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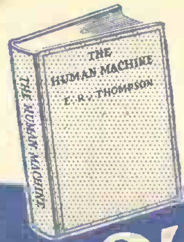

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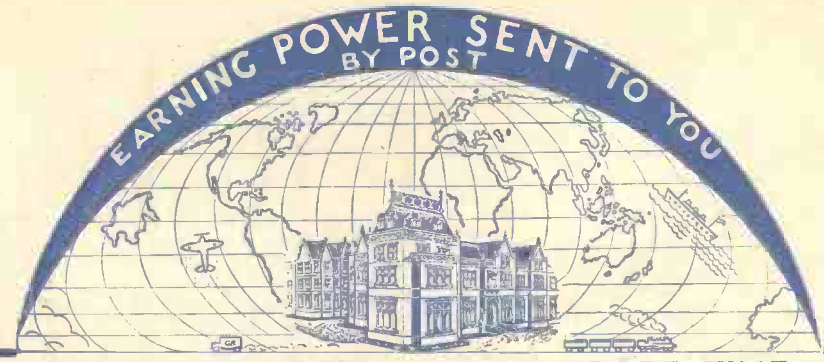

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OPEN LETTER TO PARENTS

Dear Sir or Madam,—When your children first arrived they brought with them a wonderful lot of sunshine. Later you became proud of the intelligence they displayed, but still later you became anxious as to what would become of them in the future. Perhaps you were anxious when you visualised them as grown men and women. Even with plenty of money it is not always easy to select the right career, and a parent is sometimes inclined to ask advice of some relative and in ninety-nine cases out of a hundred that relative knows nothing at all about the possibilities of employment. Why not let me relieve you of some of your anxieties? In fact, why not let me be their Father? We do not profess to act as an employment agency, but the nature of our business compels us to keep an eye upon the class of men and women that are wanted and who wants them. There are some people who manufacture an article and put it on the market to sell. We do not do that, we work in exactly the opposite direction. We find out what employers want and we train our students to fill those jobs. We have to be experts in the matter of employment, progress and prosperity. If you have any anxieties at all as to what your sons and daughters should be, write to me, or better still, let them write to me personally—Fatherly Advice Department—and tell me their likes and dislikes, and I will give sound, practical advice as to the possibilities of a vocation and how to succeed in it. Yours sincerely.

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TO STUDENTS LIVING ABROAD

or on the high seas, a good supply of lessons is given, so that they may be done in their order, and despatched to us for examination and correction. They are then sent back with more work, and in this way a *continuous stream of work* is always in transit from the Student to us and from us to the Student, therefore distance makes no difference.

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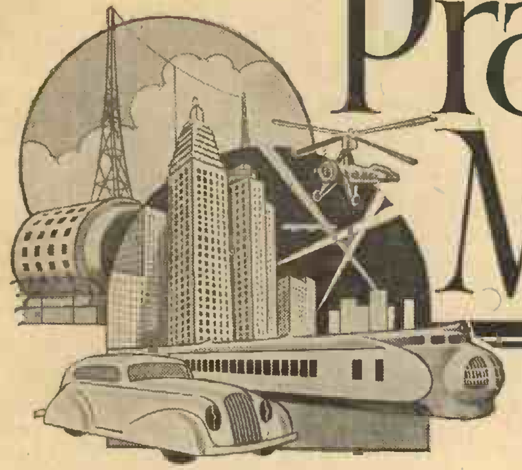

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Notes, News, and Views

A Radio-controlled Farm Tractor

FROM Chicago comes the news that the International Harvester Co. have produced the first radio-controlled farm tractor. The farmer can, from a distance, by means of radio-control equipment, start and stop the tractor, make it turn to the left or right, or can make it run backwards.

Speed on Rails

DRAWING four coaches and a dining car, a locomotive has attained a speed of 125 m.p.h. on the Berlin-Hamburg route. This speed was reached during a trial run.

Cars Without Petrol

WE learn that a Polish engineer has invented a new engine for motor cars, which will run on all types of fuel, including alcohol, vegetable oils, crude petroleum, and petroleum waste. This is, of course, not new, as methods of enabling cars to dispense with petrol were successfully tried out in England in 1932.

