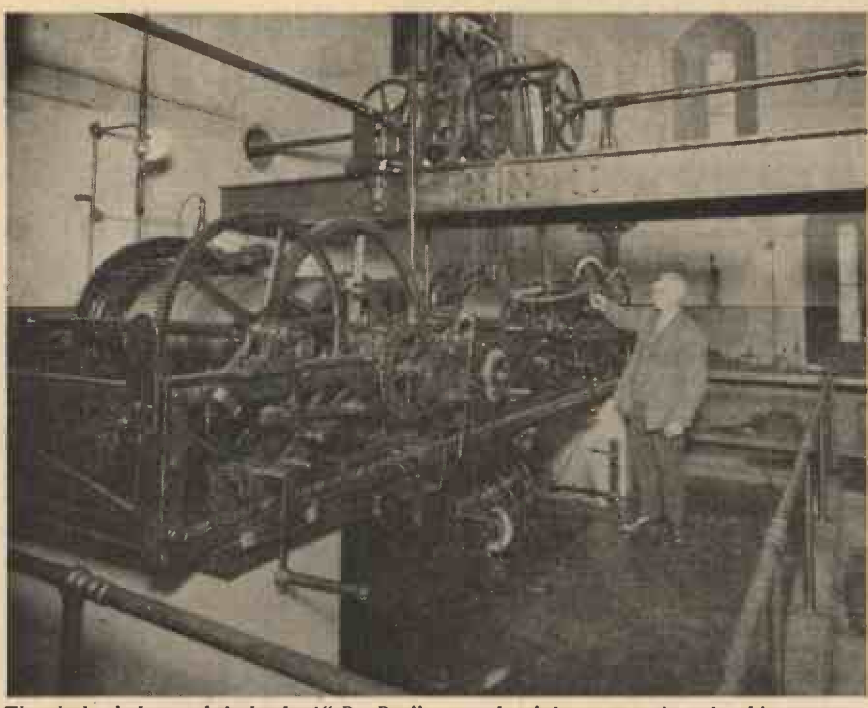
There are three methods allowed for launching gliders. (1) Hand-launched, (2) catapult-launched, (3) cable-launched. In the case of the catapult, the line must not exceed three metres. In the case of the cable launch, the line must not exceed two hundred metres, with one end stationary. In the case of the running launch by cable, the line must not exceed one hundred metres and the operator must not run more than seventy-five metres.

All times are taken from the moment the model is released until the machine lands, touches some object, or goes out of sight of the timekeepers *who must remain stationary, but optical aids may be used.*

In the case of the glider, the fall of the model must not be more than nine metres per minute of flight and the distance they travel must be measured on an ordnance map. All claimants for records must hold an F.A.I. licence. Machines must not be commercially made.

Left: the Judges in the "Petrel" contest confer. Mr. F. J. Camm is on the right. Centre: the winner, Mr. C. R. Jefferies, with his model, and right, Mr. Jefferies' model well up during the contest.

THE MONTH IN SCIENCE AND



The wheels which control the hands of "Big Ben"; some idea of their size can be gathered by comparison with the man in charge of the mechanism.

A Mechanised Library

THE famous library of the British Museum is being modernised. Mechanical aids may seem out of place in this storehouse of knowledge. But where several thousand books are consulted by readers every day, speed-up is required. Accordingly a pneumatic post system is being installed by which readers requirements may be posted to the book-stores. The books are sent back by a mechanical book-carrier working on the roller conveyor system. Another interesting feature is the rehousing of the books on new steel shelves as the old cast-iron racks have become inadequate to bear the many tons of books of the library. Incidentally, the total number of volumes stored is now close on the 5,000,000 mark.

Driverless Shunting

WHILE talking of automatic deliveries the recently constructed automatic shunting yard of the German State Railways at Stetting may be mentioned. The shunting yard works on the central ramp principle where trains are put on the top of an incline and the trucks are allowed to run down. The whole operation of distribution is worked from a central cabin. The operator, with schedules of the make-up of trains in front of him, drops off the trucks, shunts them and reassembles them entirely by a switch board in front of him. Not only has he complete electrical control of the whole yard but on a special indicator board in front of him the moving picture of the whole shunting yard is presented to him.

Gas Switch Board

DISTANCE control of operations over a large area in conjunction with the indicator diagram panel is, of course, becoming more and more common in industry. An example on the largest scale is provided by the Ford Motor Works at Dearborn, U.S.A. This works starts with coal and iron and finally turns out motor cars. From its blast furnaces and from the coke ovens which supply the blast furnaces millions of cubic feet of fuel gas are produced. This gas provides the fuel needed in all the many complex stages of production of motor cars from the simple raw materials. Nearly 100 million cubic feet of gas are handled daily. The distribution of this vast volume through huge 6 ft. mains and feeders of diminishing diameter is handled from one central valve-room. Here switch controls to distant valve-motors stop or release the flow of gas as the distribution engineer directs. Back to him from flow and pressure gauges on the mains-lines, the whole picture of the gas flows is flashed and recorded on his gas map. The whole layout is one of the most unique examples of master brain control.

New Coke Ovens

BRITISH industry is, however, developing on an equallyl arge scale. The great steel company of Dorman Longs has recently opened at Middlesborough a new coke oven plant which is the largest yet built in this country. Over one million tons of coal are to be converted to coke annually. By-products include 3·5 million gallons of benzole and 12,000 tons of sulphate of ammonia available for fertilisers. The plant covers 6¼ acres and comprises a battery of 136 ovens with ancillary plant. The speed of erection was such that the plant was at work within twelve months of the driving of the first piles of the foundations.

Hong Kong's Wonder Dam

THE great Jubilee Dam in Hong Kong is the largest of its kind in the world.

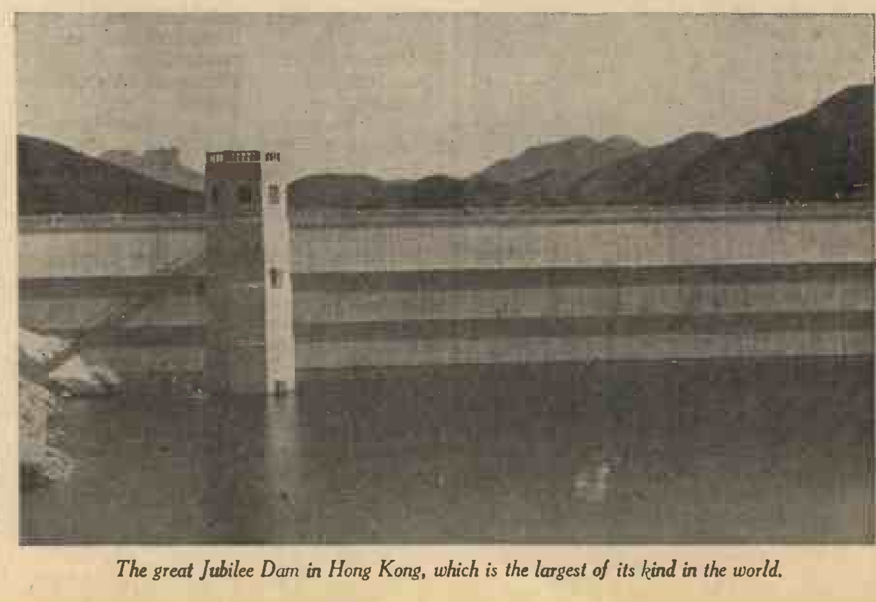
It is 300 ft. in height, and its construction entailed the use of 200,000 cubic yards of solid concrete, and 500,000 cubic yards of rock filling.

The reservoir formed by the Dam is capable of holding 3,000,000,000 gallons of water.

This water is obtained from the extensive ranges of hills which surround the Shing Mun Valley, leased territory on the mainland.

Hitherto Hong Kong island has been poorly supplied with water, and the purpose of the Jubilee Dam is to enable the island to draw on this vast supply in a possible emergency.

This has been achieved by running a



The great Jubilee Dam in Hong Kong, which is the largest of its kind in the world.

pipe-line across the bed of the harbour, so connecting the waters behind the Jubilee Dam with Hong Kong island.

Ocean Air Lines

THE Air Lines of the Oceans are rapidly being mapped out and a commercial struggle is shaping for them. Our own series of ocean flying boats are amongst the giants of the air. News now comes that the Pan-America clipper lines are designing an even bigger series of boats weighing 42 tons, 109 ft. in hull length, and with 150 ft. wing span, with a top speed of 200 miles per hour. The gross horse-power of these giants is to be nearly 5,000. Germany is looking particularly to the South Atlantic. She is putting her faith in smaller short range craft, flying between a series of mother ships. The recently launched catapult ship, Ostmark, is a type of these. Dornier flying boats, designed to operate in conjunction, land every thousand miles and taxi up to the mother ship. They are grounded on a canvas apron towed astern of the ship. This picks them off the waves and thence they are hauled aboard by crane on to a run-way. After refuelling and overhaul they are once more shot into the air off a long catapult run-way extending the full length of the ship. The catapult, operated by compressed air, shoots them off at a speed of 200 m.p.h.

Superlight Concrete

AMONGST the many unusual features of the great San Francisco Bridge across

THE WORLD OF INVENTION

Oaklands Bay is the special concrete which was used in filling up the roadway of the bridge. In place of ordinary broken stone aggregate a new material called Gravelite was employed. This was supplied in the form of evenly graded porous pellets. It is made by burning balls of a special wet clay. The steam evolved in the burning blows out the clay into the form of an artificial lava-like stone. It is so light that it floats on water. By using this material a saving in dead weight of over 15,000 tons was obtained in the structure of the bridge.

Spun Glass

ANOTHER interesting new material is glass tape, thread and cloth. Molten glass may be blown out with steam into extremely fine glass wool. This may be carded and spun just like cotton-wool. The threads may then be braided or woven into tape and cloth. Garments have, in fact, been made up from the new material. This, however, is not its most popular use, naturally. But electricians and engineers find in it an ideal high temperature heat and electrical insulator.

Extending Battersea Power Station

EXTENSIONS costing £1,500,000 are to be made at the London Power Company's electricity station at Battersea. New plant with a generating capacity of 100,000 kw. is to be installed, and the existing building will ultimately be doubled in size. During the winter of 1939-40, greatly increased demands on the output of electricity are expected, and therefore the generating capacity of the station is to be raised to 500,000 kw. Several new ideas are being introduced into the plant.

A Submarine Depot Ship

THE *Maidstone*, which is a 15,000 ton depot ship for submarines, is to be launched from John Brown's Clydebank shipyard on October 23rd.

Pilotless Aeroplanes

THE Radio Society of Great Britain demonstrated at this year's Olympia Radio Exhibition the principle of how pilotless aeroplanes may be controlled from the ground by wireless. The apparatus, although actually devoted to another purpose, was made by Mr. J. E. Bryan from discarded electric totalisator switches. Among the uses to which it could be adapted would be the wireless control of model boats.

An Ultra-violet Meter

DR. M. LUCKIESH and Mr. A. H. Taylor, of the General Electric Lighting research laboratory, have produced an ultra-violet meter. This new device employs a photo-cell which responds only to that band of wave-lengths in the sun's spectrum which causes sunburn. In operation, this cell, when exposed to sunlight, passes a small current which in turns clocks a counting relay of e-viton, which is a unit of ultra-violet, producing the minimum perceptible erythema. The counting continues as long as the meter is exposed, measuring the sun's rays.

New Discovery in Physics

A SOVIET scientist, P. A. Cherenkov, is reported to have made an outstanding discovery in the field of optics. For some years Mr. Cherenkov had been engaged in research in the emission of light by different substances exposed to the action of radium gamma-rays (light rays with a very short wave-length). During his experiments the young scientist discovered that substances subjected to the action of the gamma-rays emitted light in a very curious way. The light was not diffused in all directions, but mainly in the direction of the movement of the gamma-rays. The properties of the light, as well as the experiments in the magnetic field showed without a doubt that the light came from the electrons created by the action of the gamma-rays.

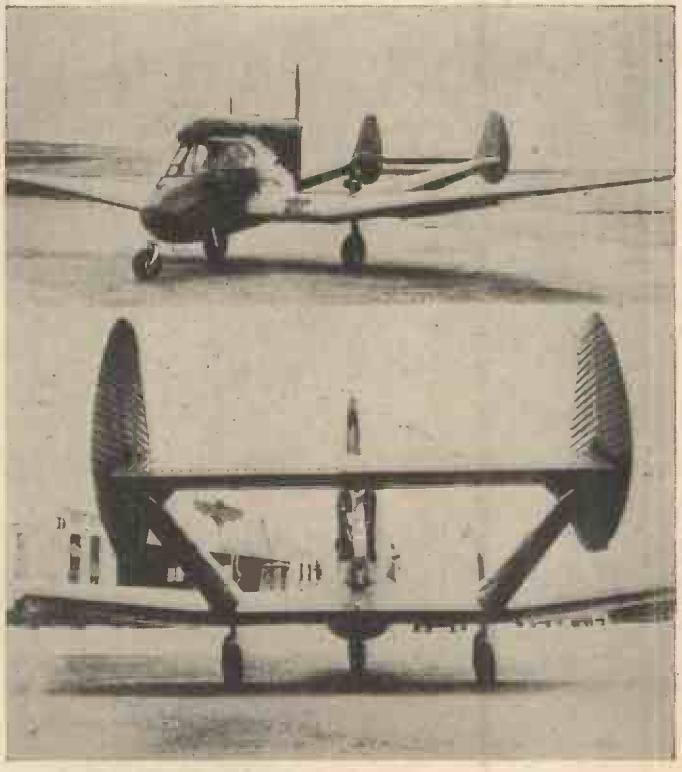
Explaining this phenomenon, Academician S. I. Vavilov, director of the Institute of Physics, said that it was analogous to a phenomenon familiar in artillery when a shell, moving with a velocity greater than that of sound, itself begins to emit sound and radiate sound-waves. In the case of Mr. Cherenkov's experiments the electron moved with a velocity greater than that of the light in the ether and itself began to emit light. Though many details of the new phenomenon still require investigation it is the view of both Soviet and foreign physicists that the discovery is of great importance, not only to optics, but to the study of the nucleus of the atom.

"Private Secretary" for the Blind

THE Braille Manuscript Department of the National Institute for the Blind has taken on the duties of honorary private secretary for a host of sightless people. It transcribes and dispatches correspondence between them and their sighted friends.

One recent post contained requests for a gas-stove chart, a knitting pattern, a sermon, and an inscription on a greeting card.

There is also an increased demand for Braille watches at the National Institute



America's new "Grasshopper" Plane.—A view from the bow and stern of the new type of 'plane which has been built by Stearman-Hammond of San Francisco, and is shown while undergoing tests at Roosevelt Field, New York. The 'plane is of unusual design resembling a gigantic grasshopper while another unorthodox feature is the addition of a third wheel forward.

for the Blind. During the past twelve months, the Institute has supplied nearly 350 such watches to blind people.

World's Biggest Icebreaker

THE giant Soviet icebreaker, *Joseph Stalin*, built at the Orjonikidze shipyards in Leningrad, was launched on August 13th. At the time of the launching, the *Joseph Stalin* was said to be 70 per cent. finished. The *Joseph Stalin* is intended as the flagship of the Soviet Arctic fleet. The icebreaker has a displacement of 11,000 tons, and is 106 metres long, 23·2 metres wide and 20 metres high. Her three 3,350 h.p. steam engines, fed by nine boilers, will enable her to develop a speed of 15½ knots in calm water. The hull of the vessel is specially reinforced. Steel ribs are placed 31 centimetres apart throughout the whole of her length, while those parts which will receive the full impact and pressure of the ice are reinforced by metal plates 45-50 millimetres thick.

The bunkers of the icebreaker are capable of holding 4,000 tons of coal, and she will be able to carry enough drinking water to permit of long Arctic cruises. A system of ballast tanks will make it possible to increase or lighten the weight of any part of the vessel that may become icebound. The stem of the vessel weighs 21 tons, the steel stern-post 36 tons, and each of the three propellers 17½ tons.

Modern Navigation Instruments

THE vessel's centrifugal pumps are capable of pumping 1,500 tons of water per hour. The *Joseph Stalin* is equipped with a refrigerator of 75 cubic metres in volume, fresh-water stills, a compressor for an aeroplane catapult, a gyro-compass, and other modern navigation instruments. Current for lighting purposes is supplied by a 25-kw. steam dynamo and two 50-kw. turbine dynamos, as well as a Diesel-driven emergency dynamo.

A place for a large hydroplane and two small airplanes, as well as for a take-off catapult, is provided in the stern of the vessel. The *Joseph Stalin* will carry four 3-ton and two 1½-ton electric cranes, four life boats, each capable of carrying 38 persons, two cutters and several other craft, including a motor barge.

The crew's quarters have two and four-berth cabins. The Red Corner, dining-room, common-room, captain's cabin and other parts of the vessel are panelled with rare woods, and the furniture has been specially designed by prominent artists. The dining-room is fitted with a sound-cinema projector. All the living quarters are equipped with radio and telephone.

This interesting picture shows the apparatus used for the production of a micro-film. Such pictures deal with biology, metallurgy, and other sciences in which the microscope plays a leading part. In this illustration the film camera is seen coupled to the microscope.

Radio Equipment

IN power of radio equipment, the *Joseph Stalin* will surpass any of the vessels of the Soviet civil fleet. She will have a short-wave transmitter of 1-kw. capacity for long distance communications, enabling her to maintain direct communications with Moscow and any of the polar centres from any point of the Northern sea route. A second long-wave transmitter of 2-kw. capacity will be installed for the purposes of the meteorological service, and for communication with ships sailing the Northern sea route By means of this transmitter the *Joseph Stalin* will be able to maintain telephonic communications with the stations of the Northern sea route, and through them with other centres of the Union. The ice-breaker will carry a third, distress, transmitter of small capacity, for communication with the nearest ports and coastal stations in the event of mishap, also for communications with the caravan of vessels for which she is acting as convoy. Special portable receiving and transmitting apparatus, capable of working on any range, will be provided for the use of scientific expeditions. The *Joseph Stalin* will also have powerful relay equipment.

New Million-volt X-ray Equipment

A NEW X-ray equipment, designed to give a beam of higher intensity and of greater penetrative power than any so far employed for the treatment of disease, has just been installed at St. Bartholomew's Hospital.

The X-ray tube itself is of very remarkable design. It is thirty feet in length and weighs 10 tons. It consists essentially of a long steel tube in which the filament and target are mounted and in which a high vacuum is maintained by continuously operating oil vapour pumps. Only the central twelve feet of the tube are contained in the treatment room, the two ends projecting into the two generator rooms which are situated on either side of the treatment room. To prevent the spreading of the X-ray beam, the central portion of the tube is surrounded by a protective sheath consisting of a six-inch layer of closely packed lead shot which is contained in two co-axial steel cylinders. An aperture in the sheath allows the transmission of the X-ray beam in the required direction.

In view of the great weight of the tube, it would not have been practicable to move it to adjust its position over the patient, so the floor of the treatment room was made movable instead.

A Special Circuit

THE voltage for working the tube is derived from a step-up transformer which gives 150,000 volts. By means of a special circuit employing columns of continuously evacuated rectifying valves and large oil-immersed storage condensers, a rectified current of 600,000 volts may be obtained. The generating equipment is duplicated, and by connecting both sides in series, a maximum potential of 1,200,000 volts is available. At this voltage, the tube takes a current of five milliamperes.

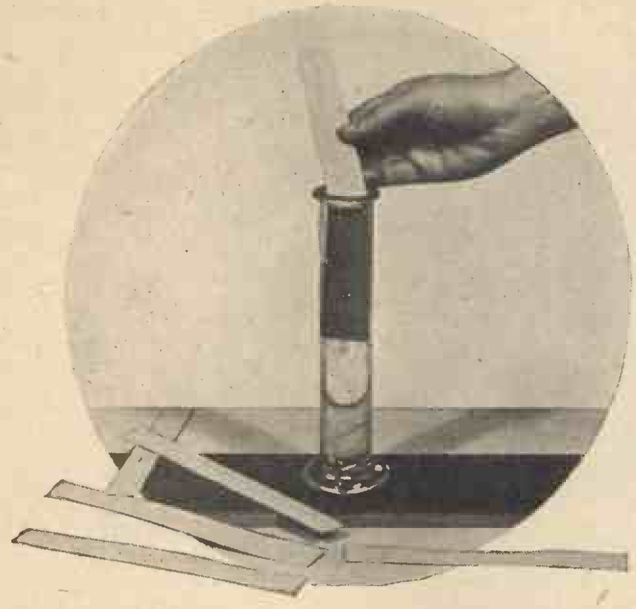
The new equipment has been designed and manufactured by Metropolitan Vickers Ltd., of Manchester, and it is hoped that it will prove of value in the further conquest of that dreaded disease, cancer.

A Huge Telescope

KNOWLEDGE of the southern celestial hemisphere will be increased in the near future by the erection of the Radcliffe Observatory, which is to be transferred from Oxford to Pretoria. This will be the largest observatory south of the equator and its huge reflecting telescope of 74 inches aperture will rank among the biggest in the world. The entire outfit will cost £72,000 of which £40,000 will go towards the construction of the instrument and its equipment. The 2-ton mirror has been cast in America in low-expansion Pyrex glass, so as to minimise the effects of temperature variations which are apt to distort the highly magnified images projected into the eyepieces or cameras. The final grinding, polishing and "figuring" will, however, be done in England. The great duraluminium tube will be 35 ft. long and eighteen motors will be required to operate the complicated mechanism. Much is expected from this magnificent acquisition; for the southern heavens are richer in stars and more frequently visited by bright comets, than the regions of the north.

PREPARING PERFUME PAPERS

HOW TO MAKE FRAGRANT-BURNING PAPER AND OTHER MATERIAL FOR HOUSEHOLD AND SIMILAR USES



Impregnating a strip of paper with the perfumed spirit. Note that the latter is contained in a narrow vessel for the sake of economy.

THE well-known paper ribbon which, when ignited by a match, smoulders slowly and emits a pleasant odour in so doing is a type of material which may very readily be prepared by any individual having the necessary chemicals available. Not only is the home manufacture of perfume papers of this nature an interesting chemical occupation, but it is, also, an exceedingly useful one and, indeed, may very easily be a profitable one, for carefully-made perfume paper, given a well-chosen perfume or blend of perfumes, is a very attractive material and commends itself in many directions as a disinfectant, steriliser, odouriser, and general freshener-up of rooms.

Paper of the above nature consists merely of material which has been impregnated with saltpetre and, also, with certain essential oils, the latter being "sealed" within the pores of the paper by the use of certain agents. When the paper is ignited, it smoulders slowly without actually taking fire, the heat of the paper's slow combustion being sufficient to drive off the volatile essential oils with which it has been impregnated.

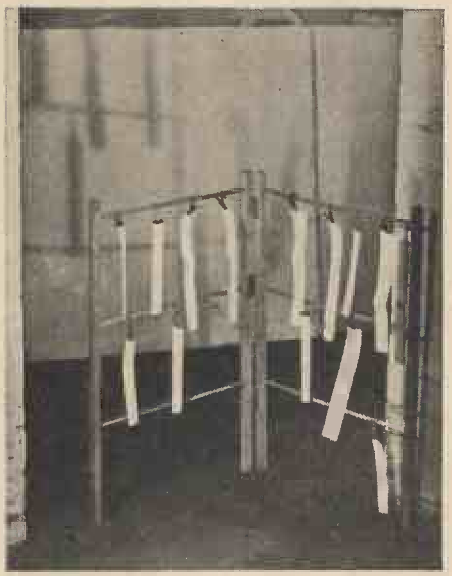
The Paper Used

In order to prepare paper of this nature we start with ordinary blotting paper. The paper should not be too thin, otherwise it will not "hold" a sufficient quantity of the essential oil. If the blotting paper is not already coloured, the amateur may desire to colour it according to his own tastes and this he may do very easily by soaking it for ten or twenty minutes in a hot solution of one of the many packet dyes which are nowadays obtainable. After this dyeing operation, the paper should be rinsed in water and dried.

The paper should now be cut up into long strips or ribbons, each about half an inch in width. It is now soaked for a quarter of an hour in a solution made by dissolving one ounce of saltpetre (potassium nitrate) in about eight ounces of water. After this saltpetre immersion, the paper is hung up to dry *without being rinsed.*

Testing by Burning

At this stage a test should be made of the combustible qualities of the paper. Take one of the strips and apply a match to it. If it smoulders slowly, the strength of the saltpetre bath has been correct for the paper used. If, however, it smoulders too quickly and shows a tendency to burst into flame, the saltpetre bath has been too strong, whilst if the opposite of this occurs and the travelling glow on the paper becomes extinguished, the saltpetre bath has been too weak. Different varieties of paper require different concentrations of saltpetre solution in order to render them nicely combustible, but the above-mentioned strength of saltpetre (1 ounce in eight ounces of water) is a fair average concentration for the bath.



A small clothes-horse from which strips of perfume papers are suspended, standing in an open doorway in order to provide for the rapid drying of the papers.

The Perfumes

We must now prepare the odoriferous constituents of the perfume paper. Here, the home chemist has a wide choice of materials in front of him. Almost any odorous material may be used for the impregnation of the paper. The following compounds, however, are particularly recommended, and they may be used singly or in admixture, according to the choice of the experimenter:

Ionone, Peru balsam, Attar of Roses, Safrol, Oil of Spike, Oil of Lavender, Rosemary oil, Cedarwood oil, Balsam of Tolu, Storax, Clove oil, Cinnamon oil, Oil of Lemon, Cumarine, Methyl salicylate ("Wintergreen oil"), Pine oil, Thymol, Camphor, Menthol, Eucalyptus oil and—with careful blending—almost any toilet perfume available.

Take a few ounces of good-quality methylated spirit ("rectified spirit" is better for the purpose, but it is, unfortunately, much more expensive), place it in a bottle provided with a well-fitting cork and add one or more of the above perfume materials to the extent of about one quarter per cent. of the bulk of the spirit used.

The spirit, having been perfumed to the satisfaction of the amateur, must now be provided with a "sealing" agent in order to seal the perfume within the pores of the paper. The best sealing agent is gum benzoin, after which come either gum myrrh or frankincense. One ounce of any of these materials should be dissolved in every ten ounces of the perfumed spirit employed. Kept in a tightly-corked bottle, the perfumed and "sealed" spirit will retain its properties quite indefinitely and it can be used over and over again for the impregnation of paper.

Impregnating the Paper

When impregnating the paper with the prepared methylated or rectified spirit, it is best, for the sake of economy, to pour the spirit into a tall, narrow vessel, as, for instance, a long vase or a chemical measuring-cylinder. If, of course, the bottle containing the prepared spirit has a fairly wide neck, it may itself be employed for the impregnation of the paper. The paper which has been previously treated with saltpetre and carefully dried is dipped into the prepared spirit and allowed to remain therein for about a quarter of a minute. It is then allowed to drain and finally hung up to dry.

Drying the paper must not be effected by heat, otherwise the volatile odoriferous materials with which it is impregnated will be driven off. It is best to clip the prepared strips of paper to the rails of a small clothes-horse and to stand the latter in an open doorway. The current of air passing through the doorway will quickly evaporate the surplus spirit and result in a speedy drying of the paper. The strips of paper, once dry, will be ready for use. They should be stored in a cool place and, preferably, should not be kept for a longer period than six months, for, even with the most careful storage, there is continually taking place a slow volatilisation of the essential oils from the paper.

Perfume Pastilles

"Perfume pastilles" are merely a modification of the principle of the previously described perfume paper and, no doubt the amateur chemist may be interested to have a few notes on the best method of making them.

The basic material of the pastilles consists of a mixture of 8 parts of finely-powdered charcoal and 1 part of powdered saltpetre. This mixture, when ignited, burns slowly. In the preparation of perfume pastilles the charcoal-saltpetre mixture is made into a stiff paste by stirring into it a small quantity of perfumed rectified or methylated spirit and, also, a few drops of gum water to act as a binder.

Any of the perfumes previously mentioned may be employed in the preparation of the perfumed spirit for pastille making. The spirit should contain a fairly high percentage of the perfume and it is an advantage for it to contain a little gum benzoin, gum myrrh or frankincense to prevent or, rather, to slow-down the volatilisation of the odoriferous constituents from the pastilles.

The perfumed spirit and the small quantity of gum water having been incorporated with the charcoal-saltpetre mixture, the resultant material is shaped into small cones. This can best be effected by preparing a moulding-block, made by filling a small cardboard box with Plaster of Paris and, just before the plaster sets, by plunging a conical-shaped article into the latter and withdrawing it immediately. After the plaster has hardened, the conical-shaped cavities are lightly greased with a little vaseline and the perfumed pastille mixture pressed into them. The mixture will dry and consolidate rapidly and, in so doing, will contract slightly, thus rendering it an easy matter to extract the pastilles from their moulds.

"Perfume pastilles" and the home-made plaster mould used in their shaping.

When a lighted match is applied to the top of one of these pastilles it will ignite and smoulder for a period of time ranging from two or three minutes to a quarter of an hour or even more, according to the size of the pastille. During this time, the fragrant-smelling constituents of the pastille will be evolved continuously into the surrounding air, thereby diffusing into the room a pleasant and healthful odour.

From freshening-up a room which has become "stale" with tobacco smoke or inadequate ventilation, a single perfume pastille or a twelve-inch length of perfume paper when ignited and allowed to smoulder is exceedingly effective. The paper or the pastilles are equally useful in sick rooms, but their odours should be delicately compounded, care being taken not to make them too powerful.

BIOLOGICAL EFFECTS OF RAYS

The Nondehiscent Lily

THE electrical industry in America is making steadily advanced strides and now is invading a new field in the Government patent office. C. N. Moore, an electrical engineer has applied for a patent on a "nondehiscent regal lily." Appropriately enough the flower in question is, at least temporarily, being called the Roentgen regal Lily—it was Roentgen who discovered the X-ray, and it was among X-rayed bulbs of ordinary regal lilies that the new form was found.

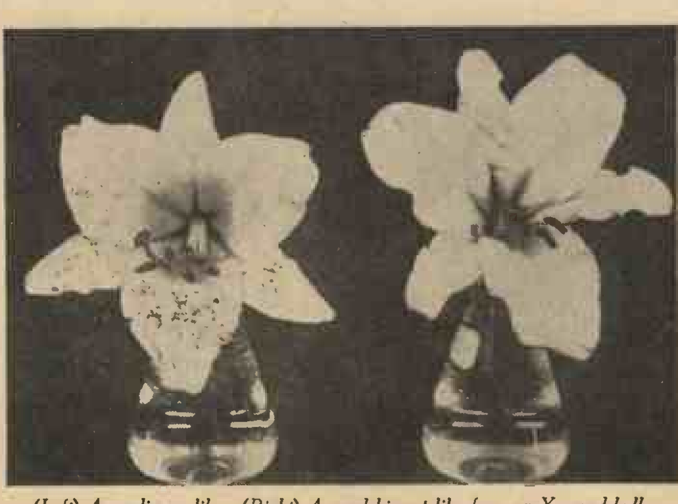
The term "nondehiscent" means that the anthers of the flower do not open and shed their pollen. Ordinarily the commercial growers of regal lilies must pluck the pollen-laden anthers of the flower promptly, for the anthers quickly swell and burst after the flower has opened, shedding a wealth of golden pollen that sticks tenaciously to the white petals, more or less ruining the flower for display or commercial purposes. The newly "invented" Roentgen lily behaves differently—the anthers swell as do those of the usual lilies, but the outer skin does not burst. Instead, the anthers slowly shrink in size as the flower ages, and the pollen is not liberated.

Monstrosities

In the spring of 1931, Mr. Moore, investigating biological effects of rays, treated bulbs of regal lilies with varying doses of the rays. Of 100 bulbs, obtained from a commercial grower, and 25 were kept as controle; 25 were subjected to 30 milliampères and 200,000 volts at 20 in. for 3 seconds; and the final 25 were so treated for a minute. The bulbs were then planted in a Long Island garden.

The untreated bulbs grew into normal plants that year. Among the treated ones were a few monstrosities—deformed stems, twisted and misshaped flower petals, and similar defects—which offered no desirable possibilities; the other treated bulbs seemed to have produced normal flowering plants.

The results were different the next season, however, when plants and flowers grew from embryonic structures. Progeny of two of the bulbs treated, that had received 30-minute doses of X-rays produced flowers with non-shedding anthers.



(Left) An ordinary lily. (Right) A nondehiscent lily from an X-rayed bulb.

Succeeding Years

Each succeeding year has seen the new strain continue true. Bulbs and bulblets from these two bulbs treated in 1931 have continued to bear nondehiscent flowers—the property is now considered as a fixed character, and the Roentgen lily is now established as a variety of the regal lily.

"Investigations with X-rays in biological fields have long showed that surprising mutuations and variations are to be expected if living cells are subjected to bombardment with X-rays," says Mr. Moore. "In the nucleus of every body cell of a plant there are a certain number of chromosomes; and each chromosome is a vehicle which carries a very large number of "factors" or "genes" which are the real determiners of the characteristics of the plant which bears them. If something happens to a chromosome of an egg cell or a young pollen grain when it is approaching maturity, it is likely that a "sport"—offspring with different characteristics—will be produced. Such "sports" occur spontaneously, and more or less rarely, in nature. Such happening are increased in number many hundred fold when the single cell encounters the shattering force of the X-ray beam and the electrons which it releases."

Other Plants Treated

The nondehiscent regal lily is but one of a multitude of biological changes which have been effected in the electrical laboratories in America with X-rays and cathode rays. Abnormalities of many kinds have been observed in a wide variety of plants, but the new variety of the regal lily is the first to which the phrase "patent applied for" has been appended.

MASTERS OF MECHANICS

No. 26.—The Fathers of Modern Shipbuilding: David and Robert Napier

THE River Clyde was by no means endowed by Nature for the purposes of shipbuilding. In the year 1790, it was a slow, semi-rural stream, meandering leisurely through the Scotch countryside and having here and there on its banks a rising townlet or an industrious community of settlers. The river, in most parts, was narrow. It was also an extremely shallow river, its shallowness being derived from the large accumulations of sand which it received from the tidal waters which entered it from the west and which silted up its bed for many miles in an easterly direction.

A River Transformed

It is, perhaps, so far as the duration of human life is concerned, a far cry from the year 1790 to 1937—the year in which the world's largest steamship, the future companion to the *Queen Mary*, is under active process of construction in the Clyde shipbuilding yards. The Clyde still flows from east to west, but, apart from that broad characteristic granted to it by Nature, it is, in modern times, a river transformed. Upon the erstwhile shallow and partially blocked-up stream gently picking its way westwards between great banks of sand, many of the world's largest and most successful seagoing vessels have had their home. The *Queen Mary* and its still more gigantic future companion are merely the present-day developments of a long line of vessels which have had their origin on the Clyde and which have made that Scottish river and its great shipbuilding yards famous throughout the civilised world.

To return, however, to the year 1790. There was at that time living in picturesque old Dumbarton, a town near to the conflux of the river Leven with the Clyde, several branches of the Napier family, some of whose future members were destined to make history, and, incidentally, their own individual fortunes, in the world of engineering and mechanics. The various Napiers were, for the most part, families of blacksmiths who for a century had pursued their calling in and around the historic town of Dumbarton. The Napiers, it was remarked, were all "born with a hammer in their hands." Certainly, if there is anything in the notion of hereditary skill, the various Napiers were possessed

Robert Napier.

of it. We find some of the Napiers departing from their customary occupation of blacksmithing and turning their attention to iron smelting and to devising improvements on engines of the Newcomen type in the latter half of the eighteenth century. Another Napier—James—was the inventor of the tubular steam boiler which he patented in 1830 and which, after a few years of opposition, revolutionised the technique and efficiency of steam-raising methods. The cousin of this James Napier, William Napier, was one of the first to build ocean-going vessels of iron, whilst even in our own era, a descendant of the family, Montague Stanley Napier, prominently presided over the introduction and manufacture of the early motor-cars in this country.

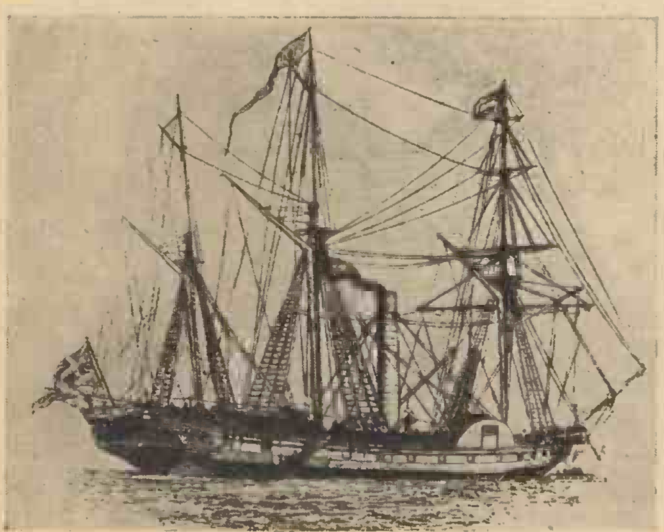
A Skilled Family

The Napiers, it will be seen, through two centuries or more were a family in which inborn engineering, constructional and mechanical skill manifested itself under many guises. It is, however, with but two of the Napiers that we propose to deal in this article, for it is the activities of these individuals and, in particular, to the enterprise of the younger of the two, that modern shipbuilding in Britain owes the debt of its inception.

David and Robert Napier, the abovementioned individuals, were cousins. Both were born in Dumbarton, David in 1790 and Robert in the following year. Though born into frugal and hard-working families in which the demand for pence was greater than the supply, the two cousins, in consequence of the foresight of their parents, were given a good education at the local grammar school. David, the elder of the two, acquitted himself particularly well at this institution and afterwards his training was continued at Glasgow.

It was intended that Robert should prepare himself for the Scotch Ministry. When, however, the time came for him to undertake his theological studies, the attractions of an engineering career proved too strong for him, with the result that he renounced his projected career in the Church in favour of a younger brother.

Thus it was that Robert Napier, at the age of fourteen, began work as an apprentice under his father, an engineer, foundryman, and blacksmith. After the elapse of three years, Robert's apprenticeship came to and end. He worked for a short time in Dumbarton as a journeyman and then set out for Edinburgh, in which city, after a period of disappointments, he obtained a position under Robert Stephenson.



The "United Kingdom," the "Queen Mary" of a century ago. It was built in 1826 and engined by David Napier.

A contemporary view of the paddle boat "Marcon" on Loch Lomond. David Napier fitted his first marine engine to this vessel.

His Own Business

After obtaining various other posts, Robert Napier borrowed fifty pounds from his father. With forty-five pounds of this total capital he purchased the goodwill, and tools of a small smith's shop in Glasgow, and in May, 1815, began business for himself as a mechanical engineer, smith, and foundryman. The business prospered. So much so that shortly afterwards, Robert married one of his fair cousins and set up a home for himself not far from his smithy.

By this time, his cousin, David Napier, had started a foundry at Camlachie, near Glasgow, and was specialising in the manufacture of marine engines and engine parts. Henry Bell's famous steam vessel, the *Comet*, had some years before begun to ply on the Clyde and it was David Napier who had taken part in the building of the vessel's engine. Consequently, David had now come to be regarded as an individual of prominence and authority in this new branch of engineering activity.

An Educated Man

The foundry of David Napier at Camlachie prospered exceedingly. Unlike the earlier pioneers of steam navigation, David Napier was an educated man, familiar with the theoretical aspects of tidal resistance, fluid flow and the physics of navigation. In 1818, he put all the resources of his knowledge into the building of the *Rob Roy*, a steamship upon which the majority of the so-called experts predicted failure. With the *Rob Roy* David Napier instituted regular sailings between Greenock and Belfast. The vessel, contrary to all expectations, proved a great success and subsequently Napier sold her to the French Government which changed her name to *Henri Quatre* and used her for years as a Channel steamer. Thus started Britain's foreign trade in steamship vessels.

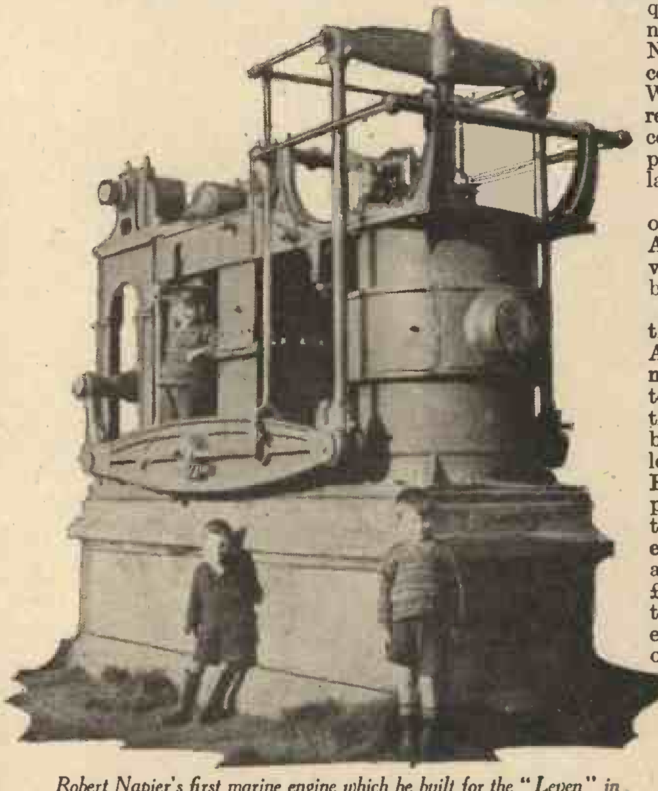
David Napier's reputation as a marine engineer brought him numerous orders from steam boat projectors. In 1826, he engined the *United Kingdom*, a celebrated vessel and a counterpart that time of our present-day *Queen Mary*. It was predicted that, owing to the then unheard of dimensions of the *United Kingdom*, the vessel would flounder when at sea. Actually, the maiden voyage of the ship was a great success. She left the Clyde on 29th July, 1826, with upwards of a hundred passengers on board and steamed round the North of Scotland in sixty-five hours.

In addition to actual marine engine construction, David Napier paid much attention to improving and developing his engines. To him were due a score of inventions, all of which effected both an economy in fuel consumption and an increase in speed of the vessels. David Napier experimented with other mechanical devices, among which may be mentioned a breech-loading gun. He was, also, one of the first constructors of a steam-propelled carriage for road use.

First Trans-Atlantic Steamship Service

Whilst the brain of David Napier was fertile in invention and in ingenuity, that of his younger cousin, Robert, was more stolid and its creations were more substantial. Robert Napier was by no means an inventor. Conservative in habits of mind, thorough and painstaking in practical ability, he applied the inventions of others to his own ends. It is to Robert Napier more than to any other single individual that the shipbuilding industry of the Clyde owes its origin. It is to him, also, that the first trans-Atlantic steamship service was mainly due.

Robert Napier's first Glasgow engineering and blacksmith business thrived greatly. So much so that in 1821 he arranged for the lease of his cousin David's premises at Camlachie at a rental of £300 per annum, a large sum in those days. David Napier at this time had removed to London, in which locality he was actively engaged in experimental engineering work and in enlarging his marine engine interests. Robert Napier's first contract when he entered upon the lease of his cousin's engineering works was the supplying of large water-pipes for the City of Glasgow. It was a contract which he carried out satisfactorily. Then came to Robert Napier a few orders for mill engines. Some of these engines were so substantially built that they were running at the time of Napier's death, fifty years afterwards.



Robert Napier's first marine engine which he built for the "Leven" in 1823. It is now preserved in the grounds of Dumbarton Castle.

Robert Napier, with his shrewd, penetrative insight into affairs, clearly perceived the need of the times for strongly-constructed and reliable marine engines. Accordingly, he turned over a large section of his factory to their development. It was a considerable time, however, before he was able to obtain his first order for a marine engine, but ultimately this came in 1823 in the form of a contract to build an engine for the *Leven*, a small luggage-boat which plied around Dumbarton. Napier put his best into the building of the *Leven* engine. So strongly did he construct the engine that it outlasted three entirely different vessels and ultimately found a permanent resting place in the grounds of Dumbarton Castle, in which situation it is to be seen at the present day.

After the building of the *Leven* engine, Robert Napier found that his name as a marine engineer had become equal in prominence to that of his cousin David. Contracts for the construction of other and more powerful marine engines came in plentifully to his factory and more than once he found it necessary to extend his premises. In 1830, Napier equipped the Vulcan foundry in Glasgow with new and heavy tools and was thereafter in a position to construct the largest marine engines which might be demanded.

It was at the beginning of 1833 that Napier's interests were first practically aroused in the matter of Atlantic steam navigation. As far back as 1819, the *Savannah*, a diminutive sailing vessel equipped with small steam-driven paddles, had crossed from America to this country partly under steam, but her performance was so unsatisfactory that the question of a regular Atlantic steamship service was allowed to remain in abeyance.

In the August of 1833, the *Royal William* steamed across the Atlantic from Quebec. This feat aroused intense interest in the question of Atlantic steam navigation and Robert Napier found himself consulted by a Mr. Patrick Wallace, of London, in regard to the matter of constructing engines for a projected vessel for Atlantic use.

Napier gave it as his opinion that a regular Atlantic steamship service was well within the bounds of possibility.

He laid down, however, that any vessel for Atlantic service should not be less than 800 tons displacement and that it should be propelled by two engines of not less than 150 h.p. each. He even went so far as to prepare an estimate for the construction and engining of such a vessel, an estimate which totalled £34,000, but the magnitude of the projected enterprise apparently overwhelmed Mr. Wallace and his friends, with the result that the project lapsed through lack of funds.

Three years afterwards Napier was given the opportunity of actually constructing an Atantic steamship. This was in 1836, when the British and American Steam Navigation Company, which had in that year been formed with a capital of £1,000,000, commissioned him to engine the *British Queen*, a magnificent vessel which had been built on the Thames at a cost of £60,000. This was the biggest commission which had yet fallen to Robert Napier. He accepted the contract and on 12th July, 1839, the *British Queen* set out on her maiden voyage to New York, making the passage in 15½ days.

Napier's demonstration of the essential practicability of Atlantic steamship navigation attracted many interests, not the least among which was that of a certain Mr. Samuel Cunard, a one-time Boston shipping agent who had conducted a service between Halifax and England by means of a number of tub-like sailing vessels which, owing to the number of losses which had occurred among them, had become widely known as "coffins."

In 1838 Cunard visited England and, getting into touch with Robert Napier at

Glasgow, lost little time in putting his proposals before the latter. Cunard's idea was to have built a large steamship for trans-Atlantic passenger-carrying purposes. Napier fell in with the notion at once and estimated for the construction of a suitable vessel. The estimate, however, turned out to be too high a one for Cunard's financial resources. Rather than turn out an inferior vessel with inadequately powered engines at a lower price, Napier entered into an agreement with Samuel Cunard to find a proportion of the purchase money and to interest other individuals in the project. This he did, the result being the formation of a sort of co-partnership between Cunard on the one side and Napier and his friends on the other, the concern styling itself the British and North American Royal Mail Steam-Packet Company. This concern commanded a combined capital of £270,000. For it, Napier constructed four vessels, the *Acadia*, *Britannia*, *Caledonia*, and *Columbia*. Each of these vessels was equipped with Napier-produced engines and all were, of course, paddle vessels. The first to sail was the *Britannia*. This started from Liverpool on 4th July, 1840, and arrived safely and without mishap in Boston harbour fourteen days later.

An Important Rôle

Such was the important rôle which Napier played not only in the inception of regular Atlantic steamship sailings, but, also, in the founding of the famous Cunard Company.

The first Cunarders were wooden vessels, but in 1843, Robert Napier, having reached a working agreement with his relatives, James and William Napier, both of whom had special experience in the construction of iron steamships, launched his first iron vessel the *Vanguard*, a paddle steamer of some 700 tons. The *Vanguard* was so successful that Napier turned his business over almost completely to the building of iron vessels. Thus began the long cavalcade of Clyde-built ocean-going steamships which reaches down to our own days. Needless to say, the River Clyde, with every advancement in shipbuilding, underwent successive enlargements and deepenings.

As for the two Napier cousins, David and Robert, the "fathers of British steamship building," they each went their own separate and devious ways in life. David, the elder an inventive cousin, ultimately retired to Worcester, but died in London in 1869, in his eightieth year. Robert outlived him by seven years, dying in 1876, aged 86.

NEW INVENTIONS

The following information is specially supplied to "Practical Mechanics," by Messrs. Hughes & Young (Est. 1829), Patent Agents, of 9 Warwick Court, High Holborn, London, W.C.1, who will be pleased to send readers, mentioning this paper, free of charge, a copy of their handbook, "How to Patent an Invention."

Seeing the World at School

THE use of the globe to teach geography was customary in the last century. That practice will be revived, if a lately patented device is generally adopted. This invention comprises a gigantic globe having an interior accessible for viewing from the inside. Light from outside will penetrate the walls showing countries and seas as on a lantern screen—a veritable panorama of geography. This illuminated sphere will enable the schoolmaster, whom one may term the Minister of the Interior, indelibly to impress the minds of his pupils. Such a prodigious ball will naturally be costly. But the juvenile student, by trotting into the globe, can see the world without becoming a globe trotter.