Wood Like Rubber

THERE seem to be no end to the uses to which wood can be put. We have had wood alcohol, silk from wood, and the Germans claim to have invented a wood motor fuel and even a form of chocolate from wood. Experimenters at the Forest Products Research laboratories now claim that wood can be made flexible, like rubber. This has distinct possibilities.

A Mobile Telephone Exchange

A POSTAL van equipped as a telephone exchange is now used in France for the benefit of the Press. The van can be moved from place to place as the occasion demands, and connection made between it and the local exchange.

Some Drink!

A BRONZE cup weighing 36 tons and having a diameter of 40 ft. has now been placed into position at the crown of a new fountain built in the Piazza de Ferrari in Genoa.

A "Flying Spindle"

CLAUDE DORNIER, the famous aircraft designer, has recently patented a flying vessel, which he describes as a "flying spindle." It has a long rotor, which is maintained at a high angle of incidence, gives lift as well as tractive power, the ratio of which is controlled by varying the angle of flaps on the rotor wings, as well as by the plane on the empennage.

Seeing Through Fog

IT is stated that a London electrical engineer has invented an electric eye that sees through the densest fog. It is an electromechanical device, which picks up through any atmosphere the invisible infra-red rays of light, turns them into electrical vibrations, magnifies them millions of times, and reproduces them on a opalescent screen in the form of visible light.

Bronze-coloured Aluminium

A NEW metal, eloxal, described as bronze-coloured aluminium, was recently shown in Berlin. Eloxal is oxidated aluminium, produced by electrolysis. It can be manufactured in three colours—silver, canary yellow, and bronze.

Transmutation of Metals

AN electro-magnet weighing 58 tons has just been acquired by Columbia University, where it is to be used on atomic research. Protons and neutrons will be introduced into its intense magnetic field and by means of an electric installation giving 20 million volts it is expected that the disintegration of the heavy metals, gold, silver, and lead will be possible. It is anticipated that the artificial production of radioactive metals more powerful than radium, and much less costly, will result from these experiments.

A Non-recoil Anti-Aircraft Gun

A GUN that will fire 30,000 ft. upward, and 150 shots a minute, yet with so little disturbance of aim, that a glass of water could be balanced on it while it is firing, has been produced in America.

A New Mercury Switch

A NEW type of switch has been produced in which the contacts cannot work loose. A stream of mercury makes or breaks a contact, practically without friction or wear.

A Portable Radio-gramophone

IT is now possible to obtain a portable radio-gramophone incorporating a record changer. The receiver has a 4-valve (plus rectifier) A.C./D.C. chassis, with the usual four controls, and is housed in a cabinet measuring 20½ in. by 14 in. by 10 in., covered in real leather. An aerial is included in the cabinet.

Dazzle-proof Glass

GLASS that you can see through, but which will not give a dazzling reflection, has been made from cellulose acetate, in America. It is already available for photographic filters, whilst applications to other uses will be speedily forthcoming.

Materials for the Engineer

THE continual discovery of new alloys and materials renders the task of a designer a very difficult one. A few years ago one could think of a motor-car engine as mostly cast iron and nickel steel, or an aircraft engine as being mostly composed of duralumin. In the new "Pegasus" engine now being produced by the Bristol Aeroplane Company, however, there are no less than seventy different alloys and materials used in its construction.

A "Foolproof" Aeroplane

MR. H. S. CAMPBELL, an American, has produced a design for a small 'plane, which is said to be capable of travelling at 125 m.p.h., on five gallons of petrol. The propeller is at the rear, the engine self-starting, like a car's, and the total weight of the aeroplane is given as 1,200 lb.

Burning Its Own Smoke

TO save coal, Vienna railway experts have designed a two-storey locomotive which circulates the fumes from the stack through the firebox. A 20-per cent. saving in coal is claimed.

Wireless in East Africa

EXPERTS of the Air Ministry and the Marconi Company have been visiting Mombasa recently, discussing with officials the site for a powerful wireless station. In addition to the wireless station, which will have directional and position-finding apparatus working on medium and short wavelengths, Mombasa is to have a meteorological bureau which will gather data as to upper-air wind strengths and other data of importance from a flying point of view.