A Paper "Mac"

WE have all seen in a crowd, when the rain suddenly descends like silver spears, the ladies utilise newspapers to protect their flimsy headgear from the discourteous shower. This idea has now been incorporated in an emergency raincoat consisting of water-proof paper. The coat is made from a single sheet of paper, the material forming the two sides of the front opening, being folded one inwardly and the other outwardly. The edge of the fold on one side hooks over the edge of the fold on the other side to keep the coat closed.

It would certainly be appropriate for the paper of this raincoat to have a watermark.

An Umbrella Holder

WHILE upon the subject of rain, it is apposite to mention a newly devised contrivance, which will hold up one's umbrella and leave the hands free. The invention includes an arrangement harnessed to the body and a slot through which the stick of the umbrella is thrust downwardly into a socket. It is claimed that this contraption will keep the umbrella in an upright position. During the holiday season, when many folks have both hands occupied in carrying luggage, the device in question should prove convenient. But the thought of a moist vacation tends to damp one's feelings. May there be a close-season for umbrellas, and, to quote the title of a current song, no "September in the Rain!"

Jewelled in every Hole

IT appears that gems—possibly even those "of purest ray serene" which "the dark, unfathomed caves of ocean bear"—have themselves caves or rather cavities. There has just been patented in the United States a process for treating these uneven jewels. This process consists of fusing a fragment of a gem of less hardness than the one having the cavity. The tiny hollow is filled with a fused inlay. The protruding portions of this inlay are ground so that it becomes flush with the adjacent surface of the precious stone.

By the way, it is said that, among the ancients, there were sculptors who used a similar method. But it was one which, ethically, did not conform to a high standard. They filled holes in the stone with wax, producing the appearance of a solid surface. However, Time—the relentless analyst—eventually proved that this stone was not very precious.

A Handy Strop

THE palm of the hand has often been used as an improvised razor strop. Now, although the texture of the human skin may be effective as a delicate means of giving a finishing touch, it is not powerful enough to sharpen the blade of a razor. An ingenious mind has recently evolved a strop which can be attached to the hand. A strip of stropping material has at one end a flexible cap adapted to be fixed upon the finger of the user's hand. At the other end is a means of securing the strop to the wrist.

Some kind of lubricant will at times be required. I am tempted to suggest palm oil.

To Curb the Baby

WHEN the baby is promoted from the cradle to the crib, the "young hopeful," feeling his feet, occasionally finds his small prison, though cosy, somewhat irksome. He attempts to clamber out of his cot. An improved means of preventing his escape consists of a crib, the corner uprights of which are fitted with a series of notches one above the other. Each of these serves as a support for movable cross-bars designed to bear the frame of the mattress. The cot can, therefore, be adjusted to the growth of the child. If desired, a hood and wheels may be affixed. This crib will curb the vaulting ambition of the rising generation.

DYNAMO.

Conjuring with Cigarettes

By Norman Hunter

(The Well-known Conjurer of "Maskelyne's Mysteries" Fame)

Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

Fig. 6.—Spring-hinged flaps running the length of this cigar box make a false bottom when they are pressed down into a horizontal position.

THE feat of producing lighted cigarettes, apparently from the air, is always an effective and puzzling piece of magic. And the effectiveness of it is dependent upon two things. In the first place, although a cigarette is only a small thing such as may easily be concealed in the hand and so seemingly caught in the air, when the conjurer "catches" one after another until he has several dozen, the effect becomes more and more astonishing with each production. Then again, the fact that the cigarettes are alight suggests that they would be very awkward things to palm with any degree of safety.

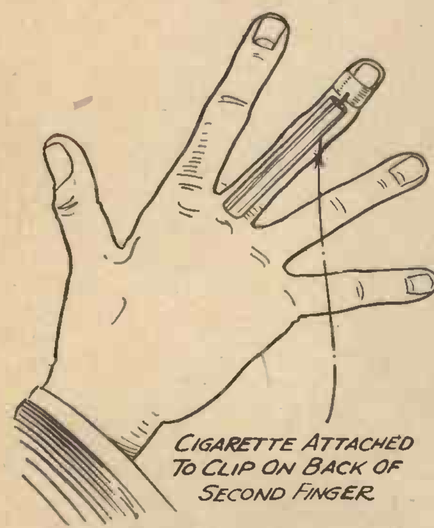


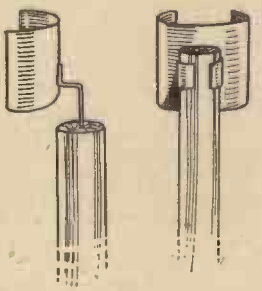
Fig. 1.—The palm of the hand is facing the audience.

To begin with I will describe a method of producing a quantity of cigarettes unlighted, as in that way we shall be solving one part of the problem at a time.

A Number of Cigarettes

The principle upon which the trick is based is that one cigarette is produced again and again and apparently dropped into a hat or other receptacle, the said receptacle already containing, in a secret compartment, the number of cigarettes it is intended to produce. Reference to Fig. 1 will show one of the many ways of producing a cigarette. A small piece of metal, painted flesh colour, is bent into a clip and fitted to the back of the second finger of the right hand, over the finger-nail. A cigarette, either real or imitation, is fixed to this either by being impaled on a needle-point soldered to the metal or by being fastened into a small clip projecting from the metal. Figs. 2 and 3 illustrate these details.

To produce a cigarette the hand is held, fingers wide apart and palm to audience, as shown in Fig. 1. The cigarette is hidden behind the finger. A catching movement is made in the air and the fingers bent. This brings the hidden cigarette into view at the tips of the fingers (see Fig. 4). When the cigarette is apparently dropped into the hat, the fingers are merely straightened and the cigarette is again hidden behind the finger ready to be "caught again." Needless to say the receptacle into which the cigarettes are seemingly placed must be large enough to conceal the hand temporarily in order to cover the movement of the cigarette.



Figs. 2 and 3.—(Left) A cigarette impaled on a needle point and (right) fixed in a clip.

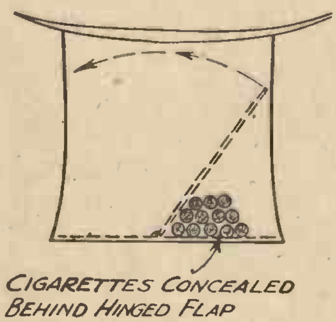


Fig. 5.—Details of the faked hat for concealing a number of cigarettes.

A Prepared Hat

It will now be clear that the conjurer can produce as many cigarettes as he pleases, from almost anywhere he likes. But in order to bring the trick to a convincing conclusion he must show the heap of cigarettes at the finish. If he is dropping them into a hat, the hat may be prepared with a partition swinging from side to side as illustrated in my article in the July issue of PRACTICAL MECHANICS, "Trick Hats and Hat Tricks," and shown again in Fig. 5. The partition covers the cigarettes and the hat may be held upside-down so long as the fingers of the hand holding the hat retain the partition. At the finish of the trick the partition is swung over and the cigarettes poured out.

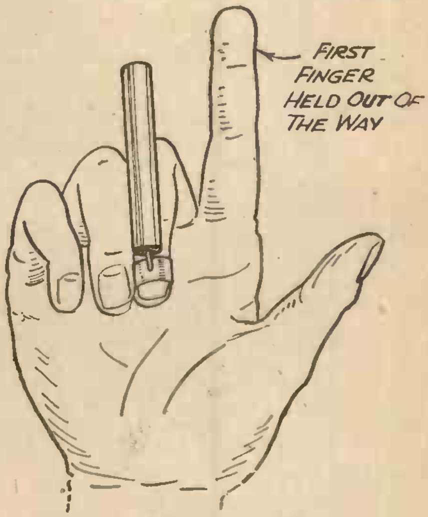


Fig. 4.—How the hidden cigarette is brought to the finger-tips.

It is not important that their number should correspond exactly with the number the conjurer catches. In fact he may catch a good many more than he actually shows.

Another piece of apparatus which may be used in place of the hat is illustrated in Fig. 6. This is a cigar-box fitted with

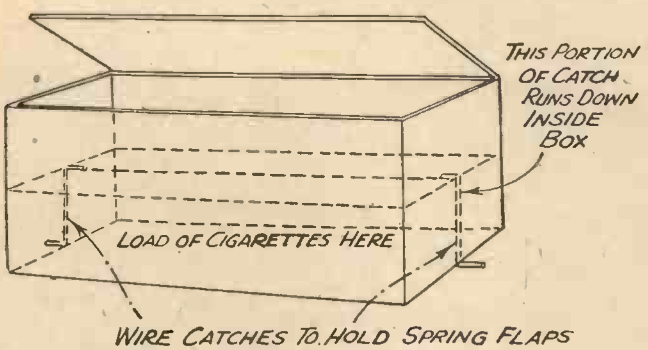


Fig. 7.—The faked cigarette-box.

two flaps running the whole length of the box and meeting down the centre when pressed down into a horizontal position. The hinges are fitted with springs which keep the flaps normally flat against the sides of the box, but when the flaps are depressed they form a false bottom an inch or two above the real bottom of the box. A simple wire catch, shown in Fig. 7, holds them in place until it is desired to release them.

In use the box is brought forward and a few cigars may be taken out, after which the box can be shown with a sweeping movement and will appear to be empty. It may also be held upside-down as a further suggestion of its emptiness. It is then placed on a table or held in the left hand and the catch released, leaving the cigarettes, which have been previously placed under the flaps, readily get-at-able. The production of cigarettes and apparent dropping them into the box then proceeds.

Producing Lighted Cigarettes

If the conjurer wishes to produce his cigarettes alight various modifications have to be made in the procedure. To begin with, he may produce them with the same fake as that used for unlighted cigarettes providing he takes care to keep his fingers slightly curved in order to prevent the lighted end of the cigarette, which would be the end not attached to the clip, from coming in contact with the back of his hand. Then there is another method, equally applicable to lighted or unlighted cigarettes, which is illustrated in Fig. 8. The cigarette is held between the first and second fingers in the conventional smoking position. The fingers are now bent and the unlighted end of the cigarette is gripped in the fork of the thumb. The fingers may now be outstretched and so long as the back of the hand is kept turned towards the audience no sign of the cigarette can be seen. To produce the cigarette the fingers are bent and the cigarette taken from the fork of the thumb under

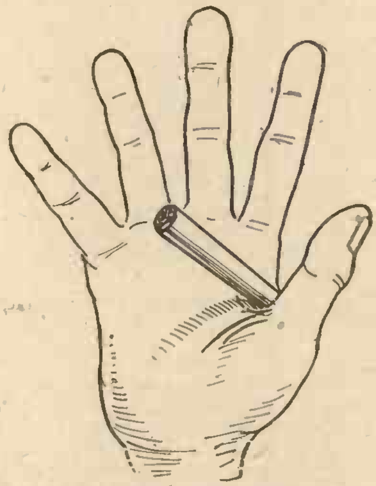


Fig. 8.—A cigarette "thumb-palmed" in the fork of the thumb.

cover of a catching movement in the air. Fig. 9 shows the fingers in the act of taking the cigarette out of what is known as the "thumb-palm."

A cigarette having thus been produced, it is apparently placed into a metal fern-pot, being really thumb-palmed again ready for another production. The fern-pot has straight sides and a flat base and is fitted with a hinged flap exactly in the same way as the hat already described, which serves to conceal, until they are wanted, a supply of lighted cigarettes. It should be noted, however, that some ventilation must be provided in the form of tiny holes in the side of the pot, to ensure that the cigarettes remain alight. Moreover they must be placed with all the lighted ends together, as otherwise one cigarette will burn into another. It is advisable in this, and in fact in all tricks where lighted cigarettes are to be produced, to have the apparatus containing them brought on just before the trick, so that the cigarettes do not have to remain burning away for too long.

Fig. 9.—"Catching" a cigarette from the air. This photograph shows the first and second fingers taking the cigarette out of the fork of the thumb, where it has been "thumb palmed." The back of the hand is towards the audience.

An Improvement

To carry the trick a step further, half a dozen cigarettes may be produced and laid on a flat ash-tray in full view. For this the method of catching is that just described, utilising the thumb-palm, but the supply of cigarettes cannot now be concealed in the ash-tray so some other device must be adopted.

A small metal container is made, similar to that shown in Fig. 10, capable of holding the required number of cigarettes in an upright position. The container is divided into sections, one to each cigarette, so that when one is taken out the others do not fall together. It is not necessary to have partitions the whole depth of the container for this, in fact little bits of wire across the top at intervals will serve very well. The container is only just over half as deep as a cigarette is long, so that the butts may project above and ventilating holes are provided at the bottom to keep the cigarettes alight.

The container may be attached to the trousers at the back, under the coat, slipped into the waistcoat pocket, or arranged in any other position where the conjurer can get at it conveniently and without making awkward movements.

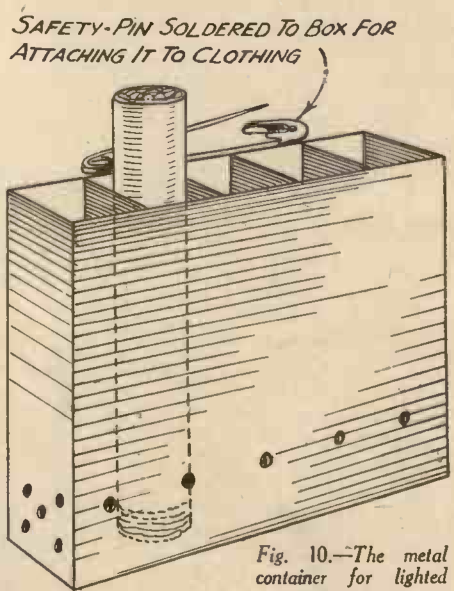


Fig. 10.—The metal container for lighted cigarettes.

The procedure is as follows. One cigarette being already thumb-palmed, it is caught and laid on the ash-tray. While this is being done the other hand secures a cigarette from the container and thumb-palms it. This is then caught with the left hand, transferred to the right hand, and put down while the left hand again secures another. Or again, two containers may be used, and while one hand catches its palmed cigarette the other hand secures a further cigarette and palms it. Thus the production is continued with both hands alternately until the store is exhausted.

A Real Mystery

In my last article I promised to explain a method whereby an article could be destroyed, one piece held by a spectator, and afterwards the pieces made whole again so that the odd piece fitted exactly into the space left. This effect seems so impossible and yet is so easy to produce that in one form or another it is a favourite with most conjurers. I will describe the effect as applied to a card trick, but as a cigarette is employed as well it comes also under that category.

The conjurer first borrows a cigarette and puts it on the table in full view. Then, taking a pack of cards, he asks a spectator to choose one. The chooser then tears the card into pieces and one of the pieces is given to him to hold. The conjurer burns the remainder of the pieces and sprinkles the ashes over the cigarette. He then tears open the cigarette, and inside it, rolled up, is found the card, completely restored except for one small piece. When the spectator applies the piece he holds it fits exactly.

First of all you have to decide what card is going to be chosen. This means that you will have to do what conjurer's call "force" the card when you have the selection made. I will explain this presently. In the meantime, suppose we take the ten of diamonds as the card. Tear a piece from one corner and put it in your waistcoat pocket. Roll the remainder of the card into a neat roll and, with a cigarette paper, make an imitation cigarette of it. Stuff a little tobacco taken from a real cigarette into the ends and the result should be a very convincing imitation.

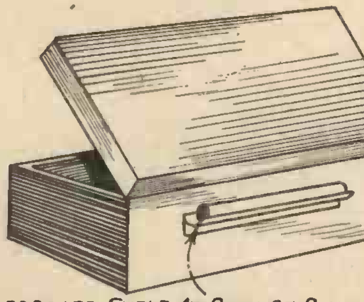


Fig. 11.—A cigarette concealed on a shelf on the back of the box.

The Card Box

The box containing your pack of cards should be of the kind shown in Fig. 11, that is larger than a pack and having a hinged lid. To the back of the box fix with drawing pins a piece of post-card bent along the centre to form a sort of shelf (Fig. 11). This box, with the pack inside, stands on the table, the cardboard shelf being at the back. Just under the shelf, on the table, place your dummy cigarette. Make sure that you have a duplicate ten of diamonds on top of the pack and you are ready.

Begin by borrowing a cigarette. Take it in your right hand and apparently put it down behind the box, picking up the box with the left hand. What you really do is shown in Fig. 12. You drop the genuine cigarette on to the little shelf and allow your fingers to rest on the dummy cigarette as the other hand takes the box away. To the audience the illusion is perfect and nobody will have the least idea that you have changed the cigarette, particularly as nobody knows what you are going to do.

Open the box and take out the cards, then put the box aside, taking care not to expose the back of it.

Forcing the Card

Now for the force of the ten of diamonds. An experienced conjurer would bring the card to the middle of the pack, spread the cards fanwise and move the card along so that the person choosing a card had the ten of diamonds very subtly insinuated into his hand. This method, however, needs a good deal of practice and experience. Here is an easier one. Hold the pack in the left hand and ask someone to stick a paper-knife, or a finger, into the pack somewhere. Open the pack at the point indicated and lift off the upper part. As you do this, press with the fingers of your left hand on the top card, which is the ten of diamonds, so that it is held back and slips down on to the lower half as you take the top half away. Apparently you have cut the pack at the chosen point and offer the card cut at to be taken.

Fig. 12.—Exchanging a cigarette. The real cigarette is being placed on the little shelf behind the box, while the dummy is on the table, ready to be revealed when the box is lifted.

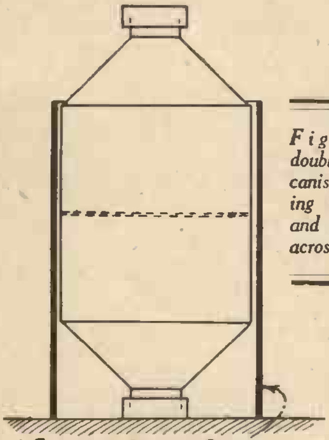


Fig. 13.—A double-ended canister with sliding outlet sleeve and partition across the centre.

Ask the chooser of the card to tear it into small pieces. While this is being done, put down the pack and pick up an ash-tray, at the same time getting hold of the corner from the card that is in the dummy cigarette, which you will remember is in your waistcoat pocket. Conceal this corner in your hand and receive the torn pieces of card on the ash-tray. Now apparently pick up one of the pieces and hand it to the person who chose the card. What you really do is to put your fingers on the pieces and bring the concealed piece to your finger-tips. Thus you pick up and give your assistant the actual corner torn from the card in the cigarette.

The rest of the trick is simple. Burn the pieces and sprinkle the ashes over the cigarette. Tear open the cigarette and offer the apparently restored card to have the missing piece tried. As it is the piece originally torn from that card it is, of course, bound to fit.

You might finish off the trick by catching a few cigarettes from the air as described

(*Continued on page 60*)

Fig. 14.—A changing canister. This photograph shows how the double-ended inner canister is pushed through its outer casing, thus making the compartment in the opposite end of it available.

PROTECTION

The Sprinkler Idea for Fire Extinguishing Seventeenth Century, and To-day this Extensively Throughout

Figs. 1 and 2.—(Above) The "Grinnell" sprinkler. (Right) The "Quartzoid" bulb sprinkler.

THE sprinkler method of fire extinguishing is now universally accepted as the only means of adequately protecting property, and the substantial premium reductions on insurance companies' fire policies give evidence of the efficiency and ultimate considerable reduction in serious fire risks occasioned by the incorporation of such equipment.

An inventor, Frederick Grinnell of U.S.A., in the year 1883, after many setbacks, succeeded in constructing a sprinkler head which became generally accepted as foolproof, and now after fifty years of research by a leading company, the "Grinnell" automatic sprinkler and fire alarm system are recognised throughout the world as suitable for use in all conditions.

Its Advantages

Now, in many systems the principles adopted are similar, the major differences in design being by way of the sprinkler heads, but before dealing with a few of the more popular methods, it would be as well to explain, for the benefit of those little acquainted with the subject, the main objects and advantages derived from the installation of such apparatus.

A system of piping runs throughout the building which is being protected and at intervals there are connected sprinkler heads or valves, the object being, of course, to effectively extinguish any fire which might break out, and in the shortest possible time, thus preventing a greater conflagration. Here, then, it will be seen that in a large building, with say a number of floors to be equipped, a considerable number of these sprinkler heads would be necessary to ensure adequate protection, whilst at the same time any large fire resulting from any highly combustible material, such as cotton, would be handled by a proportionately large discharge of water from the sprinklers prior to the arrival of the fire brigade.

A Small Fire

Presuming now a small fire—possibly only smouldering—to have occurred in a warehouse, the abnormal increase above the predetermined temperature conditions would cause the sprinkler valve in the immediate vicinity to operate, allowing a strong water spray to play on the fire, thus at least confining its activity to that quarter, at the same moment an alarm is brought into operation, and this will continue to ring loudly until such time as the sprinkler heads are restored to normal, signifying also that attention has effectively been drawn to the outbreak. It is important to note here that the use of an automatic alarm equipment is not necessarily confined to the vicinity of the building, in many instances a further circuit is incorporated and so arranged that the nearest fire station is instantly notified of the fire and the brigade is immediately able to ascertain its exact location by the fire station's indicator boards.

The question of water-supply for the sprinkler valves freezing, climatic conditions, and corrosion have all to be very carefully considered when the design and erection of both the sprinkler and alarm equipment is contemplated, and the years of research given to this "art" have culminated in outstanding achievements in this direction. Consider now the "Grinnell" sprinkler head as illustrated in Fig. 1. This, the original "Grinnell" head, consisted of a strut composed of three pieces of metal joined together by fusible solder which, when softened by the heat from the fire, falls apart, causing the glass valve to be blown away by pressure on the diaphragm, thus allowing the water to gush forth, be sprayed by contracting with the deflector, and efficiently deluging a wide area.

An Improved Design

An improvement was attained in the design of the "Quartzoid" bulb sprinkler head, as depicted in Fig. 2, and was perfected to meet the demands for an anti-corrosion head, the risk, therefore, of defect through a head located in an atmosphere subject to permeation with acid vapours—to which the original "Grinnell" fusible type was susceptible—being nullified. The "Quartzoid" bulb sprinkler, however, follows the same symmetry of design, as will be noticed in the illustrations, the flexible diaphragm being also retained. There is provided a soft metal valve seating against which is forcibly held a glass valve forming a strong self-sealing joint, the bulb is constructed of "Quartzoid"—an exceptionally strong transparent material—and contains a coloured liquid with highly expandible properties.

When being hermetically sealed, a bubble of gas is entrapped, this serving the purpose of permitting normal temperature fluctuation without affecting the valve. The liquid expands when the unit is subjected to an increase in temperature, and the bubble of gas decreases, and as the temperature continues to increase the gas bubble finally disappears, thus leaving further expansion to affect the actual bulb which is then entirely filled with the liquid, until fracture results through the irresistible pressure, the "Quartzoid" becomes shattered and the prompt opening of the head ensues.

Wharfs and Shipping

The metal work of this type of sprinkler is coated with acid-resisting enamel, and for conditions arising through extraordinary acidity in the atmosphere the metal work is coated with lead and the diaphragm protected by acid-resisting celluloid. Another important consideration taken into account by the use of "Grinnell" sprinklers in wharfs and shipping is their adaptability for use with sea water, possible corrosion being similarly obviated by nature of the above mentioned preparations.

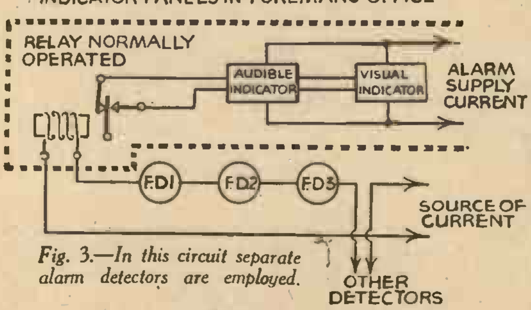


Fig. 3.—In this circuit separate alarm detectors are employed.

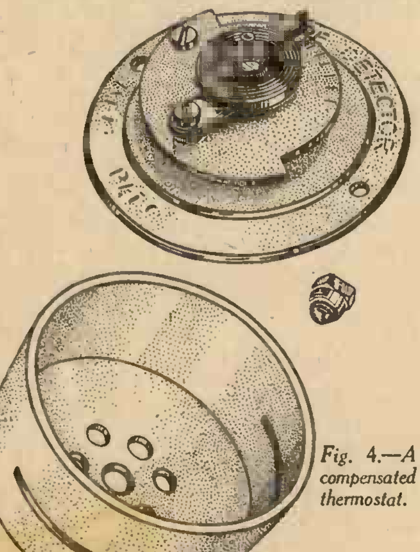


Fig. 4.—A compensated thermostat.

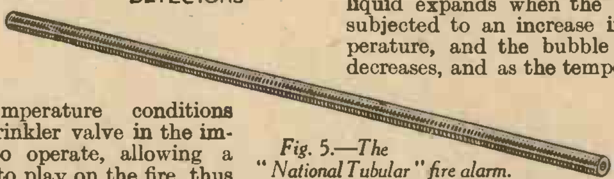


Fig. 5.—The "National Tubular" fire alarm.

AGAINST FIRE

dates back to the System is used the World

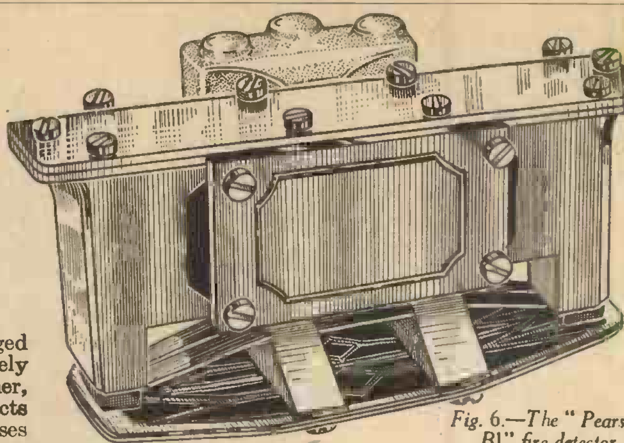


Fig. 6.—The "Pearson B1" fire detector.

To contend with the possibility and detriment of freezing in the pipe-lines, a "dry pipe" or air system is employed, and in this manner the installation pipes are charged with air at a moderate pressure, the water-supplies being held back beyond the reach of the frost by virtue of this air "charge" in the pipes. This system has, however, the same dependability as the water-charged system.

The action of a sprinkler valve is naturally slow, and only serves to check the possible spreading of the fire. The solution to this is found in the extension of the alarm system to the local fire station or call office, and an example of one such system will show more clearly a typical layout.

Alarm Detectors

Fig. 3 shows a skeleton circuit of a building employing a series of fire alarm "detectors." These detectors are so designed that a sudden rise above normal temperature conditions will cause a circuit to be completed, which will result in the alarm bell in, say, the foreman's office or on the outside wall of the building being rung, the exact location of the fire being determined by the indicator board immediately, and the alarm bell is within audible range of either employee or outsider.

Simultaneously with the above functions an alarm is automatically sent to the fire brigade or call station, indicated on the fire brigade's indicator panels, thus assuring immediate attention—this operation takes longer to describe than to perform.

Now, reverting back to the sprinkler valves, it will be recalled that mention was made of the automatic alarm which constitutes part of the sprinkler equipment. In this system the opening of the valve heads actuates the alarm circuit, whilst in the example illustrated by Fig. 3 separate alarm detectors are employed, this being simply a question of design and convenience, no difference whatsoever is effected in the timing, since all installations are adjusted to suit conditions arising out of the requirements of the architect.

A Thermostat

Fig. 4 illustrates a compensated thermostat of particularly unique design, the operation being as follows.

Normal changes in temperature, due to seasonal or weather conditions, have no effect on the movement, whilst a sudden rise in temperature, as would be experienced by a fire, causes the contacts to separate and the circuit continuity is broken, this causes a relay (Fig. 3) to become de-energised and an alarm circuit to be completed.

From the illustration it will be seen that this detector consists of two concentric bi-metal spirals, arranged so that they are effectively insulated from each other, and each carrying contacts at its end. Normal increases in temperature cause these two spirals to rotate together, both being equally heated, and the two contact pieces being normally closed their relationship is in no way interrupted by this operation. Now, consider the effect of a sudden rise in temperature; immediately the hot air circulates round the exposed spiral, this spiral rotates more quickly than the other spiral, thus causing the contacts to separate and consequently the alarm circuit is put into operation.

When an installation is contemplated, and whilst the types of sprinkler heads and alarm detectors described constitute the very essence of neatness, there, however, does often arise the necessity for a system,

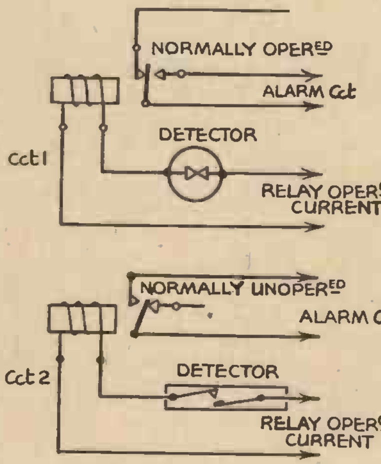


Fig. 7.—The alarm circuit relay.

which after fitment is unobtrusive, and one such fitment is illustrated in Fig. 5. This is the "National Tubular" fire alarm detector, and together with the "Pearson B1" fire detector, illustrated in Fig. 6, constitute the types included in the George Newnes building installation.

The unit (Fig. 5) is usually placed in a member of the moulding of a ceiling, and it is interesting to note that it is in no way discernible even when within a foot or so from its position, and so it is that this sensitive tube detector finds great favour in the eyes of architects and the owners of those premises where ornamental ceilings and surrounds are in evidence.

How it Operates

A length of sensitive copper tubing (less than ½ in. in diameter) is fixed, as mentioned, in the moulding of the ceiling, the ends terminating in a pair of flexible diaphragms. An expansive fluid fills this copper tube, being allowed to enter by one of the diaphragms, the other diaphragm being arranged to retard the rate of flow. The movement of both diaphragms under the pressure of the liquid causes a pair of contacts to be lifted. Now, as with the thermostatic spiral type already described, both contacts move at a uniform rate when under the influence of a slow rising temperature, but under an abnormal increase in temperature one contact overtakes the other and when they meet an alarm circuit is completed. It will be noticed here, that whilst one unit (Fig. 4) breaks a set of contacts to effect the alarm circuit, this type makes a pair of contacts, the difference, of course, being in the alarm circuit relay employed, a simple practical analogy of these two functions is clearly shown in Fig. 7.

The "Pearson B1" fire detector is an efficient instrument, attractively designed, and employing the principle whereby an alarm is given by the heat acting upon sensitive metal strips, making them expand and complete an alarm circuit.

The construction is as follows: An oblong casting approximately 5 in. × 2 in. constitutes the "chassis" of the unit. Upon the underside of this casting are located the two sensitive strips mentioned above, these being fixed rigidly to the casting. Two pins, in the centres of the strips respectively, pass through packed glands into the interior of the unit, the glands protecting the contacts against any accumulation of moisture, acid fumes, dust, etc., thus leaving the strips to move for the purpose of making contact when influenced by the sudden increase in temperature. Two contacts connected to terminals and a limit stop constitute the internal apparatus, all being mounted on an insulated base. Adjustment is made so that one contact is susceptible to a rapid rise in temperature, whilst the other is arranged to operate when, maximum temperature has been reached, the ultimate effect being that any deflection of the sensitive strips affects the position of the contacts and an alarm circuit is completed when the high temperature is reached. Should the fire be of a smouldering nature or gradual, the adjustable stop limit comes into action and contact is immediately made.

There is another interesting alarm detector manufactured by the Associated Fire Alarm Company—manufacturers of the "Tubular" and "B1" systems—and this unit is shown pictorially in Fig. 8 and is known as the "May-Oatway" fire alarm. The action, briefly, is similar in principle to those just described.

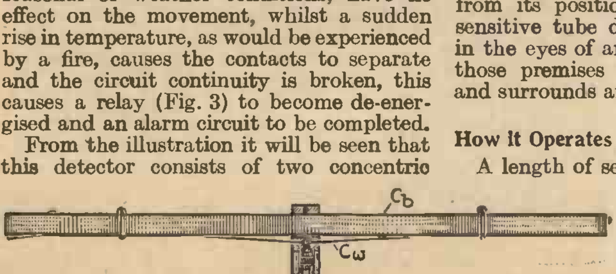


Fig. 8.—An interesting alarm detector known as the "May-Oatway" fire alarm.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR OCTOBER

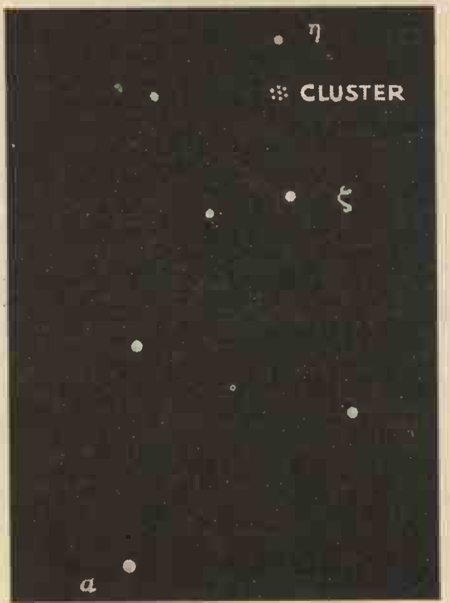
SUMMER Time ends at 3 o'clock on the morning of Sunday next, the 3rd, when all timepieces will be put back one hour. This sudden acceleration of the shortening of the autumn evenings will probably be more acceptable to stargazers than to devotees of outdoor sports.

The Planets

Neither Mercury, Venus nor Mars are at present of much interest to amateurs. Saturn continues above the horizon throughout the night; but the ring system is temporarily again becoming more foreshortened owing to the changing relative positions of the planet and the Earth as they move along their respective orbits. Nevertheless, on dark clear nights, the slender band of light representing the edge of the rings may be perceptible in small astronomical telescopes; as may Saturn's largest satellite Titan. Under very favourable atmospheric conditions the main cloudy belts on the ball may perhaps also be discerned in such an instrument, if not of less than 2½ inches aperture. The planet now rises due east at 5.30 p.m. and can be identified a couple of hours later as a dull yellowish star-like object over the south-eastern horizon. Jupiter remains conspicuous low in the southwest from dusk until it sets, shortly before 11 'clock at the beginning, and 9 o'clock at the end, of the month. It will be slightly more than two Moon's widths above Mars on the evening of the 29th. On the 2nd at 8.0 p.m. (B.S.T.) only two of Jupiter's four principal satellites will be visible, one on each side of the planet. Of the others, one will be immersed in Jupiter's shadow and the other in transit across its disc. On that evening also, Sat: III will disappear at 10.2 p.m. (B.S.T.). Further apparent reduction to two "moons" may be observed at 7.0 p.m. (this time G.M.T.) on the 11th and 18th. But on these occasions both the missing attendants will be hidden in eclipse on the same side of Jupiter. At the same hour on the 3rd and 26th, transits of Sat: I and on the 27th of Sat: II, will be found in progress.

A Wonderful Star Cluster

In the stellar universe the feature of the month is the Great Globular Star Cluster in Hercules. The constellation of that name is now high in the western sky at about nine or ten o'clock, and the cluster is situated between the stars η (Eta) and ζ (Zeta) of the group. This remarkable assemblage of scintillating suns can be detected by average unaided vision, and readily discerned through a binocular, as a faintly luminous spot. It is the third finest cluster in the heavens, and long-exposed plates indicate that the nucleus contains at least 50,000 brilliant stars. The reproduction on this page of a photograph taken at the Dominion Observatory, British Columbia, shows only the brighter of its many components. Viewed visually through the mammoth reflecting telescope of 72 inches aperture, the sight is astonishing; but quite a small astronomical instrument will show the starry character of the misty object. The individual stars in the cluster vary considerably in size. Many of them are bigger than our Sun; and, as their actual distances apart are probably not much less than those that divide us from our nearest stellar neighbours, their seeming proximity to each other suggest inconceivable remoteness. This has been estimated at 33,000 "light years"; which means that we do not see the cluster as it may now exist, but as it was 330 centuries ago!



The principal stars of the constellation Hercules, showing the position of the great cluster and Alpha Herculis.

A Giant Sun

There are other marvels in this extended constellation. Among them is α (Alpha) Herculis, a reddish astral giant consisting of a comparatively small massive core enveloped in a scorching atmosphere of glowing gas. Although not strikingly brilliant, it is one of the largest stars known. Interferometer measurements yield a diameter of 350,000,000 miles, or 400 times that of our source of light and heat. Were Alpha Herculis to be brought as near to us as the Sun, its disc would stretch right across the sky and our tiny world would be submerged beneath the surface of that colossal globe of fiery mist to a depth of over 80,000,00 miles. Fortunately Alpha Herculis is 400 "light years" away, otherwise everything on the Earth would be completely incinerated. ζ (Zeta) Herculis is of special interest for, in size and luminosity, it strongly resembles our Sun. It moreover consists of a yellowish central body with a "planetary" companion revolving round it at a distance, and in an "annual" period, not much greater than those of the planet Saturn. This companion is likewise much smaller than Zeta, but denser. Its ruddy tint points to either an older or more rapid rate of evolution.

Notes

The astronomers at Mount Wilson Observatory, California, predict that the maximum of the current sunspot cycle will be reached at the beginning of 1938.

A recent series of observations discloses an intimate relationship between the coincidence of sudden fadings on radio short waves in daylight, and simultaneous intense but fleeting outbursts of hydrogene flames on the Sun's surface. Corroboration of these conclusions is provided by later results obtained by the Australian Commonwealth Research Bureau. It is evident that the solar radiations causing the fadings travel at the speed of light.

. . . .

Certain mathematical calculations controvert the modern theory that the planet Jupiter possesses a rocky core covered by a layer of ice which in turn is surrounded by an atmosphere nearly 4,000 miles thick. It is said that such an atmosphere could not exist unless at a temperature far too high to permit the maintenance of a contiguous coating or ice. The depth of the Jovian atmosphere must, it is asserted, therefore be regarded as not exceeding fifteen miles.

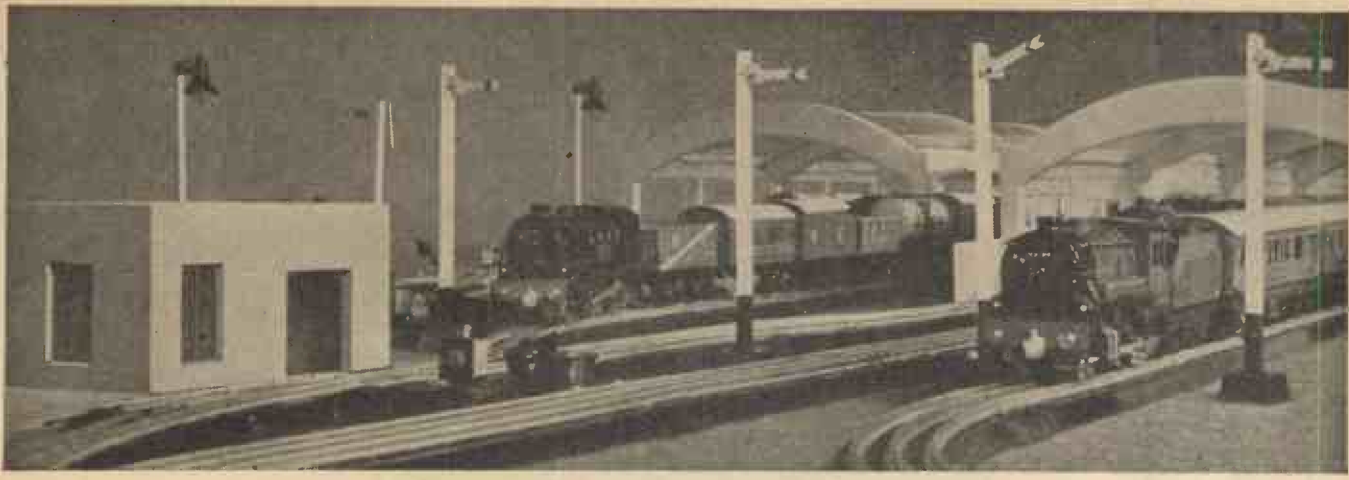
. . . .

Comet Whipple (1937b) has become extremely faint and is practically out of view. It has passed from the constellation Hercules into that of Ophiuchus which sinks below the western horizon concurrently with the oncoming of dusk. Comet Finsler (1937f) ceased to be visible from these latitudes after the middle of last month, when it began to "set" before twilight faded. It was never much more than a ball of diffused luminosity shedding a few tail-like streamers. Had this comet delayed its arrival for another three months it might perhaps have been quite a conspicuous object against the darker autumn sky.

. . . .

Photographs of the total eclipse of the Sun on June 6 last, taken from an aeroplane at an altitude of 25,000 ft., over the Pacific Ocean, claim to reveal the existence of a hitherto unperceived extremely tenuous exterior solar atmosphere. This vast intangible envelope appears to extend beyond the farthest limits of the longest coronal streamers, and may prove to be connected with the origin of the mysterious Zodiacal Light. Verifications during future solar eclipses are however awaited before drawing any definite deductions.

The great star cluster in the constellation Hercules.



Trains leaving a through station built up from "Many Ways" units.

New Features of the Table Railway

By W. J. Bassett-Lowke, M.I.Loco.E.

READERS who have already started the fascinating hobby of Table Railways will be interested to hear of the new developments of the Twin Trains for the coming season.

The 4-6-2 continental type Pacific.

Gauge "00"—3½ mm. to the foot and 16 mm. gauge (called by some "H.O.")—is now firmly established in this country and has been the means of centring more interest from the public in the hobby of model railways than any other development within recent times.

Station Sets

The "Many Ways" station sets, already referred to in these pages, were displayed at the British Industries Fair and should be available to the public by the time this article appears in print. The particular feature of these stations, apart from their beauty of appearance and ingenuity of design, is the fact that each building, though a unit in itself, can be embodied with other units to make up almost any type of railway-like station. Starting with a simple suburban through station with just a waiting-room and booking office, then an island platform or a more elaborate suburban station with dignified clock tower and entrance steps, it is possible to work up to a full-blown "Euston or Waterloo" terminus station or a big through station like Crewe. The various units consist of platforms, fences, main buildings, spans with celastoid roofs, tower building, steps, ramps, quadrant pieces, etc. The engine and goods sheds are, of course, a separate unit.

A Modern Note

These "Many Ways" station parts have certainly struck a new and modern note in railway buildings and have the advantage that when a new layout is planned and the track has been relaid, the station buildings can be rebuilt in accordance with the owner's new ideas.

In addition to the station units there are also scale model station staff and passengers, electric-type trolleys, trucks, milk churns, barrels, and luggage, all properly proportioned and correctly coloured.

For those who are most interested in the working parts of the railway, the most

Electric locomotive—London Transport.

important among the new locomotives in gauge "00" is a 4-6-2 Pacific-type express locomotive. As will be seen from the illustration, this is a fine-looking engine, is 10 in. long overall and 2 in. in height from rail to funnel. Despite its huge size it will safely negotiate the 14-in. radius curves on the Twin Train track. This model comes on to the market in December and will be in the continental outline and colours. Its performance is remarkable. It will pull the heaviest loads and the longest trains with perfect ease.

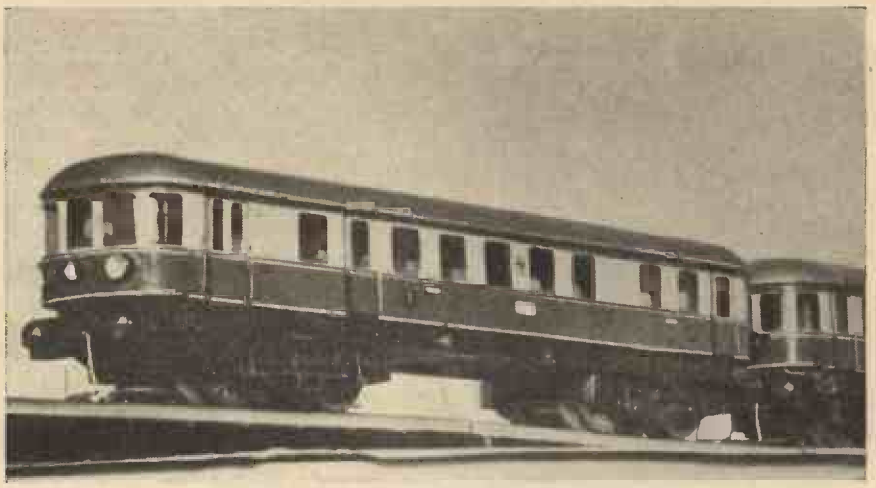
Rolling Stock

New rolling stock is also available for this locomotive—long bogie coaches, Mitropa sleeping and dining cars, 8 in. long, which can be supplied fitted with electric lights. The feature of this lighting is that the lights can be switched on or off independent of the locomotive mechanism.

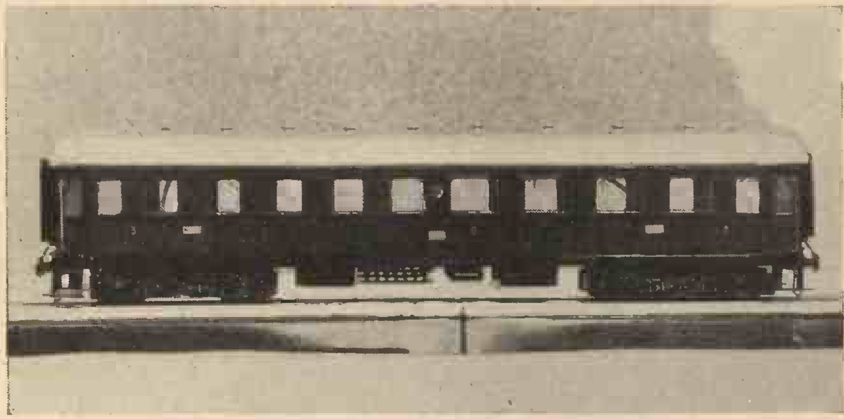
The Diesel flyer, which in real railways is now used extensively on the continent and to a limited extent in this country, is another novelty for this year in gauge "00." It is complete as a two-coach unit with motor-coach and trailer with a white headlight and a rear red light—and here is something special; when you reverse the train the lights reverse automatically.

Other Wagons

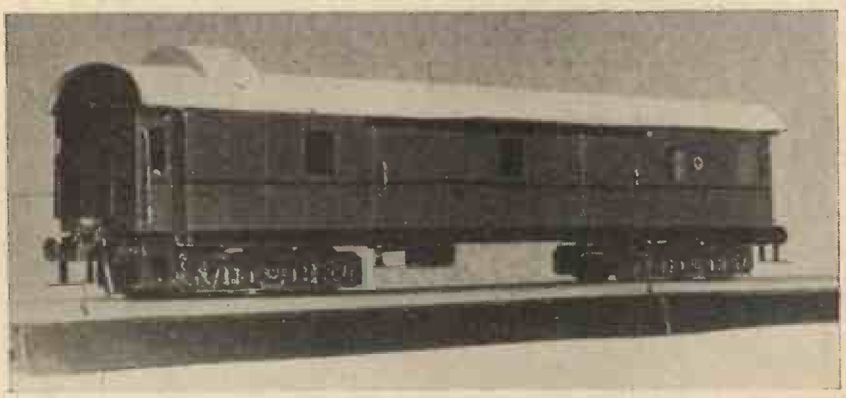
In goods vehicles, new wagons of continental design are also available, an open truck with brake cabin, a petrol wagon, a 20-ton covered van, a tank truck, and also a short continental suburban coach. An electric locomotive unit which will appeal to all in London and district is a neat model in familiar colours of London Transport.



The Diesel flyer which is a two-coach unit.



A standard continental bogie coach fitted with electric lighting.



A standard continental baggage van.

A Mitropa dining car.

ITEMS OF INTEREST

"Brass Pressings"

WE have just received an interesting handbook, bearing the above title, which deals with the many brass and other copper-alloy pressings which are now cold-formed from strip and sheet-metal. The book, which is well illustrated in gravure, deals chiefly with the many uses of these pressings, together with the properties of the materials. An outline of the more important metal-working operations such as spinning, joining, and annealing, is also included in the book, a copy of which will be sent free of charge to any reader on application to the Copper Development Association, Thames House, Millbank, London, S.W.1.

The Institute of Marine Engineers

AN examination for admission to Associate Membership of The Institute of Marine Engineers is to be held on May 16th–19th, 1938. The annual examination for admission of Probationer Students and Students will be held on May 23rd–31st, 1938.

The Institute's examinations are held in London and other centres according to candidates' places of residence. Full particulars of the syllabus and exemptions allowable may be obtained on application to the Secretary, The Institute of Marine Engineers, The Minories, London, E.C.3.