Building the "PRACTICAL MECHANICS" Outboard Speedboat

An Easy-to-Build Speedboat, the Parts for which Cost not more than £15. A Second Article will Appear Next Month

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THE method employed in building this craft is technically known as seam batten carvel, that is to say, the planks do not overlap as in the clench-build method, upon which most small craft are built.

In this method the planks butt edge on, but owing to the thinness of the material, it is not possible to caulk them as would be the case in larger craft.

The seams are therefore rendered water-tight by means of a batten running along them inside the boat, and to which the edges of the planks are nailed. This is known as a seam batten hence the term seam batten carvel construction.

The craft unlike a round bilge clinker boat is not built on moulds and subsequently timbered, but is built up on a series of simple frames.

Although falling into a class of craft known as the flattie, this boat is given a flare on its sides forward, and a tumble home stern which makes it resemble orthodox launch practice. The bottom too is curved in a direction fore and aft.

The first job to be taken in hand will be the frames, of which there are six, and numbered consecutively from bow to stern. The frames are made in three simple parts, namely two side members and one floor member.

The sides are made from $2\frac{1}{2}$ in. $\times$ 1 in. mahogany and the floors 2 in. $\times$ 1 in. of similar material. The construction of these frames is a straight forward job, but calls for accuracy and care.

The Side Members

The side members are screwed to the side of the floors with brass countersunk head screws, $1\frac{3}{4}$ in. long and number 8 gauge.

Before assembling them however, it is as well to paint the surfaces which touch in order to preserve them and eleminate rot.

From the drawings of these frames, it will be noticed that the sides are not at right angles to the floors, but at varying angles according to their position. To adopt a square frame would result in a box like contraption, unsafe and unworthy of the name boat.

Reference to the drawings will also show that these frames are notched out at various points, and it is here that the builder must be most careful to follow the plans, for the ease with which the boat can be subsequently assembled, and its ultimate shape will greatly depend on the care exercised at this juncture.

Fig. 1.—Showing the motor, rudder bar, and propeller assembly.

Fig. 6. shows the first or No. 1 Frame which can be assembled and notched in accordance with the drawing, after which the other frames can be taken in hand, great care being exercised in getting the angles of the side members correct, which, of course, will automatically set themselves if the width at the top and bottom of the frame are correct.

In setting these side members, it must be borne in mind that the dimensions of the top and bottom of the frame can be correct, and still have the angles wrong, if the structure is, as it were, "askew."

To prevent this, it is as well to tack a batten on to the floor member at its centre and at right angles, and measure from this. To make sure that the angles are correct, it is obvious that each side of the batten will produce equal dimensions, thus we are working virtually in half-breadths, which is really the customary way, in the boat building industry, of showing dimensions which refer to the beam or width of a boat.

Fig. 5 shows how this is done, and also shows a simple way to make the frames up without error. It will be noticed that owing to the angles made by the side members with the floors, the ends of any of the pieces used, are not square, and therefore to avoid the necessity of marking off all these angles which differ with each frame, it is better to use pieces of timber a few inches longer than necessary in the following manner.

The Floor

On the floor member mark off the bottom dimensions, which in the case of frame No. 1, is 1 ft. $2\frac{1}{2}$ in. Mark this off in two half-widths of $7\frac{1}{4}$ in. each from a line marked on the exact centre of the piece of timber. It will now be possible to erect your temporary