MAN-POWER FLIGHT

By
Granville Bradshaw
O.B.E.

This Article is Reproduced by Courtesy of "Flight"

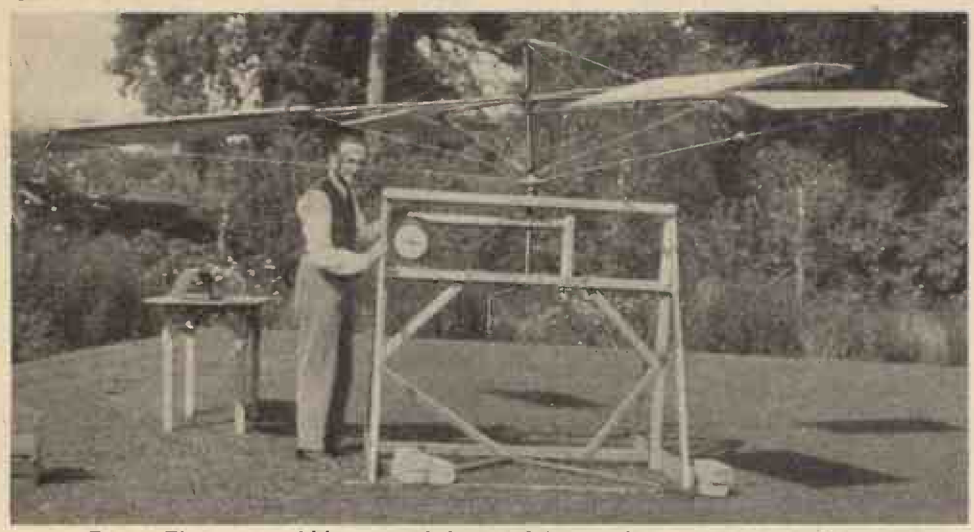


Fig. 1.—The experimental lifting rotor which gave indifferent results. *Photograph by courtesy of "Flight"*

EDISON has been called "the greatest inventor of all time," but I do not believe he ever "invented" anything in his life. Not what we call invention. He was far too practical in his methods. What he did, for instance, was to ask himself if sound could be recorded, and then, starting at the beginning, he worked upon a process of technical research, experiment, and development until the device assumed a practical form and finally emerged as a *fait accompli*.

Nowadays there is too much accumulated knowledge and data necessary to success in technical subjects for one to be able to sit down and to "invent" a new and immediately successful process. Probably the only inventions that can truly be described as inventions are small gadgets like patent fasteners, potato peelers, tin lids, and miscellaneous devices one sees in an industrial exhibition.

Being convinced of the desirability of research methods and equally convinced of the possibilities of flying by manual effort, I have spent a great deal of time during the past twelve months in carrying out some experimental work which might bring it a few stages nearer to a solution.

My friends in aviation technique have always said that man cannot develop sufficient b.h.p. ever to be able to fly. This, of course, is easy to appreciate if one's views are bounded by the theory and practice of aeroplanes of the type originated by the Wright brothers.

To State the Case

What I have never been able to get out of my mind is the fact that man undoubtedly possesses sufficient power to lift himself from the ground. He can, for instance, hoist himself on his toes, he can climb a ladder, walk upstairs, hoist himself with his arms, can jump several feet above the ground, and, when it comes to leverage, he can lift as much as a ton or more.

Why, then, hesitate to agree that he ought to be able to fly? If man can lift himself comfortably and easily with one hand by means of a rope over a pulley, surely all that he requires in order to fly is the right kind of pulley?

Often have I said to myself, "Supposing man could stand on a light 'air-borne' aeroplane and could jump and then lift the aeroplane after him, then jump again and carry on and on?" This, in a crude form, would be flight by manual power.

These things naturally pass through one's mind when seeking a solution to a problem like this, especially as one obviously realises that it must be some revolutionary device if success is to be achieved.

I first decided to study man as a motor, and for my first experiment I went to Leicester Square Underground, where they have the longest escalator in London.

However sceptical readers may feel about the problem of man-power flight, they must admit that the author of this article has worked out a novel and interesting line of attack. Incidentally, he appeals to gliding experts to help him with certain data. Mr. Bradshaw, whose inventions in many fields have achieved real success, was one of the pioneers of British aviation in that he designed and produced aero engines as early as 1911. In the following year one of his A.B.C. engines established a record by flying for more than eight hours in a Sopwith-Wright biplane piloted by Harry Hawker. During the War Mr. Bradshaw designed the A.B.C. Dragonfly and other radial engines, which were remarkable for their low specific weight.

The centre stairway, which was stationary, consists of 120 steps each 8 in. high, a total of 80 ft. On an automatic weighing machine I weighed 148 lb. I took out my stop watch and ran up the stairs in 40 seconds almost exactly (and very nearly dead). This shows that my legs developed 0·54 b.h.p. I have since discovered that 8-in. steps are not necessarily the best for the human form for a test of this nature—for instance, 6-in. steps suit me better, and running two steps at a time gives more rapid ascent, with the result that the power would increase to approximately 0·65 b.h.p.

Three or four trials satisfied me, as you may well expect, that if manual-power flight would necessitate anything approaching the amount of effort that I had just expended, it would not be worth having even if it were possible. On the other hand, I realised that I was ascending at least ten times as fast as would be necessary to satisfactory flight.

Flying or Hopping

I think it will be agreed by everybody that flight by manual effort will be useless if the human is not able to keep flying for an hour at least and without heart attack; otherwise it is merely interesting for academic reasons and possibly for a few hundred feet of newsreel.

However, I started with an open mind in order to find out what I could, and I decided to let it lead me where it would. I then built a lever mechanism on a spring balance to test the power of the arms, and was not at all surprised to find that man can develop quite as much power by his arms as by his legs. Our ancestors back through the ages of evolution to the days of the anthropoid ape used to swing from tree to tree, hanging on their arms and using the powerful breast and back muscles. We have undoubtedly retained some of the original strength in these same muscles.

I found that, rowing fashion, I could pull more than 100 lb. a distance of 4 ft. at nearly fifty strokes per minute, which gives a b.h.p. of 0·65.

Therefore the b.h.p. of an ordinary person may be reckoned at between $1\frac{1}{4}$ and $1\frac{1}{2}$.

From these and subsequent tests I would estimate that supermen in first-class training, like the Oxford and Cambridge boat-race crews, are each developing between $2\frac{1}{2}$ and $3\frac{1}{2}$ b.h.p. in a race of that description. It has been demonstrated that a good cart-horse can develop from 12 to 16 b.h.p.

I carried out many other tests on the human "engine" with some astonishing results, which we will discuss later, it being sufficient at the moment to say that it appears to be the most variable, most

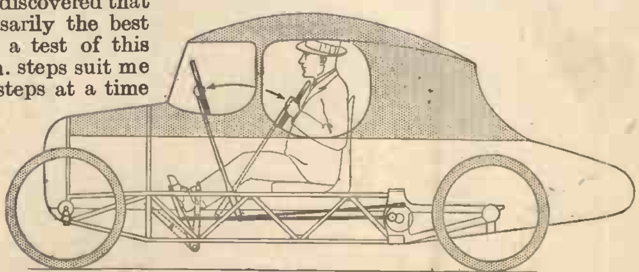


Fig. 2.—The experimental cyclecar described. It is propelled by a carefully worked out combination of leg and arm power. (*Sketch by courtesy of "Flight"*)

flexible, most inconsistent, and the most bewildering device ever " invented."

You cannot treat it like a petrol engine, the crankshaft of which you know will give you (say) 100 b.h.p. at 2,500 r.p.m.—*which you can employ as you may wish.*

Try to get power out of a human motor in the wrong way, such as by using the wrong muscles, or in the wrong line of thrust, or at the wrong speed, and you will find perhaps only 10 per cent. of what you might otherwise expect. Alternatively, give it some inducement, and it will stand a 300 per cent. overload and will enjoy it.

Fig. 3.—A Belgian Velocar—a popular method of transport on the Continent.

This being the case, I decided that an ounce of practice was worth a ton of theory. One well remembers that in the early days of flying the mathematicians produced extensive calculations to prove that certain new machines would not fly, but they did fly, and the problem of flight by manual power may well be in the same category to-day.

My next effort was to test man's ability to propel an aerofoil through the air. I had given up all thought of thrusting planes forwards by means of an airscrew, because I realised that they would be getting their lift second-hand, and I knew that I could not afford airscrew losses.

The Wrong Kind of Lift

I argued that if planes are designed to lift at (say) 30 m.p.h., why not push them round at 30 m.p.h. by the engine itself and measure the lift direct? I had made arrangements for forward travel by the tilting of the surfaces to a slight angle in the direction I wished to travel which, of course, gave a horizontal component. Incidentally, this part of the device worked quite well. I therefore built a large testing rotor, which is illustrated in the heading photograph, Fig. 1. It would not be difficult to predetermine the amount of engine power required to turn it, but that would tell me nothing about manual power and physical reaction, which I considered to be all-important.

As I have said, man is a curious animal and does not obey mechanical laws as we are accustomed to them. For instance, one might think that on a pedal cycle it is only necessary to have a gear ratio low enough, and one would be able to climb any hill in the country. But it is not so, as man's physical properties refuse to cope with it; therefore a low first speed, as in car practice, is quite useless.

The rotor had four orthodox blades each 4 ft. long by 2 ft. 2 in. chord and of a well-known section. The outside diameter was variable from 10 ft. to 16 ft., and the angles of incidence of the plane surfaces were cross-connected in pairs, which was found necessary in a wind, as one side would lift more than the other. The angles of all four planes were controlled by one lever giving a complete range from a negative angle to that of a steep climb.

The whole rotating member was carried upon a universal joint for purposes of the tilt above referred to.

The results were extremely disappointing, and all the power seemed to disappear in head resistance.

I was, of course, well aware that we had less than $1\frac{1}{2}$ b.h.p. to play with, but with the total of about 200 lb. thrust of which man is capable, and the " fine-pitch thread " upon which this was working, I did expect more than the 30-odd lb. lift that I obtained. And the effort was infinitely worse than running up the Leicester Square stairway. Even with no lift on the blades at all I could not rotate them any appreciable amount faster than I could at the maximum lift.

However, I had satisfied myself, in the only way in which I could obtain complete satisfaction, that lift of this kind is definitely unsuitable for man power.

One has seen reports in the Press that flights of short duration have been made by man power, and it may be that some athlete has scraped off the ground by almost superhuman effort, but the absence of confirmation leads one to think that no real measure of success has been achieved.

It is the *type* of effort which is all wrong—that dreadful drag which can be likened to pushing a car through thick mud. The physical form likes spring and rebound, and, above all things, it likes rhythm in its actions.

It is possible that I did not build the most efficient type of test machine and that considerably greater efficiency could have been obtained, but I am satisfied that as a type for operation by manual power it is useless.

I feel quite sure that if the wing power of a bird were converted into continuous torque and used in known aeroplane manner it would not succeed in lifting the bird off the ground.

I became more and more convinced that I must seek lift of a different kind, and I returned to the problem of working upon a large plane surface and using it as a stepping stone.

Since that time I have frequently lifted myself from the ground and have become " airborne " by the simple process of forcing a plane surface smartly downwards at right angles to its face; and it required no more effort to lift myself and the weight of the plane than jumping over a stile.

This is not flying (yet), but it appears to be a more efficient form of lift than the one commonly used. It is lift by reaction as compared with lift by drag, and I believe that very little effort is lost in obtaining lift of this description.

" Reaction Lift "

My technical friends will say " the ornithopter, of course," but I cannot entirely agree, although there is a little similarity. A flapping wing, to my mind, presupposes air disturbance, and this causes loss of power. You cannot start air or water in motion and leave it to carry on without having lost the power that set it in motion. My aim is rapidly to compress the air under the plane locally and to benefit by the rebound.

A flapping wing, with its radial action, would appear to be almost doing its best to throw the air off. Reaction lift, therefore, may well be a step in the right direction. It uses the manual motor in a way to which it is accustomed and which it likes.

Solid drudgery, like turning an airscrew, the human engine will not stand—was not the treadmill designed as a punishment?

I therefore decided to work upon these " reaction lift " lines as the most likely to produce results.

The next stage was to endeavour to find the best arrangement or combination of our two kinds of power, i.e., the legs and the arms, and for this purpose I built a small cyclecar weighing 55 lb. This is illustrated in Fig. 2, and in it I must have tried over twenty combinations and arrangements.

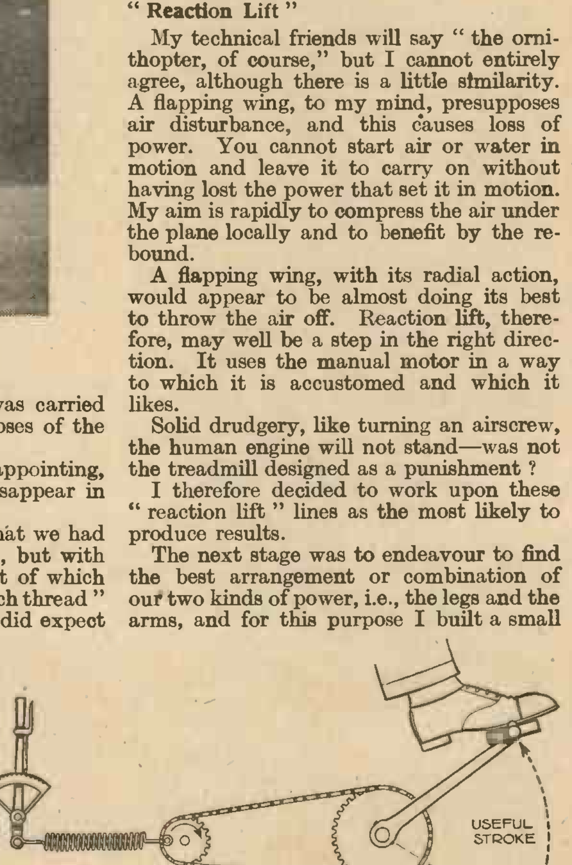


Fig. 4.—Overcoming the top dead centre difficulty, one cause of fatigue in the human motor.
(Sketch by courtesy of " Flight.")

For the arms I can find nothing better than a rowing action; therefore the whole steering-wheel and column rocks to and fro, and the extent of their travel can be adjusted whilst the car is moving. It is astonishing how easy it is to get into the habit of rowing and steering at the same time. It seems perfectly natural to swing the body when the legs are pedalling

I first thought that ordinary rowing practice with a sliding seat must be the best (and probably *is* the best) manual-power producer in common use to-day, but I do not think that it is quite the best that could be done. In fast rowing with a sliding seat the leg power is, we might say, in series with the arms, i.e. the power that is produced by the legs is transmitted to the oars via the arms—I have tried them in parallel and with adjustments for the separate travel and leverage of each, and I have found considerable improvement.

Rotating pedals as in ordinary cycles appear to be of a low order in manual propulsion. The rotary motion of the feet and lower limbs brings into play secondary muscles that were never intended for heavy pressure. These muscles are easily overstrained and tired, especially when pedalling a bicycle up a hill with the rider trying to force the pedals forward at the top and backward at the bottom of the working strokes.

Perhaps the most valuable thing that I discovered is the fact that the human engine becomes more tired and loses its power more readily when it is straining at something which is stationary than when it is doing work. For instance, if the foot is pressing against a fixed pedal it will tire more quickly than if it is moving the pedal against an elastic medium.

Muscles apparently were not designed for stationary strain, and it may be that the circulation of the blood has something to do with it, or possibly the muscles become "knitted," or the lubrication of the joint fails. There is certainly some truth in the old saying that when the potter is pedalling his wheel it is the leg that is standing on the ground that becomes tired, and not the one that is doing the work.

The most tiring period of pedal action on a hill is the slow part just over the top dead centre (I mean slow with respect to the straightening of the leg), and this tiring part of the stroke is the very part which is doing the smallest amount of work. Thus millions of cyclists are probably wasting energy every day.

The human engine is different from, shall we say, the steam engine. We all know that in a steam engine the crank, when in a certain position, is at a bad angle for turning effort, but at the same time we know that energy is not being lost, for the simple reason that the piston is moving correspondingly slowly, and consequently little steam is being taken from the boiler.

In our manual engine, however, the very fact that the leg is moving slower than the minimum rate for manual efficiency is the very thing that is causing a loss of manual power by overstrain, and so we have to get off and walk. No other engine loses energy or power in this manner.

We have seen efforts made by inventors to overcome the "top dead centre" trouble, but seldom do they appear to be sound in principle.

I decided to endeavour to overcome this drawback by providing a torque equaliser. I could see no way in which I could alter the crank, so I decided to alter the torque. I thought that I would ask for more power at the easy part of the travel, and give it back again at a time when the legs were being overstrained, and this proved successful. The device is simple and is illustrated in Fig. 4.

A Torque Equaliser

Briefly, it is a two-to-one gear, an additional small crankshaft, and an adjustable spring of about 60 lb. maximum tension controlled by a lever. The pedal crank is easy to push down during about one-quarter of a revolution, as shown in the diagram and marked "useful stroke," and during this quarter of a revolution the spring crank (which turns at twice the speed) obviously moves through half a revolution and tensions the spring. It is timed to pass over the dead centre at the end of the useful part of the pedal stroke, and during the time that the pedal crank is passing through the tiring quarter of a revolution the energy stored up in the spring is given back with a mechanical advantage of two to one on account of the gear ratio. The result is that the drudgery has disappeared, the machine feels light and lively, and where one would expect to feel the strain of pressure the machine actually travels forward on its own. The spring is adjustable by a gear lever, and, like changing speed on a car, it has to be suited to the hill.

A surprising thing is that, possibly because the manual motor is relieved over the tiring patch, it does not notice the additional push it has to give during the easy part of the stroke.

There can be no doubt but that the manual motor is at its best when it is overcoming a quick and springy resistance. It is best likened to volleying at tennis, with all one's effort thrown into a terrific swipe at the ball.

On this manually propelled car I have started from rest quite comfortably on a one-in-five gradient, and have exceeded 40 m.p.h. on the level. Therefore I feel that I am obtaining a considerable amount of the right kind of b.h.p. from the manual engine. I am sure that a rowing "Blue" would exceed 60 m.p.h. without difficulty.

This arrangement of gear, however, will not be the most suitable for our flying machine, the aim in which is a bouncing push on a large flat surface at regular intervals with which to lift the fuselage and pilot, which is the first essential. For this latter purpose the gear which I have tested is a plain lever with cross-bar gripped by both hands and two pedals carried upon another lever, the two levers being coupled together so that they are slightly out of phase. The reason for this is that the greatest power period in rowing is the final jerk which is customary just near the end of the stroke. The feet also like to give an extra jerk, but it does not appear to be efficient for them both to do it at the same time, as they each like the extra jerk when it suits them best; therefore the rhythm is "pull-jerk jerk, pull-jerk jerk," and so on. It may sound tiring as read, but it is quite a pleasant and smooth action in practice, and it removes the possibility of a "dead centre," which may be dangerous in the air from the point of view of control. (We must not forget that whilst pedals can only push downward, the hands can both pull and push, but I have disregarded the push with the arms for increasing power, as it takes away the rest period, and I have retained it only for helping the controls.)

I feel that I have definitely proved that lift by reaction is sound and efficient. I believe that, except for pure speed, it is many times more efficient than lift by drag, and that all that we have to do is to find a satisfactory means of employing it.

Work to be Done

In my first attempt at the complete machine I am working upon the slowest speed I can obtain, and this is where I am asking for constructive criticism from readers with experience in the design and testing of modern gliders. I shall be grateful for any figures.

Supposing we can build a glider weighing 80 lb. (which with pilot at 150 lb. will be 230 lb. in all), and supposing it can maintain a gliding angle of 1 in 30 at 8 m.p.h. in still air. (What are the best figures for modern gliders, by the way ?) If we can do this, then our rate of vertical descent is 24 ft./min. We must, therefore, raise 230 lb. at the rate of 24 ft./min. in order to fly level, i.e., to change a 1 in 30 glide into horizontal flight. If we row at forty-eight strokes per minute we must lift the weight 6 in. at every stroke.

Let us take 150 lb. of the weight on the arms and the remaining 80 lb. on the legs and see what the figures are.

The arms have a stroke of (say) 3 ft., which gives them a leverage of 6 to 1 (on 6 in. lift), and this will necessitate a mean pull of 12½ lb. on each arm. The legs have a stroke of 18 in., giving a leverage of 3 to 1, and this is a mean push of 13⅓ lb. on each leg. Neither of these efforts would be a discomfort to man, and, in fact, the leg push is consistent with the average push on a pedal cycle; therefore we may assume that the arms provide the necessary further power to produce the lift.

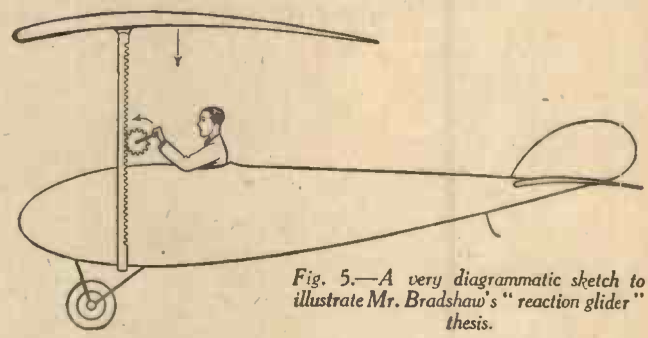


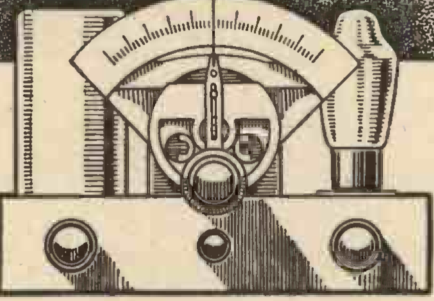
Fig. 5.—A very diagrammatic sketch to illustrate Mr. Bradshaw's "reaction glider" thesis.

There will be no loss in the transmission as there would be with an airscrew, and the power necessary to maintain the lifting of 230 lb. a height of 24 ft. every minute is actually less than one-fifth b.h.p. The problem with regard to the power absorbed by head resistance is a curious one. Our glider, for instance, would normally glide at its natural gliding angle losing height all the time *but still gliding downwards and forwards*, and all that we are seeking to do is to restore height. I have already developed what appears to be a satisfactory method of raising the fuselage and pilot with respect to the planes on the reaction principle to which I have referred, and of restoring the planes to their former height, all with no appreciable loss and without interfering with the glider gliding as a glider should. I have also provided for additional forward velocity by altering the angle of reaction.

Where is the snag ? It is merely a glider on which a weight is raised whilst it is in flight. If the weight is greater or the natural gliding angle of the machine is steeper than 1 in 30, then one will have to row harder, but if the gliding angle were 1 in 60, for instance, then one would only require one-half the above power. If the gliding angle is 1 in 30 and the principle of lift by reaction is as efficient as I think it is, the power required to fly level should be no more than that necessary to climb a gradient of 1 in 30 with my test cyclecar loaded up till it weighs 80 lb. all told, and this, I find, is child's play.

(To be concluded next month)

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



SEEN AT THIS YEAR'S RADIO EXHIBITION

THE theme of this year's Radio Exhibition at Olympia was All-world Radio. The majority of the receivers shown there employed multi-circuits, tuning to the short waves as well as to the normal broadcast wavelengths, and the home-constructor was enabled, for the first time, to purchase tuning units of a simple type incorporating all-wave tuning. The short waves are now being employed extensively as an adjunct to the normal wavelengths, not only for entertainment, but also for definite research purposes, as there are many peculiarities experienced in short-wave transmission and reception the nature of which is still obscure. Among the new tuning units which are now obtainable for inclusion in a home-built wireless receiver are those supplied by B.T.S., Bulgin, Wearite, and Varley.

This is the ingenious Long Arm remote control unit supplied by W.B. for distant-listening purposes.

Whiteley Electrical are now producing complete receivers, and this is one of the new models.

W.B. Receivers

The stand of the Whiteley Electrical Radio Company, Ltd., was particularly notable in that as well as a completely new range of the Stentorian type of speaker, they broke new ground by exhibiting a fairly comprehensive range of receivers. Models shown included a four-band A.C. Superheterodyne, with an ingenious arrangement providing individual dials with station names for each wave-band; a four-valve All-wave Battery Superheterodyne; a three-valve A.C. All-wave Receiver, and two self-contained battery receivers for transportable use. All are at approximately current market prices, and it is a significant fact that whatever the size of the demand, the makers announce they will definitely limit production with a view to maintaining a high order of reliability.

A " Long Arm " remote control of similar external appearance to last year's accessory was also shown. It will be remembered that this, when used in conjunction with any but the smallest Stentorian cabinet, enables the listener to operate the on-off switch of the set from the extension point.

Most novel amongst the chassis loud speakers was the new "Planoflex"—a completely new design suitable only for use with quality amplifiers.

An All-stage Valve

This year the High Vacuum Valve Co., Ltd., showed for the first time in its production form the Hivac Harries All-stage valve, which is the result of four years' intense work by Mr. Stephen de Laszlo in cooperation with Mr. J. H. Owen Harries, the inventor. This valve is a multi-grid critical-distance valve which is so constructed that it makes possible the production of a multi-valve receiver, such as a superheterodyne using only one type of valve throughout. It is applicable to many specialised purposes, and may be used either in the transformer-fed A.C. receivers or in series heater type A.C./D.C. instruments. The valve is put forward as the first fundamental advance in valve engineering (apart from the critical-distance principle itself) which has been made for some years. A complete chassis using these valves was shown on the Hivac stand.

Other exhibits included a range of special 2-volt short-wave receiving valves, and a complete range of battery and mains valves. There were also models of the " Wayfarer " Major Portable receiver and the Wayfarer Grand. These instruments are now being marketed by Hivac.

A novel portable seen on the High Vacuum Valve Company's stand (Hivac). This is the Wayfarer Grand, and the tuning panel is shown inset.

An ingenious midget charger seen on the Heayberd stand. This useful piece of apparatus costs only 12s. 6d.

This is the Wayfarer Major portable.

Actual Photograph of
Bond's British Permanent Way.

THE CHEAPEST SUPER DETAIL PERMANENT WAY . . . .

IN ALL GAUGES FROM "OO" TO ¾" SCALE.

We illustrate above an ACTUAL PHOTOGRAPH of Bond's Super Detail Permanent Way. The Rail Sections faithfully reproduce the outline of the Full Size Rails, also the Model Chair.

If you want Super Detail for your Model Permanent Way, you can only get this with Bond's Super Detail Permanent Way Parts.

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Cast Chairs, for wooden keys	per 100 1/2
Keys	per 100 6d.
Fishplates	per doz. 3d.
Sleepers, stained correct colour	per 100 2/3
Battens, ¼" × ¼" section	per yd. 2½d., 2/3 doz. yds.
Pins, approx. 1,000	6d. packet
Track Gauge, special, with elec. chair jig ..	9d. each.

All Prices Plus Postage. For Prices of Gauge "OO," "1," ½" Scale and ¾" Scale, see the 1937-1938 200-page General Catalogue, Price 6d., which illustrates all the requirements of the Model-maker, including a complete list of Tools and Materials.

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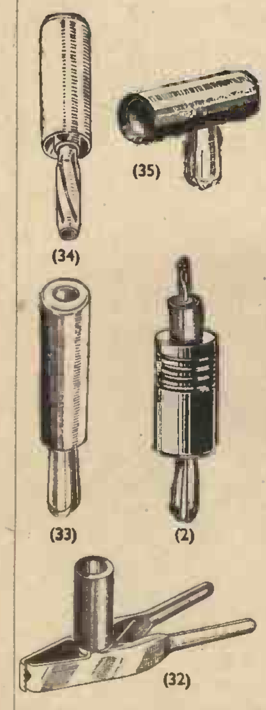
ALL-WAVE RADIO



The higher the frequencies, the more important it becomes to use low-loss contacts, or in other words "CLIX," the contact components which, because of their proved high efficiency, are used by the leading set designers, experimenters and home constructors.

In the limited space at our disposal we illustrate a few of the 36 which are included in our latest Components Folder. Why not send a post-card request for a Free copy of this and the Clix Folder "P.M." on Valveholders and Connection Strips?

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Clean accurate work, to fine limits.

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Works with either a small motor or treadle. Supplied with one tilting table that can be fitted in many positions.

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as illustrated, with extra equipment
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Appeals to the Locomotive and Aero Modeller, Woodworker, Constructor and Handyman.

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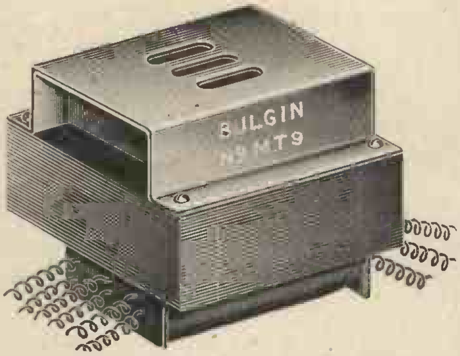
The following valves are additions to the already existing Hivac range, and were shown for the first time at Olympia.

QP 240.—	A new improved 2-volt battery valve for economy Q.P.P. operation, having smaller dimensions and giving a greater power output, 1·5 watts approximately.
PX 5.—	A new 6-watt 4-volt directly heated Output Triode.
AC/Q.— *AC/Qa*.	(Equivalent to 6L6.) A new Super Power Output Tetrode marketed in two types: AC/Q fitted with 4-volt heater and standard 7-pin base. AC/Qa fitted with 6·3 heater and Octal base.
A 15.—	The Hivac Harries All-stage valve.



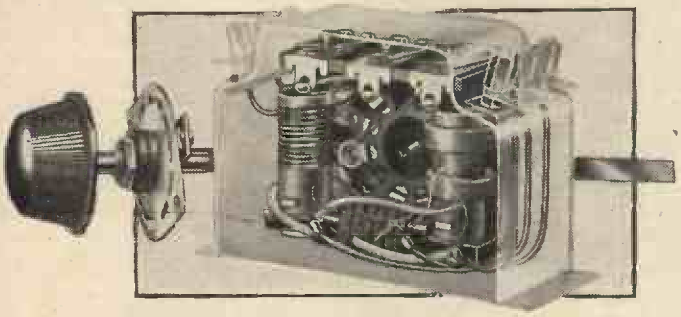
This new Bulgin transformer is arranged for chassis mounting, and is provided with sub-chassis connections.

One of the pick-ups manufactured by the Cosmocord Company, and available with a motor in the form of a complete gramophone unit.

The new Bulgin output - testing unit using a neon tube.

The Heayberd "Tom Thumb" Battery Charger.

The Heayberd "Tom Thumb" Battery Charger has been specially designed to meet the requirements of those wishing to charge their own low-tension battery at home. Its design and construction is such that the operator need not have any previous experience in battery charging. All that is required is to insert the mains lead into the nearest light or power point and connect up the battery to the output terminals. It incorporates a metal rectifier, thus no valve replacements are required, it will increase



The new Wearite all-wave coil.

the life of the battery, and it will charge a 2-volt accumulator at ½ amp. for less than ¼*d*. per week! The size for such a charger is remarkable. It measures 3½ in. × 2¾ in. × 2½ in.

A Neon Output-measuring Unit

Of the many new lines introduced by A. F. Bulgin & Co, Ltd., of interest is their neon output-measuring unit. When connected across the output of a receiver, it will indicate strength of signal, if the set is supplied with a source of modulated H.F., so facilitating ganging and comparative tests. Length of glow is controlled by means of a calibrated variable resistance. Two input impedances are provided, one for connecting across the speech coil (low), and one for connecting direct across the primary of output transformers. It is fitted with an engraved ivorine scale and terminals for connection, and is contained in a pressed aluminium case and mounted on an attractive bakelite moulding. This firm have also produced a heavy-duty mains transformer having a high permeability ferrous-alloy core. It is suitable for chassis mounting when all connections are sub-chassis. The transformer is fitted with a stout metal clamping shroud ensuring freedom from mechanical noise.

A comprehensive kit supplied by Belling & Lee to cut out the interference which is often picked up by the aerial and main leads.

An Anti-interference Aerial

The "Eliminoise" anti-interference aerial made by Belling & Lee, Ltd., is substantially the same as last year's model, though it has been strengthened and made slightly more efficient. It is effective on all broadcast bands, 10–56, 200–600, and 1,000–2,000 metres. The principal features are real suppression on all these wave-bands without serious loss of signal strength; it can be erected as easily as an ordinary "L"-type aerial and is similar in appearance. Eight to ten receivers can be fed from one aerial and may be tuned to the same or different stations without inter-action.

This firm, who have specialised for a number of years in the tracking down of electrical interference, have produced a number of interesting devices which are extremely efficient for overcoming this bugbear of radio. In addition to an ingenious mag-nickel delay fuse, Belling & Lee, Ltd., showed a full range of terminals, plugs, and other interesting lines with which the radio public is so familiar.

The popular Clix components were to be seen on the stand of British Mechanical Productions, Ltd., and of interest were the new plugs and valveholders for use with the latest Octal valves. Also displayed

In the Pilot receivers, a large clock-face scale is utilised for tuning, and this is illuminated in sections, the lights being controlled by the wave-change switch. Tuning is thus greatly simplified.

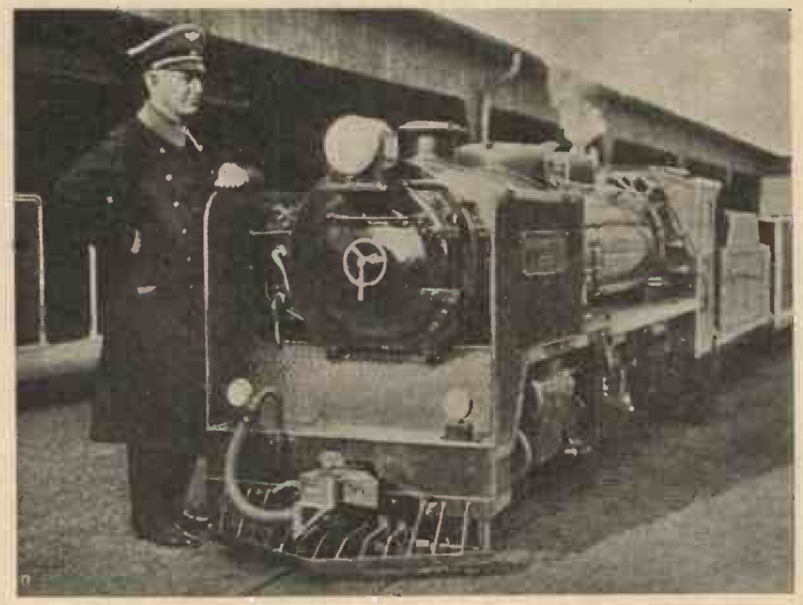
were spade terminals, master plugs, chassis and baseboard valveholders, as well as special items designed for short-wave work.

Batteries

Following the Exide "Mass"-type low-tension cell incorporating the invisible charge indicator, a new range of Exide "Hycap" accumulators, specially designed to meet the demands of high-powered modern radio receivers, was introduced. This new range, like its predecessors, has proved an unqualified success.

The metal rectifiers manufactured by the Westinghouse Company are now supplied without the perforated metal cases, and thus prices are reduced. This is one of the L.T. models.

A GERMAN MINIATURE RAILWAY



A fully equipped miniature passenger railway.

Something New in Model Railways

AT the great German Exhibition at Duesseldorf entitled "A Nation at Work," there is a fully equipped passenger-carrying miniature railway running around the Exhibition grounds. The locomotives are of Pacific type with six-wheel tender and made by Messrs. Krupp of Essen on a 15-in. gauge. The railway is called the Lilliput Bahn, and well-built stations of a good design are quite a feature of the railway. The photograph shows one of the officials wearing a smart uniform which is so noticeable on the German railways.

CATALOGUES RECEIVED

Lionel Trains

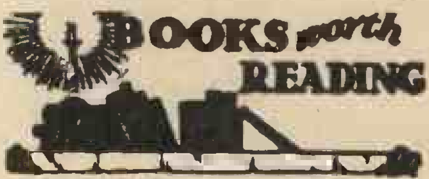
A FULLY illustrated catalogue in which is listed a complete range of Lionel trains has just been issued by S. Guiterman & Co., Ltd., 35-36, Aldermanbury, London, E.C.2. Most of the engines have die-cast frames with steel bodies giving great strength and ability to withstand rough treatment. Some of the trains are accurate reproductions of famous record-breaking expresses and contain a wealth of detail. Nearly all models are fitted with distant control which is unfailing in action, and enables complete control of a train to be effected at a distance by the touch of a button. Of the many new lines introduced in the catalogue, of interest is the Alderman type "L" transformer. A special safety lamp built into the transformer acts in the same way as a safety valve on a steam engine, and directly the transformer is overloaded, the lamp lights brightly indicating a short circuit somewhere. During normal use the lamp glows just faintly red—a sufficient indication that the current is on.

Profit from Conjuring

"MAGIC for Pleasure and Profit" is the title of an interesting prospectus just issued by the St. James' School of Magic. This booklet gives you the truth about magic. It has been written so that you may know what the St. James' School actually is, how it teaches, and what wonderful advantages a thorough study of the lessons will mean to you. They guarantee that you will be satisfied with their course of instruction and tuition in every way, and if, within seven days after completing the course and payments which are very reasonable, you make application stating that you are not satisfied, they agree to refund the full amount of the tuition fee to you. Full details of the course will be sent to you upon application to the above school at Greycoats Galleries, Greycoat Place, London, S.W.1.

Postage Stamps of the World

MESSRS. WHITFIELD KING & CO., Ipswich, have just produced their 1938 edition of their *Standard Catalogue of Postage Stamps of the World.* This is the thirty-seventh edition of this catalogue, and it is a work of reference specially compiled for the beginner and general collector and circulates amongst stamp collectors all over the world. 63,927 varieties of stamps are listed in the catalogue and it contains 7,100 illustrations. The text includes useful currency and geographical rates on the countries concerned, and prices have been completely revised to represent current market conditions. The catalogue costs 5*s*.



"Modern Woodwork and Furniture Making," by G. H. Barker, M.Coll.H. 146 pp., 58 line illustrations and eight half-tone plates. Technical Press, Ltd., London. 7s. 6d. net.

Obviously written from the point of view of the handwork teacher, this book should be useful to students and teachers with little experience. The author at once impresses the reader with his sincerity and keenness for his subject. He is a member of the staff of the Cheshire County Training College, which regularly produces a good supply of sound handicraft teachers.

Mr. Barker has a modern outlook on the question of educational handwork, and sets forth, briefly, a scheme of teaching that aims at true cultural development rather than the training of artisans. In this he is convincing and extremely helpful to those teachers who have yet to cultivate that confidence and sincerity which is essential for success.

Illustrated details for the construction of a large number of articles in wood are given, and these should give ample inspiration to those who wish to produce designs of their own.

"Technical Electricity," by J. E. Phillips, M.A., etc., and R. W. B. Stephens, Ph.D., etc. 288 pp. and 187 line diagrams. Technical Press, Ltd., London. 7s. 6d. net.

It is not easy to treat an old subject such as this from a new angle, but the authors have at least brought the information given right up to date.

The book is essentially of a technical nature and not intended for general reading. For the student it presents a large amount of information in a form that makes for easy reference. The index is very complete and the whole book well arranged.

It would not be possible to give even an outline of the extensive contents, but the following list of chapters provide an indication of the subjects covered: Magnetism, Electric Charges, Further Electrostatics, The Electric Current, Magnetic Measurements, Resistance, Heating Effects of the Current, Chemical Effects of the Current, Cells, Current Measuring Instruments, Applications of the Heating Effects of the Current, etc.

NOTES ON PETROL-DRIVEN MODEL AEROPLANES

An American Wins the Bowden International Trophy for Petrol-engined Models

Fig. 1.—The Bowden International Trophy which was won by Mr. Fish.

Fig. 3.—The model owned by Mr. Fish, which won the trophy.

Fig. 2.—(Left to right) Capt. Bowden, the donor of the trophy, holding paper, and Herr Kronfelt, the famous German glider pilot, speaking into the microphone, and the German Wakefield team manager, who acted as one of the judges.

THE object of this trophy, presented by Captain Bowden, is to encourage reliable, slow flying safe petrol models of any type.

The rules encouraged a quick start, and three flights *with the minimum of damage* within reasonable time limits, i.e. 40 seconds to 90 seconds. These flights had to be within the boundaries of the aerodrome, for it was considered that this would test control, and help towards encouraging safe flying.

Unfortunately, due to lack of time, one of the most important rules, in which the competitor is disqualified for a flight if he does not start his engine within 5 minutes from cold, had to be omitted. Competitors therefore were able to start their engines and walk up to the take-off ground with engine running.

An Excellent Entry

There were twenty-two competitors. This was an excellent turn out for the first year of the trophy, and the International flavour was represented by two from France and two from U.S.A. To strengthen this aspect, Mr. Van Hattum from Holland, an old S.M.A.E. member of renown, several years ago, when he was residing in this country, was one of the judges, whilst the German Wakefield cup team manager was another.

Herr Krondfelt, the famous German gliding expert made some interesting opening remarks over the microphone, and stayed to watch the event with great interest.

The models were first of all examined for condition, and after the flying had taken place were re-examined. Marks were deducted for damage sustained during the competition.

First away was Mr. Jeffries, a private owner, with his "Kanga Kub," a commercial model which won the Sir John Shelley power cup during the morning. He did not repeat his performance during the afternoon however, and his engine cut shortly after taking off.

It was noteworthy how many models still fail to take off under their own power. The leading French representative suffered from this defect. Incidentally this model recently won the French "Coup de France," and so must normally have plenty of power. Other Cyclone engined models did very well, particularly that of Mr. Gardner for G.B.

A Replica of the "Blue Dragon"

Mr. Harris, of early speed-boat fame, and now an ardent aeroplane enthusiast, demonstrated what light wing loading will do on very little power. With his engine throttled right back the model took off easily and flew slowly and steadily. Unfortunately his model persisted in flying out of the aerodrome. A replica of Captain Bowden's old record holder, the "Blue Dragon" also demonstrated what light wing loading can do on a few engine revs. This model, flown by Mr. Colyer was amongst the four who tied for first place, and had to fly off an extra flight to decide the winner.

Fig. 4.—Mr. Jefferies, who won the Sir John Shelley cup during the morning with his "Kanga Kub," was the first to start off during the afternoon. Mr. Jefferies also won the £50 prize offered by this journal for the "Petrel" Contest.

Mr. Trevithick was doing very well on his beautifully finished small "Brown" engined model, but unfortunately could not keep in the aerodrome. Mr. Trevithick had secured second place during the morning in the Sir John Shelley Cup.

An outstanding performer was an 18 c.c. Comet engined model from Bournemouth. This model was of the high power steep climb type.

The Winner

The eventual winner, Mr. Fish of U.S.A., was flying extraordinarily well with a parasol Monoplane fitted with a "Brown" engine. On one flight he nosed over and broke a propeller, which lost him points. He eventually found himself with equal marks with three other models. The "Comet" engined "Skyrocket" from Bournemouth, Mr. Gardner's "Cyclone" engined high wing cabin model, and Mr. Colyer's "Blue Dragon" replica model.

On the fly off, the "Skyrocket" landed outside the aerodrome and was disqualified. Mr. Gardner's model folded up its undercarriage and lost some points. The "Blue Dragon" made a perfect flight and landing, but unfortunately for its owner was not officially timed. On a further flight this model just landed outside the aerodrome and so lost its chance of a win for Great Britain through this unfortunate timing mistake.

The winner, Mr. Fish of U.S.A., made a perfect flight except that his model nosed over on landing which lost him a few marks.

The win was well deserved, as his model showed ease of take off, steadiness during flight, and an excellent glide.

Next Year

Space forbids mention of several interesting models and other good performances.

The International Trophy therefore goes over to the United States of America this year, and it is hoped that England and the other countries will be all the more keen to get it back when the competition is again flown off next year in the London District.

One of the conditions imposed by the donor was that the Trophy should be flown each year in England, the country of its origin, as it was felt that such International gatherings of enthusiasts all help in their small way to make for International good will and peace.

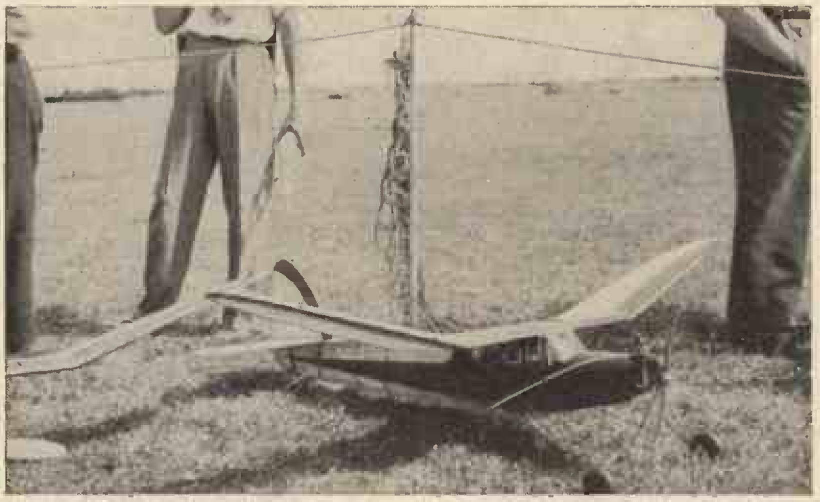


Fig. 5.—The French machine that recently won the "Coup de France," but was not in form during the International Trophy contest.

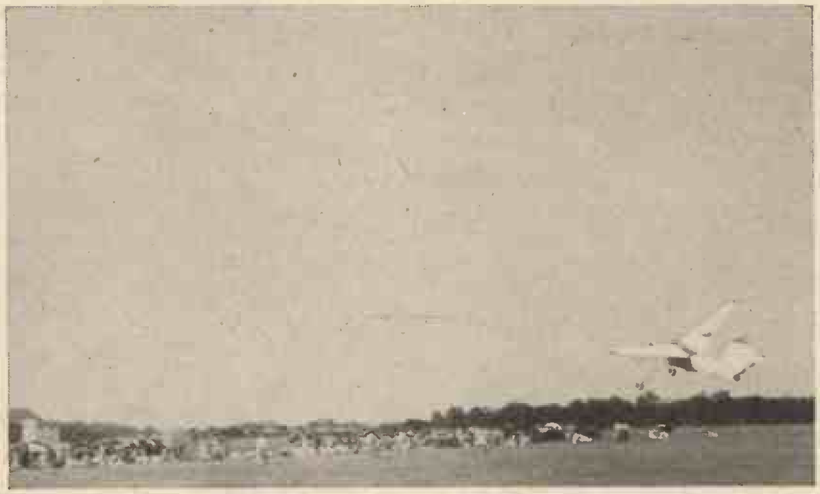


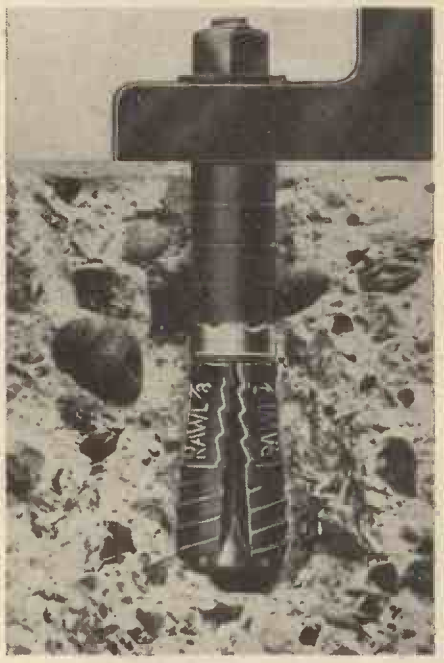
Fig. 6.—Mr. Colyer's "Blue Dragon," a replica of Capt. Bowden's old record holder, in flight.

RAWLBOLT COLLARS

WHEN making fixtures in weak material it is an advantage to sink the Rawlbolt deeper than would be necessary when fixing to material of normal strength. By slipping Rawlbolt Collars on to the bolt, and making a deeper hole, the Rawlbolt shield or fixing unit is necessarily dropped deeper into the material than would otherwise be the case. By adopting this suggestion when tackling weak material, the danger of the material splitting will be largely avoided.

The use of Rawlbolt collars also enables the range of Rawlbolts to take care of the fixing of articles, the thickness of which varies considerably.

If the bolt length available is too great for a certain job, then by adding a collar or two, and sinking the bolt deeper into the material, the bolt length is automatically reduced by the thickness of the collars added, in other words, the use of Rawlbolt collars avoids unnecessary projection of the bolt.



Showing the Rawlbolt collars in use.