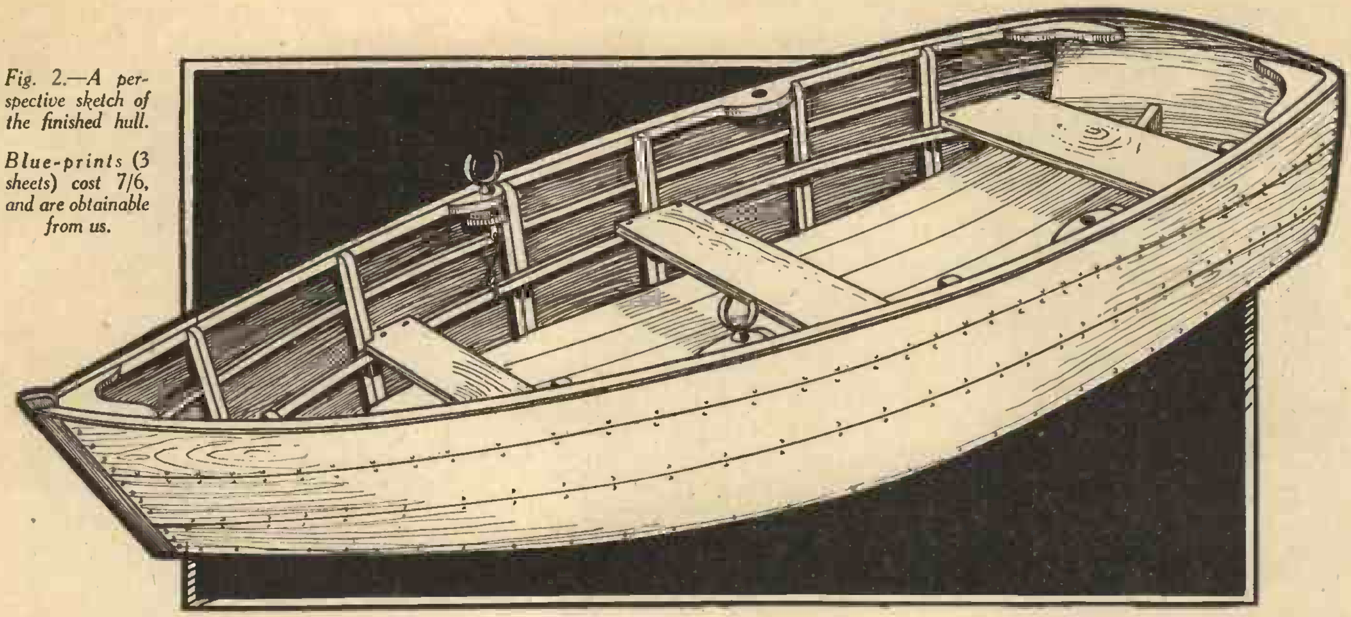


Fig. 2.—A perspective sketch of the finished hull.

Blue-prints (3 sheets) cost 7/6, and are obtainable from us.

guide batten at right angles to the floor, and centrally on this line. Next lay the floor member and its batten flat on the bench or other level surface, and mark a point up the batten equal to the depth of the frame, measured, of course, from the extreme bottom of the floor member, which again, in the case of Frame No. 1, is 15 in. Now tack another batten with its lower edge on this line, at right angles to the vertical batten, and, consequently horizontal to the floor member. If you measure along this batten the width of the frame on top, which it will be seen is 1 ft. 6 in., again working in half-breadths, and mark these points with a pencil, it is obvious that the outer edge of the side members must cut these pencil marks. In the case of the floor, however, the outside edge of the side batten should cover up the pencil mark except just at the bottom edge, whilst at the top, the edge of the side member should just touch the part of the pencil mark on the lower edge of the cross batten (see Fig. 5).

The side members may now be screwed on to the floor, and any surplus timber sawn off.

This procedure is perhaps a little difficult to grasp, but a little study will show that it can be applied to all the frames irrespective of their angles, and avoids the necessity of complicating the drawings by giving the angles for each piece of timber used.

In Fig. 5, the notches are, of course, left out so that the construction can be clearly seen. In putting in the screws, care must be taken to see that they are not in the way of the chine slot on the extreme corners.

Figs. 8 to 12 show the remaining five frames in which the principle of construction is the same, but the dimensions of slot positions and angles differ in each case, so that the drawing's must be carefully studied to avoid error.

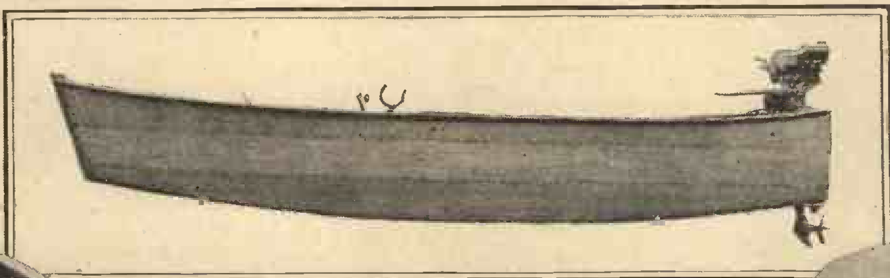
The frames, after construction may be numbered and laid aside, although a little more work will have to be done on them later on.