Reference to the Rawlbolt tables will show that there are two lengths available in each bolt size. For example, the bolt projecting type C. 2 has a length for fixing of $\frac{1}{4}$ in. and the C. 3 a length for fixing of 1 in. The difference between these two sizes covers all average jobs, but there are many jobs where the fixture has a thickness too large to permit the use of the C. 2, but if the C. 3 were used it would mean an unnecessary projection of bolt. Rawlbolt collars have been introduced to avoid this unnecessary projection of bolt. If we assume an article has to be fixed having a flange of $\frac{1}{2}$ in. it is obvious that the C. 2 would be useless and the C. 3 would leave a bolt projection of $\frac{1}{2}$ in. or more. Now by using four $\frac{1}{4}$ in. bolt diameter Rawlbolt collars (each being $\frac{1}{8}$ in. in thickness) and making the hole that much deeper undue projection is avoided and the unsightly appearance of a projecting bolt is obviated through the collars taking up excess of bolt.

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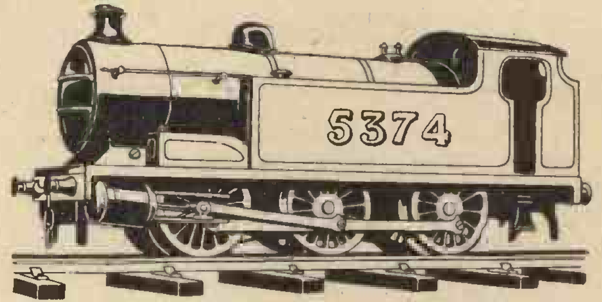

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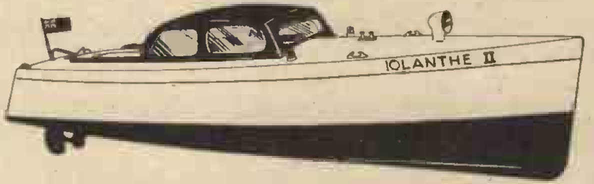

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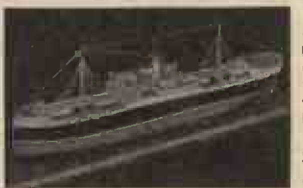

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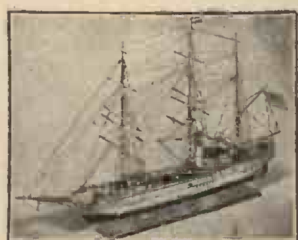

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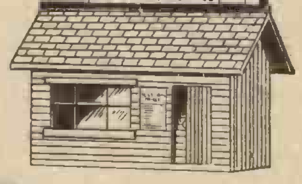

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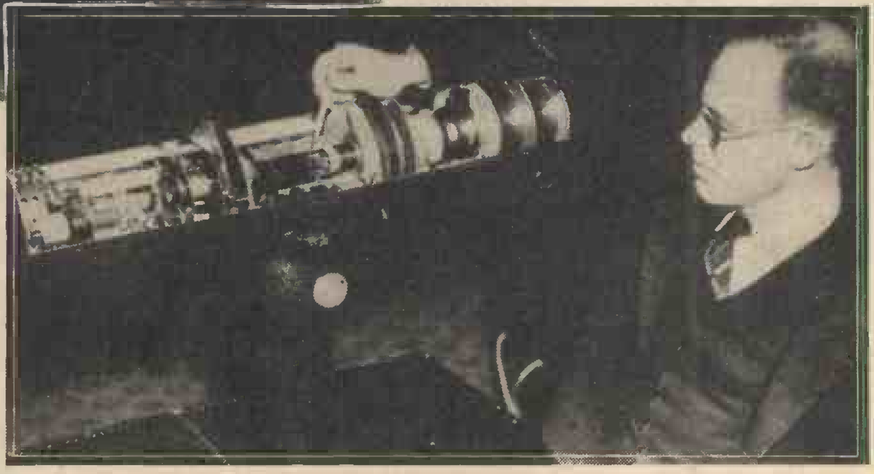
COLOUR TELEVISION AGAIN

New Developments in Television

Dr. Law is here seen examining a projected image.



Dr. R. R. Law, of the R.C.A. Laboratories, New York, with his "Electron Gun," which is part of an instrument called a "Kinescope," which projects television images on to a screen, enlarging the size of the received picture many times.

According to a report in the daily papers, colour television has come to the fore again. No details of the discovery have yet been disclosed but it is known that the picture reproducer was a cathode-ray tube. In practice, of course, a picture of any desired *single* colour can be shown with a C.R. tube by the simple expedient of adjusting the percentages of the various ingredients used in the powder sprayed on the front of the tube, and shown in a fluorescent condition by the impact of the beam of electrons tracing out the picture in line form. It was this fact which gave the clue for a colour television scheme proposed on the continent. Three cathode-ray tubes were to be employed, and each screen was to be manufactured from a different powder so that the pictures were in the three primary colours of red, blue and green. With the aid of an elaborate lens combination the observer saw these pictures superimposed one over the other, and a vivid colour effect was secured. It will be seen at once, however, that unless each tube is made to respond to each section of the picture which is its own particular colour, the resultant mixture will in no way be a true portrayal of the original colours. In the days of low definition we had Baird's demonstration of colour television in which a disc scanner having red, blue and green filters was employed at the transmitting end, and a composite picture made up from differing light modulating sources at the receiving end. Within the limits of definition then in use the principles were satisfactory, but there seems little hope of applying the idea to modern schemes of high definition television. Bearing in mind the difficulties associated with present-day monachromatic television it would appear a better plan to devote the time of original research to solving the major problems and leave the prospects of colour television to a distant future, when it can be evolved as a natural development without any of the undue complications which it now embraces.

In Japan

Some four or five years ago the Japanese were in the limelight because of the experiments they were then undertaking in daylight television. On a 60 line picture definition standard outside television broadcasts were being attempted, using a disc scanner, and high hopes were expressed that the ideas then being exploited would bring satisfactory results which could be embodied in a public service. This did not materialise, however, and for some time little has been heard concerning the work undertaken in that country. It is now learnt, however, that a sum amounting to nearly three-quarters of a million pounds has been granted by the Japan Broadcasting Association with a view to popularising both television sets and transmissions. This, therefore, brings another country into line with the many others who see in television a science which can be applied not only to entertainment, but to the more important commercial aspects of visual communication which can supplement aural schemes now so well established.

A Difficulty

The development of mechanical optical systems of television is still being undertaken with every promise of results which will be comparable with the more familiar electrical optical systems. One of the main difficulties at the moment, however, is on the question of synchronising, and it is already known that efforts are being made by the B.B.C. to meet the claims of mechanical picture reproducers. Whereas a cathode-ray tube scanner with its associated electrical equipment is adaptable quite readily to phase changes in the synchronising pulses, with mechanical receivers this is not quite so easy. With the use of a single source of synchronising pulses injected into the picture signal at the correct phase position, irrespective of the camera in use at any time, matters are quite in order, and no doubt this scheme will be operative very soon. Many readers will recall that in the earlier experimental high-definition television transmissions, separate synchronising pulse generators were used for each scanner, and it was necessary to phase the pulses correctly before the picture was faded up, otherwise it would be split horizontally. This is liable to produce a measure of hunting in a mechanical scanner, as low definition enthusiasts know only too well.

Screening and Height

It has been pointed out several times in these columns that owing to the nature of the ultra-short waves used for radiating the television signals it is important to ensure that the receiving aerial is located in a reasonably high position. There are other factors which must be taken into account, however, and one of the most important of these is screening. If trees, metal or brick buildings obscure the aerial from the directon of the propagated signals, then it may be better to choose a lower position, which, although giving a lower input signal, may have the advantage of an unscreened path. The same remarks apply to the sources of electrical interference, especially that arising from the ignition systems of motor cars. This has been brought to light by aerial surveys conducted on the high flat roofs of large buildings situated on main or busy thoroughfares. At first it seems the correct procedure to have a high mast guyed suitably on the roof and position the aerial at the top of this. If the mast and aerial are set well back from the roof coping adjacent to the road, then all will be well, for the building acts as an effective screen from the motor car ignition systems. In other words, the aerial is in the shadow of the electrical fields which would upset reception, but is suitably disposed for a relatively large signal pick-up from the Alexandra Palace station. If the roof shape prevents the mast being well set back, however, then the signal to interference ration will in most cases be improved by bringing the aerial nearer to roof level in order to give the same degree of shielding from the interference. Whenever circumstances permit it is a distinct advantage to carry out a number of tests before deciding on the final aerial site, and for this purpose a portable aerial with a length of flexible feeder cable is necessary. Experiment has shown quite definitely that in some difficult localities even the movement of a few feet can make an enormous difference, not only to the strength of the received signal but also to the signal to interference ratio. The close proximity of metal or girders which can act as reflectors, and which may assist or mar the signal, should be looked for, and in this way the set will be operated under conditions more favourable to reproduction of good pictures than would perhaps be the case if a haphazard aerial site is chosen.

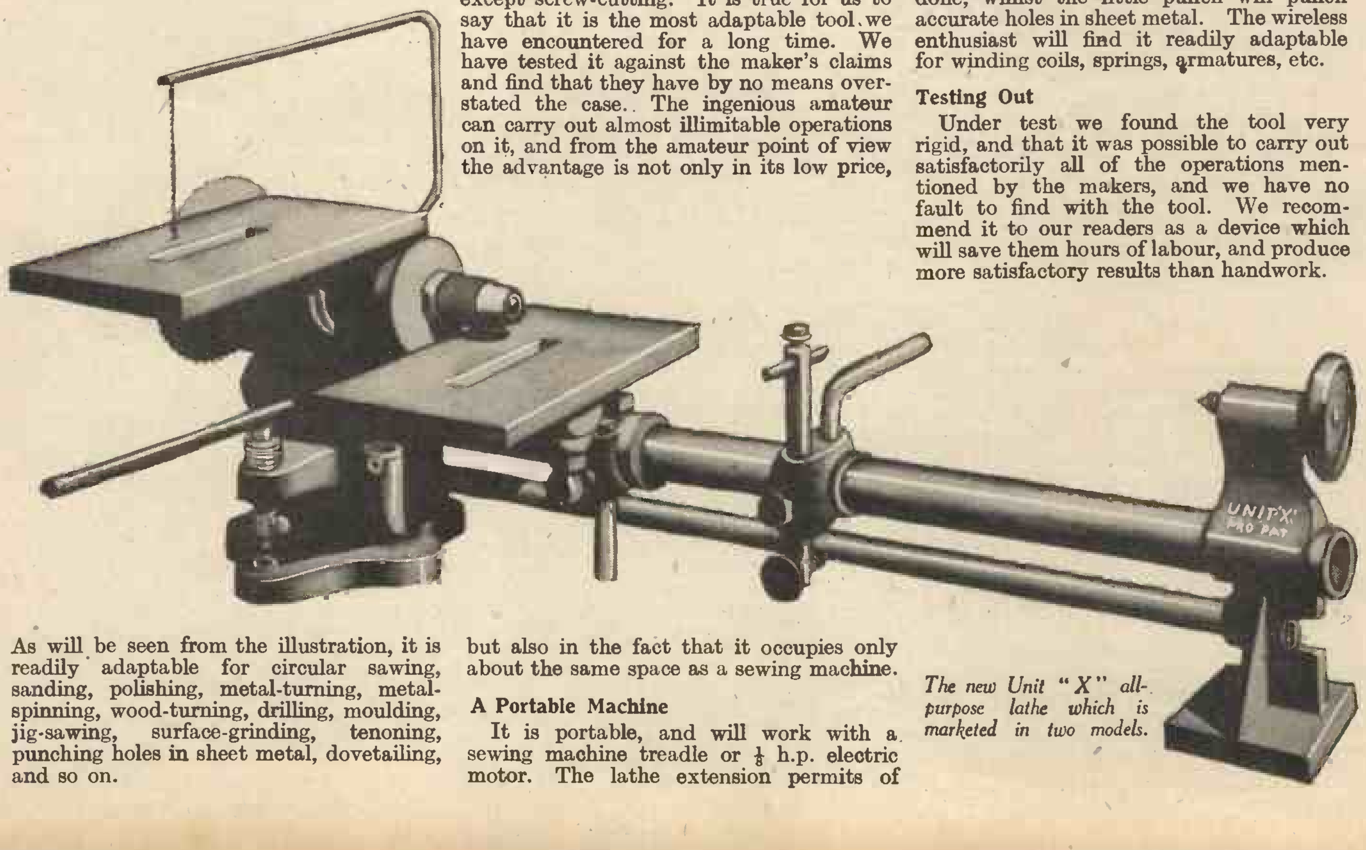
Hard or Soft Valves

SOME readers may find difficulty in appreciating the main differences between time base generators using soft valves and those using the hard variety. The term "soft valve" is, of course, applied to the gas-filled valve whose function is to bring about an ionisation discharge as soon as the charging voltage across the fixed condenser has reached an appropriate value. This type of valve is excellent when used in the time base generator supplying the frame pulses at 50 per second, but at the high line frequencies there is a tendency towards instability. If allowed to get too hot when boxed up in the receiver they are inclined to "choke" if due care is not paid to the design of the equipment. The "hard valve," that is, the high vacuum valve, on the other hand, possesses increase stability owing to the absence of any ionisation delay. Furthermore, the circuit embodying them is capable of functioning at frequencies incapable of being reached by gas-filled valves. If there is, in the future, to be any increase in the degree of line definition then the hard valve time base generator should be capable of adapting itself more readily to any changes that may occur. It is interesting to note that this latter type of time base generator is capable of working up to frequencies of a megacycle, and was first suggested and put into operation by Mr. Puckle of A. C. Cossor Ltd. for television receivers.

AN INGENIOUS ALL-PURPOSE LATHE

Scores of Different Machining Operations in Wood or Metal can be Carried out on this Lathe

MESSRS. TRIANGLE PRODUCTS, LTD. have recently submitted for test one of their new Unit "X" all-purpose lathes, which is marketed in two models—the Popular at 65*s*., or the De Luxe Model at 95*s*., both of them being available on Hire-purchase terms. It is perhaps doing the tool an injustice to describe it as a lathe, for it is possible to do many other operations on it which cannot normally be performed on a lathe.



The new Unit "X" all-purpose lathe which is marketed in two models.

As will be seen from the illustration, it is readily adaptable for circular sawing, sanding, polishing, metal-turning, metal-spinning, wood-turning, drilling, moulding, jig-sawing, surface-grinding, tenoning, punching holes in sheet metal, dovetailing, and so on.

Well Designed

It is a veritable concentrated machine shop on which you can carry out scores of different machining operations in wood or metal. Every mechanic, skilled or amateur, will find it a valuable and handy tool. It is accurately made and well designed. You can turn and bore cylinders for model petrol engines, make model locomotive parts, do boring and facing, in fact, almost every metal working operation on it, except screw-cutting. It is true for us to say that it is the most adaptable tool we have encountered for a long time. We have tested it against the maker's claims and find that they have by no means overstated the case. The ingenious amateur can carry out almost illimitable operations on it, and from the amateur point of view the advantage is not only in its low price, but also in the fact that it occupies only about the same space as a sewing machine.

A Portable Machine

It is portable, and will work with a sewing machine treadle or $\frac{1}{4}$ h.p. electric motor. The lathe extension permits of the turning of such long objects as table legs and spindles; the circular saw has a tilting table, rendering it ideal for dovetailing, mortising, moulding, etc. This is the sort of tool for which the amateur has been waiting. It will take drills up to $\frac{3}{8}$ in., whilst as a circular saw it cuts $\frac{3}{4}$ in. timber cleanly and rapidly. As a polishing head it readily gives a high polish to all materials. By inserting a suitable cutter, slotting, splining and grooving can be done, whilst the little punch will punch accurate holes in sheet metal. The wireless enthusiast will find it readily adaptable for winding coils, springs, armatures, etc.

Testing Out

Under test we found the tool very rigid, and that it was possible to carry out satisfactorily all of the operations mentioned by the makers, and we have no fault to find with the tool. We recommend it to our readers as a device which will save them hours of labour, and produce more satisfactory results than handwork.

Spectrum Analysis

By R. L. Maughan, M.Sc., A.Inst.P.

How the Colours of the Spectrum Provided a Clue to the Structure of Atoms and Molecules

THE band of colour formed when sunlight glances through a corner of glass, the sparkle of a trimmed diamond, the natural and artificial rainbows formed by water drops and sunlight are all spectra.

At first sight it might appear that these colour bands reside in the objects which produce them, in the glass, the diamond and the water drops; but simple experiments show that the colours are contained in the light itself, and are merely dispersed and displayed by the medium through which the light passes.

Approximately three centuries ago Sir Isaac Newton, an early experimenter in optics, directed a shaft of sunlight into a darkened room through a gap in a window curtain, and received this light on a glass prism. He observed that the sunlight which reached the prism as a narrow beam of white light, left it as a broad divergent beam of brilliant colours which formed a spectrum on a receiving screen. The colours occurred in the rainbow order, from red to violet through an infinite gradation of shades. Newton's study of this colour band is the first recorded experiment in spectrum analysis, and his arrangement of apparatus, the curtain, prism and receiving screen was the first spectroscope.

Through the centuries which followed, the development of this branch of applied physics ultimately yielded the knowledge that the colours of the spectrum provide a clue to the structure of atoms and molecules.

The Atom

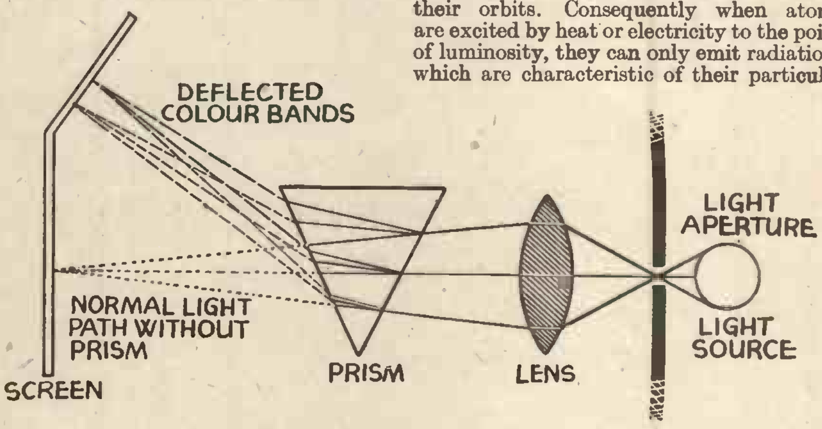
The present day concept of the structure of the atom can be described as follows. Almost all the mass or substance of the atom is concentrated in a small central region or nucleus. This nucleus is surrounded by a distribution of minute particles of negative electricity, the electrons, which are small even in comparison with the nucleus itself. All electrons are identical and at the present time are regarded as fundamental "building bricks" of matter and electricity.

In the atom, the electrons move in specified orbits which are arranged at various distances from the central nucleus, and thus trace out a series of shells in which the nucleus is contained. The similarity of this atom model and the arrangement of planets round the sun in our solar system is highly evident, there being, of course, a vast difference in the two scales. The precise difference in these two scales can be rendered intelligible in terms of numbers, but can hardly be appreciated fully in the imagination.

Light Waves

The space in which the atoms are contained is permeated by energy in the form of radiation, and the absorption of a fragment of this radiation by an atom is accompanied by the disappearance of an electron in one orbit and its reappearance in an orbit more remote from the nucleus. Conversely, the transference of an electron from an outer orbit to an inner one promotes the emission from the atom of an element of radiation or pulse of light, and the sequence of pulses proceeding from many orbits in many atoms simultaneously gives rise to a beam of light.

Light waves can be classified according to their intensity or brightness, and wavelength or colour. The wavelength is precisely determined by the distance moved by the electron in passing from one orbit to another, and the brightness is determined by the total number of atoms in whose orbits the electrons are undergoing such changes. It is evident that the examination of light which is suitably dispersed into a spectrum must therefore provide exact information as to the nature and number of the atoms contributing light to the radiated beam. It is upon this principle that the methods of qualitative and quantitative spectrum analysis are based.

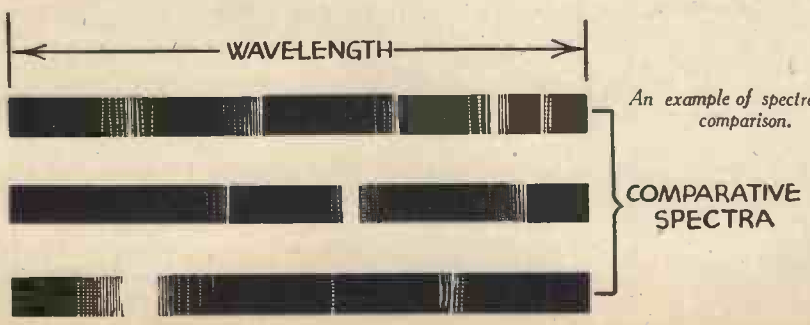


The basis of the spectroscope.

Radiations

Atoms differ chemically mainly in the number and arrangement of electrons in their orbits. Consequently when atoms are excited by heat or electricity to the point of luminosity, they can only emit radiations which are characteristic of their particular groupings of orbits. Largely due to the work of Bunsen and Kirchhoff, this fact was established experimentally during the second half of the nineteenth century, and it was realised that each element has its own set of spectrum lines by which its presence or absence is readily indicated. It is not surprising that this knowledge served to stimulate the search for unknown chemical elements, because the spectroscopic system of analysis has the tremendous advantage over the chemical system in that minute quantities of a substance, too small to be detected chemically, provide ample evidence of their existence when examined spectroscopically. Discoveries of rare alkali metals followed in close succession. Cæsium and rubidium were found by Bunsen in 1860, thallium by Crookes in 1861, and indium by Reich and Richter in 1863.

Since that era in scientific history the development of spectroscopic technique has proceeded steadily, aided a great deal by the quantity of experimental data obtained by this instrument of research and by the manufacture of still more sensitive and reliable optical and electrical instruments. However, it is not probable that the methods of spectroscopic analysis will entirely supersede the chemical methods, although in many cases they (the spectroscopic methods) provide all the information required, and have a great advantage in the rapidity and accuracy with which an analysis



An example of spectroscopic comparison.

can be made. Consequently these instruments have found their way into a great many industrial laboratories.

The Spectrometer

It is claimed that the first use of the spectrometer in industry was made by Roscoe in 1863, who applied it to the examination and control of the air blast in the manufacture of steel by the Bessemer Converter process. In this process it was found to be necessary to arrest the air blast at the moment when decarbonisation was complete. Roscoe observed that the changed appearance of the flame at the mouth of the converter (which indicated the arrest point) was accompanied by a striking change in the spectrum of the light received from this flame, thus enabling the arrest to be made with great precision.

The optical system of any spectrometer consists essentially of two tubes containing lenses, the collimator and telescope respectively, arranged end to end with a rotating table carrying the dispersing system between them. The end of the collimator remote from the table contains a slit of variable width which is directed towards the source of light under examination. The lenses in the collimator tube are adjusted until a beam of light consisting of parallel rays emerges from it and strikes the dispersing system. The simpler kinds of dispersing systems consist of one or more prisms of glass or quartz arranged with their refracting edges vertical and parallel to the collimator slit. The light is transmitted by this system and emerges as a divergent beam dispersed into its individual wavelengths and enters the objective of the telescope as such. An image of the spectrum is formed in the telescope tube, and this is observed through the eyepiece. A permanent record of the spectrum can be made by receiving it on the photographic plate of a camera which replaces the eye-piece, and this method has the additional advantage of being able to register spectrum lines in the infra-red and ultra-violet, which lie outside the limits of the visible spectrum.

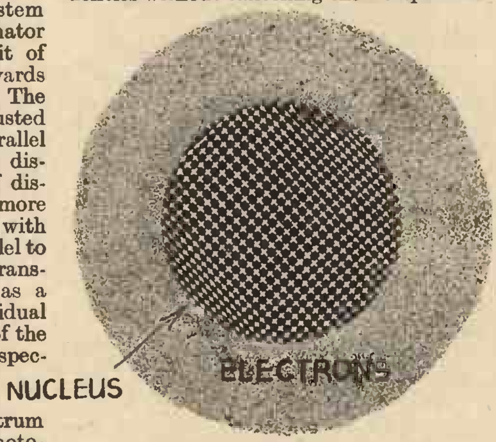
Dispersion and Separation

For higher degrees of dispersion or separation of the lines the prisms are replaced by a diffraction grating, which consists of a thin plate of transparent material on one surface of which is ruled a system of straight fine parallel lines, approximately 15,000 to the inch. Rays in the beam received from the collimator are scattered by these lines, the degree of bending depending upon the wavelength of the light, with the result that a spectrum is produced in the telescope. (The bending of light by diffraction into its constituent colours can be observed by viewing a finely woven cloth held up to the light, or in the colour which edges the eyelashes when the eye is half closed).