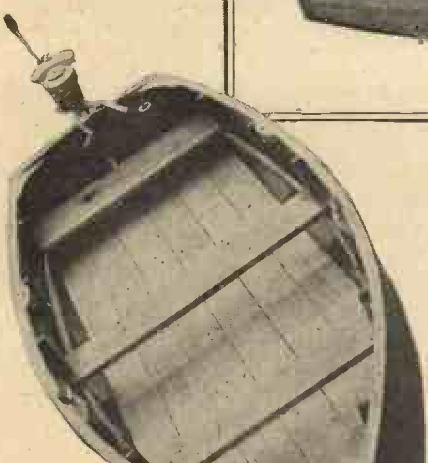
Should the builder consider the method of constructing the frames a little complicated, an alternative method is to prepare cardboard patterns, made full-size from the drawings, and set the frames up to these. There is, however, the risk of the patterns themselves getting out of truth by cockling or bending unless the material be very stout. This method involves a little added labour, but, is, of course, simpler.

For this part of the work, we shall require 17 ft. of $2\frac{1}{2}$ in. × 1 in. mahogany planed finished size. This can be purchased in two lengths each 8 ft. 6 in., but it would be better to have 2 ft. 9 ft. lengths to allow for split ends. This timber is, of course, for the side members.

For the floor members we shall require 20 ft., or two 10 ft. lengths of 2 in. × 1 in. mahogany (planed sizes).

For fastenings, we require 36 brass counter-sunk head screws, $1\frac{3}{4}$ in. long, No. 8 gauge but since we shall require more of these later on, it is as well to purchase a gross packet.





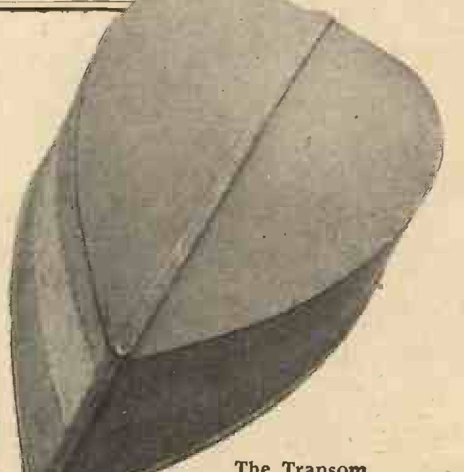
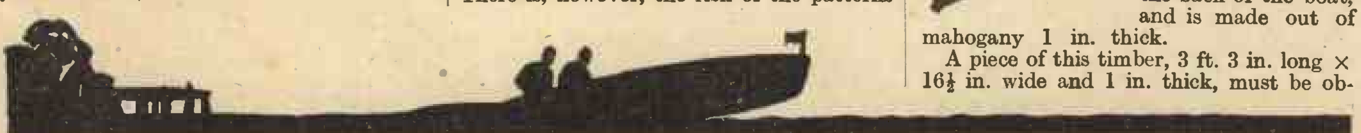


Fig. 3.—Three views of the finished boat—top, side, and bottom.

The Transom

The transom forms the back of the boat, and is made out of mahogany 1 in. thick.

A piece of this timber, 3 ft. 3 in. long × $16\frac{1}{2}$ in. wide and 1 in. thick, must be ob-



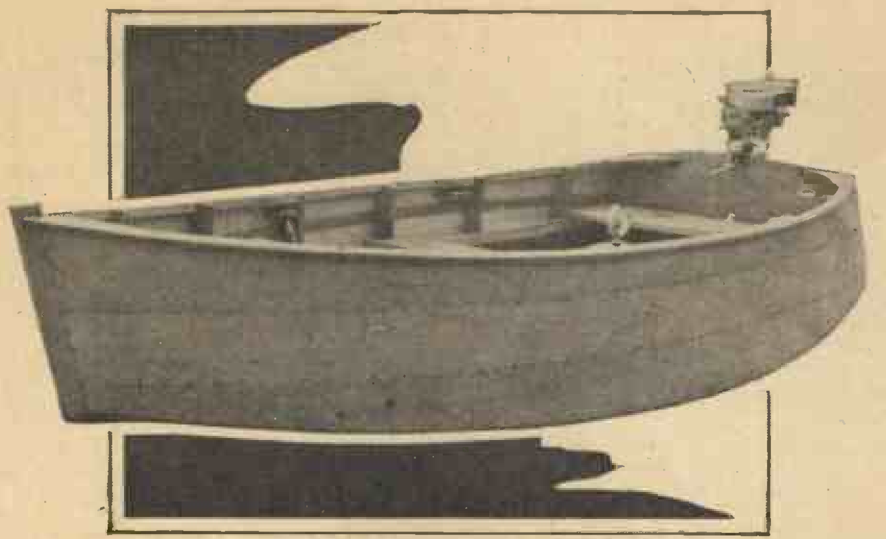


Fig. 4.—*A further view of the completed boat, showing its attractive lines.*

tained and squared up to these dimensions, and is represented in Fig. 13 by the rectangle *A B C D*.

Now all sides of the transom are curved, but fortunately the radius of the curve is not of vital inportance within reasonable limits.

Proceed to draw the line *E F* 1½ in. from the bottom edge. This will be the chine line.

Next draw the line *G H* 1 in. from the top edge, and the vertical line *H I* down the exact centre of the plank.

Starting at the point *J* where the vertical line cuts the lower horizontal one, mark off half the width of the transom which will be 19 in. (half of the total 38 in.) and mark the point *L*. Similarly mark off the other half marking the point *M*, then the line *L M* will represent the total width of the transom at this point which, of course, is 38 in.

Deal in a similar manner with the line *GH*, working from the point *K* outwards in two half-breadths of 15½ in., marking the extremities *N* and *O* respectively.

The Curved Bottom

You can now proceed to sketch in lightly, n pencil, the curved bottom, proceeding from the point *I* outwards to *L* and *M*, taking care to get each side the same and a gentle regular curve.

It is a good plan to do one side first then make a paper template from tracing paper, and transfer it to the other side.

Deal in a similar manner with the top curve which it will be noted is flatter in the centre and falls off quickly at the ends.

The side curves are similarly marked out after marking a point *P* and *Q* on each line *NL*, *OM* at its centre, and drawing a line 1 in. long at right angles to them extending outwards, the ends of these lines represent the points through which the curve will pass.

If a template be used (which for these curves is strongly advised), only one side need be so measured.

When you are quite satisfied that your curves are regular, pencil them in distinctly, and proceed to saw round them thus producing your transom. The edges may then be planed up true and smooth with a small sharp plane.

The transom is however by no means finished, for we must provide some means of housing the ends of all the seam battens, chines and gunwales without cutting into, and weakening the transom itself.

This is simply accomplished by framing the inside of the transom with 2½ in. × 1 in. mahogany, and shaping the outer edges to conform with it.

It is then slotted out in accordance with the drawing, Fig. 14, which should make matters quite clear.

What we have really done is to incorporate a seventh frame with the transom.

It should be noted that the slotting is only done in the frame work and not the transom itself.

The framing should be securely screwed to the transom with 1¾ in. No. 8 screws as used for the frames.

As shown in the drawing the side framing is only carried up as far as the line *GH* which corresponds with the line *GH*, Fig. 13.

Apart from housing the rails and battens, this framing greatly strengthens the transom and doubles the thickness of the edges