Additional refinements are added to some spectrometers in the form of small graduated scales let into the eyepiece on which the spectrum can be received. Scale and spectrum are thereby viewed simultaneously and the positions and distances between spectrum lines measured at once. Other forms possess a metal drum graduated in wavelengths expressed in Angstrom units (one Angstrom unit being one hundred millionth part of a centimetre), attached to the central table which supports the prism or grating. By rotating the drum the table is slowly turned and various lines are received in turn in the telescope. The instrument is so calibrated that the wavelength of a line seen in the marked position in the telescope is automatically registered by an indicator on the drum.

A Portable Spectrometer

The majority of these spectrometers are large and heavy and do not readily lend themselves to transport by hand, their heaviness being to some extent essential to their stability. A special form of spectrometer has been designed, chiefly for the purpose of rapid and easy examination of incandescent furnace gas, flame and other sources of light, which is portable and small. This is the direct-vision spectroscope which contains the telescope, collimating and dispersing apparatus in a single short tube of variable length. In one end is the slit and collimating lens, and at the other end the eyepiece which serves the purpose of the telescope. The dispersive system is contained between them and consists of a series of glass prisms, closely packed, alternate prisms being inverted. Their effect is to produce dispersion of the light without deviation, adjacent pairs of prisms exactly counteracting each other's deviation tendencies without cancelling their dispersions.



The formation of an atom.

Qualitative and Quantitative

The method of qualitative spectrum analysis is comparatively simple. The wavelengths of the observed lines are measured as they are received from the sample under test, and their values compared with those of lines which are produced from substances of known composition. The presence or absence of a substance in the sample can at once be inferred.

The procedure in quantitative analysis is not so simple, and as yet no complete theory has been advanced upon which a comprehensive system of quantitative spectrum analysis can be built. The general principle underlying the method is that the intensities of the lines are a measure of the amount of substance present, and by comparing the test spectrum with the spectra of a series of standard substances of known composition an accurate estimation of the contents of the sample can be made, provided there are sufficient standards available. The disadvantage of this method is that it is purely empirical and lacks the co-ordinating background of theory which is necessary to the advancement of any branch of physical science.

An Arc Discharge

The methods of spectroscopic analysis have been applied mainly to metallurgical problems for the clear reason that substances in the metallic state can be used as electrodes across which an arc or spark discharge can be directed. An arc discharge is a direct current discharge across the short air gap which separates the two electrodes. The spark is an oscillatory discharge and may be produced by introducing an inductance in the form of a coil, and a capacitance in the form of a condenser into the circuit to make up the familiar inductance-capacitance-resistance series oscillatory circuit which is of fundamental importance in wireless telegraphy. This discharge is the source of radiation which is characteristic of the substance of the electrode (the familiar green flash seen at the contacts between electric tram or train and the cable is the radiation characteristic of the copper of the contacts). The analysis of this light by means of a spectrometer supplies information as to the chemical nature of the electrode.

In the arc all the metals and in addition the five non-metals carbon, silicon, boron, phosphorus and arsenic reveal their presence by characteristic spectra. In the spark the range is even broader, and many of the non-metals, amongst them fluorine, chlorine, bromine, iodine, oxygen, nitrogen, sulphur and selenium can be detected as well as the metals.

Three Other Methods

In addition to the arc and spark processes there are three other general methods of exciting emission spectra, by flame, by vacuum discharge tube, and by the exploded wire method. The flame method, in which a salt of a metal is placed in the colourless coal-gas flame and the resultant luminous glow examined in the spectrometer, was devised by Bunsen in 1859. Its usefulness is limited, for only a few metals exist which produce flame spectra suitable for analysis.

In the discharge tube method the substance is in the form of a gas and is enclosed in a glass tube at a pressure sufficiently low to render it conducting. The application of a high voltage to the electrodes fused into the tube ends promotes a continuous passage of current through the gas which glows and emits radiation characteristic of itself. The brightness of this glow and the variety of colours presented by different gases are largely responsible for the wide use of gas discharge tubes for street illumination.

The exploded wire method is used when only a limited quantity of material is available and when it is in the form of a wire. Two or three centimetres of wire of diameter approximately 0.0015 cms. are sufficient. The wire is fused explosively by means of a sudden high voltage discharge from a battery of condensers, and the flash produced is received in a spectrometer and registered on a photographic plate. The method is highly sensitive and well rewards the patience and skill necessary to develop its technique, for as little as 0.2 per cent. of thorium and 0.005 per cent. of other impurities can be detected in a tungsten filament by this process.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 699, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

SPUN GLASS

"1. CAN you tell me where to obtain spun glass, similar to that used for sound insulating?

"2. Also where to obtain soluble rubber for moulding purposes?" (No Name, Cardiff.)

1. YOU will be able to obtain spun glass and glass wool for sound-insulating from either Messrs. Pilkington Bros., Ltd., St. Helens, Lancs, or Messrs. Butterworth Bros., Ltd., Newton Heath Glass Works, Newton Heath, Manchester.

2. We are not quite clear as to what you mean by "soluble rubber," since all varieties of pure rubber are soluble in one solvent or another. We would advise you to make your requirements known to The India Rubber, Gutta Percha & Telegraph Works Company, Ltd., 106 Cannon Street, London, E.C.4, or to Messrs. F. Reddaway & Co., Ltd., Pendleton, Salford 6, Lancs, both of which concerns supply all varieties of rubber and rubber preparations.

WHAT IS "THERMITE"?

"IN what proportions are the ingredients of 'Thermite' mixed. Also can you tell me something of its origin and to what uses it can be put?" (N. H., Nottingham.)

"THERMITE" is a mixture of aluminium powder and various metallic oxides, the proportions being more or less non-essential, so long as the aluminium powder remains in excess.

The thermite is fired by means of a fuse or a potassium chlorate mixture, whereupon an energetic chemical reaction is set up. The aluminium, having a great affinity for oxygen, abstracts that element from the metallic oxide, the result being that aluminium oxide is formed and the metallic oxide is "reduced" to the metallic state. Sometimes, during a thermite reaction, a temperature as high as 3,500° C. is reached.

The thermite reaction process is sometimes applied to the welding *in situ* of steel rails and other metallic articles, as, for instance, tramlines. So applied, it is sometimes known as the "Alumino-thermic" or "Goldschmidt's" process.

An analogous reaction can be worked with metallic sulphides mixed with aluminium powder, the final result of the reaction being aluminium sulphide and the free metal.

A BROMIDE EMULSION

"COULD you inform me as to the ingredients and quantities for making a bromide emulsion for photographic purposes, and ordinary sensitive paper?" (A. H., Merton, S.W.19.)

THE following is the formula for a negative emulsion of medium speed:

Potassium bromide	36 grams.
Potassium iodide	1·6 grams.
Nelson's No. 1 Gelatine	16 grams.
Hydrochloric acid	0·5 cc.
Distilled water	260 ccs.

Heat the above to 120° F. (49° C.) and add slowly and with constant stirring:

Silver nitrate	50 grams.
Distilled water	260 ccs.

Digest the above mixed liquids on a water bath for half an hour and then add:

Hard gelatine	65 grams.

Cool the emulsion and allow it to set.

This will give an emulsion suitable for slow and medium speed plates and also for bromide paper use.

The above emulsion may be speeded up by adding to it (just before its final cooling down):

Liq. ammonia (·880)	3·5 ccs.
Distilled water	25 ccs.

and stirring well for a quarter of an hour and finally allowing to stand for 24 hours.

Remember, of course, that during and after the addition of the silver nitrate solution, the whole of the emulsion preparation must be carried out in red light only.

Ordinary "sensitised" paper can be made as follows: Float good quality paper for three minutes on the following sizing bath:

Arrowroot	100 grams.
Ammonium chloride	60 grams.
Water	10 ozs.

The above bath should be used warm. Hang the sized paper up to dry and afterwards sensitise the paper by floating it for 3 minutes on a bath containing 40 grains of silver nitrate to each ounce of distilled water. This operation must be carried out in a red light. After it has dried, the paper is ready for use. It is toned in any ordinary gold toning bath and afterwards fixed as usual in hypo.

MAKING SOLDER

"1. WOULD you please tell me how to make solder (aluminium) that can be melted with an ordinary heated soldering iron?

"2. How to make printer's ink?

"3. I have placed some copper discs outside in the open. How long will they need to be exposed to the weather to get an oxide film sufficient to make a rectifier? I have two dozen discs." (A. S., Motherwell.)

1. BY your expression "solder (aluminium)" we take it that you do not refer to ordinary solder, which is an alloy or mixture of one part of lead and one part of tin, but to the so-called "aluminium solder" which is sold in small bars or ingots having a silvery appearance.

These bars constitute nothing other than a mixture of powdered aluminium, flowers of sulphur, and a little saltpetre, sufficient aluminium powder being added to disguise the presence of the other ingredients. The ingredients are melted up together at as low a temperature as possible, stirred well, and then cast into blocks, strips, or miniature ingots. This "solder" will melt at the touch of a warm iron and will successfully stop up holes in pans and other articles, but it has no strength and quickly deteriorates. Moreover, it is not electrically conducting to any extent.

2. The precise composition of many forms of printer's inks are maintained a close secret by their manufacturers. Essentially, however, such inks consist of a pigment (such as lamp-black) incorporated with a "drying" oil, as, for example, linseed oil.

You may experiment in the making of such inks by obtaining a quantity of thickened boiled linseed oil, dissolving a little powdered rosin in it by heating and, whilst hot, stirring into it a quantity of lamp-black or some other desired pigment. Stir the mixture continuously during its cooling

A model metre racing motor boat, "Streamlinia," doing 8 knots under test. This model was made up and described in "Practical Mechanics" last year, the parts being obtainable from Messrs. Bassett-Lowke, Ltd.

and then squeeze it through butter muslin or similar fabric into jars which are provided with well-fitting lids. If the ink is too thick, thin it down by reheating and the addition of more boiled linseed oil.

The making of printing inks at home is an exceedingly "messy" task, and, if the ink is only required in small quantity, it is usually cheaper and more satisfactory to purchase it ready made.

3. The oxide film on the copper discs of a rectifier is usually obtained by subjecting the discs to controlled electrolytical action, and you would not get reliable results by "filming" your discs merely by exposing them to the atmosphere. You might, however, obtain some interesting results with such weather-exposed discs, and an exposure of a week to the outside atmosphere and moisture will be sufficient to "film" perfectly clean and greaseless discs. You would get similar results, however, merely by passing the discs once or twice through the flame of a bunsen burner or spirit lamp.

A SURF BOARD

"**WOULD you please give me the following particulars for a surf board (adult size) suitable for beach work in North Cornwall:**

"**(1) Length, (2) width, (3) thickness, (4) curvature, etc." (J. R., Southampton.)**

1. LENGTH, 4 ft. 6 in.
2. Width, 2 ft.
3. Thickness, $\frac{3}{8}$ in.
4. Curved slightly upwards the first 12 to 18 in.; actual radius of the curve is not critical.

These boards are frequently made of six-ply wood, and if used, some means of clamping the plies together must be adopted when steaming prior to bending.

Masonite tempered pressed wood could be employed.

COMMERCIALISING SEAWEED

"**I SHOULD like to know the following:**

"**1. The method I could use for extracting iodine from seaweed, and the type of seaweed to use?**

"**2. What is the best profitable use I can make of seaweed, and are there firms that would purchase it from me." (T. S., Essex.)**

1. SEAWEED contains about 0·45 per cent. of iodine and, generally speaking, the weed obtained from deep waters contains more iodine than that derived from shallow waters.

In order to extract the iodine from seaweed, obtain several pounds of the weed, wash it well and dry it slowly in the sun. The dried weed must now be burnt in a shallow vessel, the greatest care being taken to keep the temperature as low as possible, otherwise the volatile iodine will be lost. The ash of the seaweed (known technically as *kelp*) is then boiled with water in order to extract all its soluble matter. The liquid is filtered and evaporated down to crystallisation point. The less soluble salts, such as carbonates, sulphates, and chlorides, crystallise out, leaving the iodides in solution. The liquid is carefully drained away from the crystals, mixed with concentrated sulphuric acid and distilled. Iodine is liberated and passes over in the form of a rich violet vapour, which condenses in a suitable receiver.

Conducted on a small scale, the yield of iodine obtained from the above extraction process is very small. Even when commercially worked, it is seldom possible to obtain more than 20 lb. of iodine per ton of dried seaweed.

2. Dried seaweed is used as a manure and also for sound-insulating purposes. Much of the seaweed supply comes from abroad, but it is probable that one of the subsidiary companies of Imperial Industries, Ltd. (Millbank, London, S.W.1), would be prepared to consider offers of good-quality seaweed, provided that a sufficient quantity was available.

AN OUTBOARD HYDROPLANE

"**I AM proposing making an outboard hydroplane hull. The dimensions are as follows:**

"**Length, 14 ft.; beam, 4 ft. 6 in.; stepped, 4 in., 6 ft. from the stern.**

"**The proposed materials are:**

"**Keel, 4 in. by 2 in. ash. Framework, 1 in. by 1 in. ash with mahogany bulkheads. Transom and step, $1\frac{1}{2}$ in. mahogany.**

"**1. Is ash a suitable wood for this type of boat? If not give an alternative?**

"**2. Is plywood a suitable covering (with view to lightness)? If so, what thickness would give a reasonably strong job, but at the same time keeping the weight to a minimum?**

"**3. If the above wood dimensions, etc., are unsuitable could you give a revised list, and also the titles of any books on light boat-building from which useful information might be obtained?" (R. F. P., Catford.)**

1. YOU will find ash very heavy when used in such sizes as 4 in. by 2 in., as the weight is approximately 44 lb. per cubic foot. Oregon pine could quite well be used here which weighs only 33 lb. per cubic foot.

You would not however improve on ash for the frames.

2. Plywood is suitable if waterproof. A special grade of this is made for marine work; $\frac{1}{4}$ in. would be the size, provided your hull is well framed. A more suitable method, however, is to use British Borneo mahogany, $\frac{5}{16}$-in. planks, which is very light.

Both waterproof plywood and this special mahogany which is very cheap can be obtained from Messrs. J. Williams & Son, Ltd., Timber Merchants, Christchurch Road, Collier's Wood, S.W.19.

3. The dimensions seem correct. We suggest you use Borneo mahogany for your bulkheads and step as well, as you will save considerable weight; it is cheaper than Honduras, easy to work, and durable.

A book which will give you considerable information is available and we shall be glad to advise you concerning this.

A LIGHT SAILING-BOAT

"**I HAVE built a light sailing-boat (to my own design), 12 ft. 9 in. in length, beam 3 ft. 3 in., and a depth of 1 ft. 2 in., with a centre-board keel weighing approximately 50 lb.; the weight of the hull is approximately 120 lb. (excluding the keel), and I shall be glad to know if you can inform me what size and type of sail or sails will be most suitable for this boat. I have no plans, as these were drawn full-size and used for shaping the moulds, etc., but I enclose a photograph showing the hull partly completed, which will probably give you some idea of the shape. Also can you give me the name and address of any firm who would supply either canvas for making the sail, or the sail ready made?" (R. Jones, Lincs.)**

THE actual design of a sail plan for your boat is a matter rather beyond the scope of these Inquiries, but the following information should be of assistance.

Judging from the photograph and details given a Bermudan rig would be most suitable. Use a mainsail 12 ft. 6 in. along the vertical edge or luff and 9 ft. 6 in. along the foot, and a foresail 9 ft. 6 in. vertical, 3 ft. horizontal; both sails of course are tri-sails.

The actual position of the mast must be determined by experiment, as it will be necessary to get the centre of sail effort slightly aft of the centre of lateral resistance of the hull, otherwise the boat will not come up into the wind for a turn. If the mast is to be fixed through the decking, the correct sail balance may be obtained by setting the foresail out on a short bowsprit if the boat tends to come up into the wind too much, or reducing it or enlarging the main if the boat refuses to come up into the wind.

A Bermudan rig is suggested, as the main effort is low down, minimising reeling. Thus it will be as well to make the mast (which can be quite a light one) a foot longer than needed for the sail recommended.

The main sail may be enlarged by adding a strip down the leech.

We do not recommend canvas for such sails. Get union silk, obtainable at any large drapers; it is much lighter and the sail will fill more rapidly in light winds.

Sail makers who would do the work are Sea Services, Ltd., The Quay, Poole.

WEATHER QUERIES

"WOULD you please state the following:

"1. The wettest month on record?

"2. The wettest day on record?

"3. The dates of the extremes of temperature to apply to the Stamford or Peterborough area?

"4. Could you please inform me of some method of preventing sparking at the breaker points of a 'Bunch Mighty Midget,' 6-c.c. aero petrol engine? I have tried cleaning the points with both glasspaper and petrol. Would altering the gap of the points be any good?" (G. K., Lincs.)

THE nearest station to Peterborough for which the information you require is readily available, is Cambridge. The data for that station are as follows:

Wettest month on record: August, 1912, 183 mm.

Wettest day on record: August 2nd, 1879, 81 mm.

Maximum temperature: August 9th, 1911, 96° F.

Minimum temperature: April 8th, 1879, 0° F.

The best method of preventing sparking at the breaker points of a "Bunch Mighty Midget" 6-c.c. aero petrol engine is to fit a condenser having a larger capacity, ·01 mfd. as used for wireless.,

BUILDING AN ICE BOX

"HAVING been asked to build a small ice box of brick and lined with zinc for storing fish, I should like to know of a good insulator to go between the bricks and zinc, or if it is possible to install a small ammonia plant, and where can I obtain one." (I. M., Canning Town, E.16.)

QUITE a good degree of heat insulation may be effected in the construction of your ice box by sandwiching a thick sheet of asbestos between the brick walls and the zinc lining. A still better degree of insulation may be obtained by allowing a space of two or three inches between the brick walls and the zinc lining. An asbestos sheet is placed in contact with the zinc wall and another sheet of asbestos in contact with the brick wall, the space between the two asbestos sheets being filled with loosely packed dried seaweed, clean straw, or asbestos wool. In such a construction, the upper edges of the zinc sheet will be turned over towards the brick wall in order to seal off the insulative packing.

It is quite possible to install a small ammonia refrigeration plant, but unless fairly large quantities of perishable material are required to be stored continually, it is open to question whether the expense and upkeep of the ammonia plant would be justified. At the same time, the matter is worth investigating. You will be able to obtain all technical information concerning the installation of an ammonia refrigeration plant from either of the undermentioned firms: Messrs. Lee, Howl & Company, Ltd., 73 Queen Victoria Street, London, E.C.4; A. S. Refrigerating Machines, Ltd., Magnet House, Kingsway, London, W.C.2.

A MOTOR-POWERED DINGHY

"BEING interested in speed boats I would be pleased if you would help me on the following:

"1. What licence is required on the Thames for a motor-powered dinghy 10 ft. long (4 ft. beam)?

"2. How can I fit a 250-c.c. 2-stroke engine in the above. Can you inform me how the stern shaft and propeller shaft are connected?

"3. Is it possible to have a reverse gear of some sort fitted on the dingy?" (No Name, Shepherd's Bush.)

1. YOU do not state on what part of the Thames it is proposed to use the boat. Below Teddington Lock the river is under the control of the Port of London Authority and no licence is required.

Above this point the river is controlled by the Thames Conservancy Board, to whom all inquiries of this nature should be sent. The address is 2/3 Norfolk Street, London, W.C.2.

2. In the absence of a diagram of your engine it is not possible to furnish a drawing of how to fit it, as the position of the bearers will depend on the holding-down lugs on the engine itself.

The usual method is to fit two wooden bearers running fore and aft parallel to each other and the width of the engine apart. The engine rests on these in such a manner that the holding-down lugs can be bolted to them.

Your inquiry does not state the type of engine to be used; if it is a proper marine engine the lugs will be cast across the crankcase in such a manner that they are the widest part of the engine, thus they sit on the bearers and can have bolts or coach screws passed through them, the crank-case being suspended between the bearers.

If, however, the engine is a converted motor-cycle type made to fit in a frame, you will have to have special brackets made for it to convert it to the orthodox type.

3. The propeller shaft is connected to the engine by means of flanged joints on each shaft which are bolted together.

4. The best way for you to get a reverse gear is to fit a reversing propeller. This also gives a neutral position and allows the pitch to be varied, having the effect of a variable gear; thus it is not so important to get exactly the right size and pitch propeller. Messrs. Wortham Blake, Whetstone, London, N.20, make these propellers complete with stern fitting and control. They are easy to fit and cheaper than a reverse gear with solid propeller. This firm will supply all details on request.

CONJURING WITH CIGARETTES

(Continued from page 33)

at the beginning of this article, to present to the gentleman who lent you the cigarette at the beginning.

The Broken Plate

The method used for the broken and restored plate trick to which I referred in last month's article is essentially the same as for the card, but as of course the pieces of plate cannot very well be burned, they are vanished by some other means. One of the trick boxes described in a previous article of this series serves admirably for this purpose.

My own method of beginning the broken-plate trick is as follows. I have a plate already in my trick frame. This plate has had a piece carefully broken out of it by gouging a groove in the china with an old file and tapping round the groove with a hammer until the piece breaks away. This piece I hold in my left hand, behind another whole plate of the same pattern. I break the plate by giving it a blow with a hammer and all the fragments fall to the floor, leaving me with the odd piece broken from the other plate. To the audience it appears that I have broken the plate and kept the part of it I was holding it by.

Finally, here is a useful piece of apparatus which, although not necessarily exclusively a cigarette trick, is very useful in connection with such tricks. It takes the form of a small metal canister, and can reasonably be referred to as a tobacco-jar. Any article placed into the jar can be made to vanish or turn into something else. For instance, a heap of loose tobacco and some cigarette papers can be magically converted into a number of cigarettes. Or several cigarettes can become a cigar. The jar can also be used to change the colour of handkerchiefs, by substituting those of one colour for some of another and for various other changes.

The Jar

Reference to Fig. 13 will show the construction of the jar. It is composed of two main parts. One is a canister shaped something like a bottle with a neck at each end. This has a partition across the middle dividing it into two equal parts and a lid fitting on either end. The other part is a plain cylinder sliding easily but not loosely over the double-ended canister. This cylinder is of such length that when the canister is stood on either of its lids, the cylinder reaches up to the shoulder, thus giving the appearance of an ordinary jar with a bottle-shaped neck.

It will now be seen that anything placed in one part of the canister can be secretly changed to whatever is in the other part by the simple process of pushing the double-ended canister through the cylinder. The edges of the cylinder should be turned in slightly to prevent the canister going too far. Fig. 14 shows the change being made. It can be done under cover of turning to place the jar on a table, or the jar may be wrapped in paper or covered with a cloth, which will form ample screening for the movement. Either way up, of course, the jar presents exactly the same appearance, but the presence of the narrow neck counteracts any idea that the spectators might have of the canister having been turned upside-down.

PHOTOMICROGRAPHS WITHOUT A MICROSCOPE

(*Continued from page* 13)

of medium speed. Slow plates, despite all statements to the contrary, do not produce the best results, since they give images which are too hard and detailless. As a matter of fact, provided that exposure times can be estimated accurately, the very fast plates are the most suitable for the majority of photomicrographic subjects, for they render all detail and do not give blocked-up highlights.

Developing

Develop the plates with an ordinary metol-hydroquinone developer, used in somewhat diluted condition and print the negatives on glossy paper. If, subsequently, the prints are glazed, photomicrographs of exquisite detail will be obtained.

The beginner in this absorbing branch of photography must not be disappointed if he does not get first-class results first time off, so to speak. More than in any other branch of photography, the art of photomicrography is one calling for patience and experience. These factors, however, are quickly gained, as the amateur who puts into practice the instructions contained in this article will rapidly realise.

TRANSMITTING MATTER THROUGH SPACE

(*Continued from page* 16)

are, in a sense, merely " half-smells " and could, no doubt, be transmitted similarly.

Transmission of Smell

In the electrical transmission of smell, all we should have to do would be to place the odoriferous material in an apparatus which transmitted not the material itself, but rather the tiny " smell particles " which it evolves. This feat should surely be less formidable than that of transmitting the material itself and, no doubt, it may be accomplished by one means or another in the not too distant future.

But what, you may ask, is the use of transmitting smell or taste ?

They asked the great Faraday a similar question when he showed them his first dynamos. We know now the use of a dynamo. Who shall say, therefore, that a century hence, when electrical science has mastered the principles of taste and smell transmission and is feeling its way towards the more important and spectacular feat of transporting matter itself by cable or radio, that these facilities, which nowadays smack somewhat of the trivial, will not have developed many important applications in everyday life and have become as much an adjunct of civilisation as is the present-day wireless transmission and reception of sound ?

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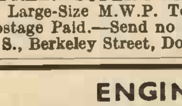

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