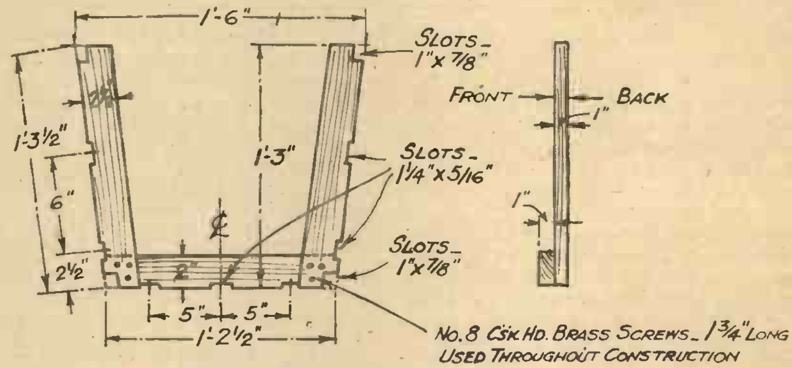


Fig. 6.—*A front view of frame No. 1.*

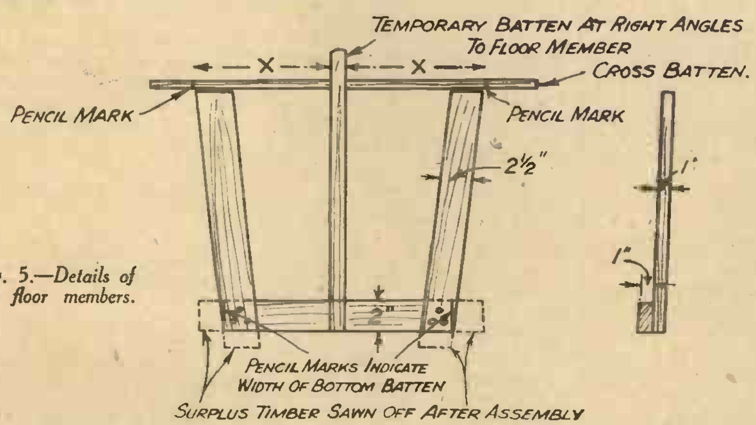


Fig. 5.—*Details of the floor members.*

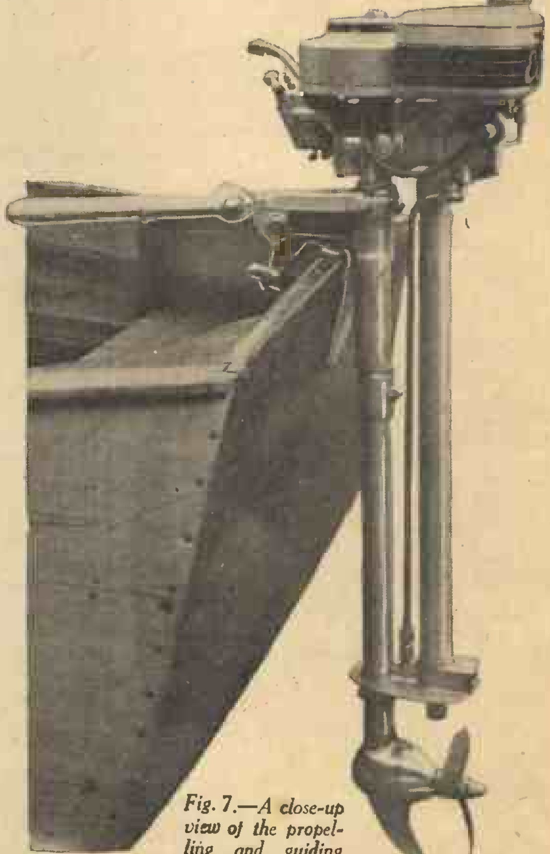


Fig. 7.—*A close-up view of the propelling and guiding mechanism.*

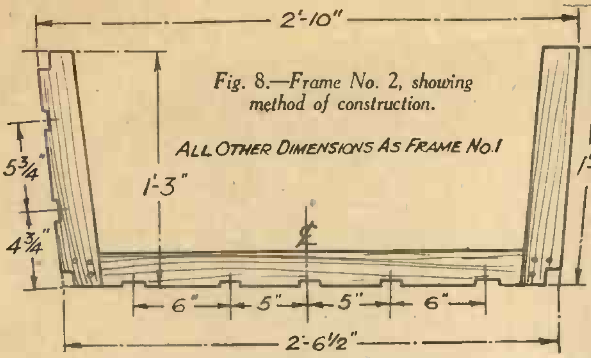


Fig. 8.—Frame No. 2, showing method of construction.

to which the planking ends will ultimately be secured.

For the framing a further piece of mahogany $2\frac{1}{2}$ in. × 1 in. × 6 ft. long should be provided.

The Stern Post

This is made from 2 in. × 2 in. oak, and the usual method of construction and the one employed by professionals is to rabbet the side grooves into the solid piece, but it is thought that this method is likely to produce some difficulties to the amateur boat-builder, and to introduce even further difficulties when it comes to slotting out the spaces for the battens, etc., which would have to be done on the rabbeted portion.

We shall therefore deviate at this point from standard practice and construct the stern in two parts. The second part being put on after assembly.

The method too is stronger for this class of boat and allows a better landing for the plank ends.

Obtain a piece of good straight oak, 2 in. × 2 in., × 17 in. long, and square up the ends, and referring to Fig. 16, proceed as follows.

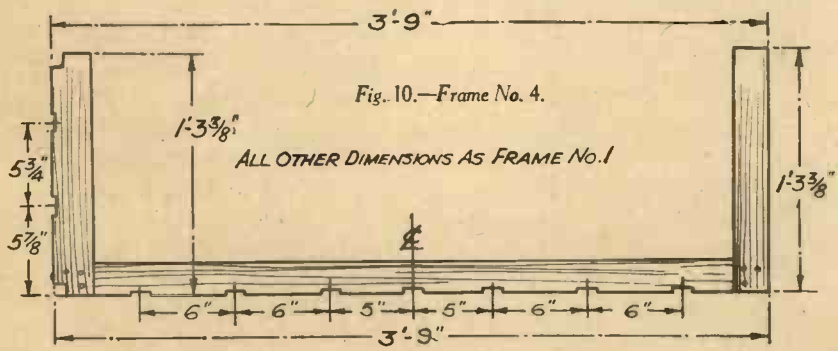


Fig. 10.—Frame No. 4.

On the end mark the line AB which joins diagonally opposite corners, then draw CD parallel to it, but $\frac{1}{4}$ in. distant from it. A line on each side of the timber can be carried down from the points C and D, and the post is then sawn down vertically along this line, which will have the effect of splitting the post in two parts lengthwise. Next mark off the line E F which is $\frac{1}{4}$ in., and plane off this corner. Now round off the corners A B when the resulting post will resemble Fig. 17. The other piece cut off is not wanted.

The sawing operation is somewhat tricky, and if the builder doubts his ability to cut this straight he can cut clear of the line into the waste part, and finally finish off with the plane.

The post will of course have to be slotted for the battens, etc., but we shall do this after the job has been temporarily set up.

Having got our frames, transom and stern post made up, we can temporarily set them up in order to obtain other dimensions which can only be accurately obtained in this manner.

Setting Up

For this operation we shall require a springy batten of wood, ordinary deal will do, 2 in. wide and say $\frac{5}{8}$ in. thick, about 11 feet long. We shall also require a wooden block about 1 ft. long and 5 in. wide, about 2 in. thick, also another one 1 ft. long, 4 in. wide and 2 in. thick.

Provided with this timber and referring to Fig. 18, proceed as follows.

On the 2 in. surface of the batten, mark the line A 3 in. from the end, then $9\frac{1}{2}$ in. from this the line B, follow on with the lines C, D, E, F, G, which are spaced 1 ft. 6 in., and finally the line H which is 1 ft. 2 in. These lines represent the positions which are occupied by the stern, frames, and transom.

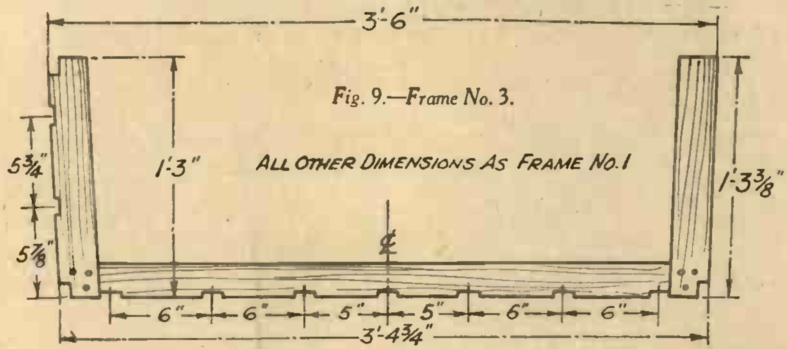


Fig. 9.—Frame No. 3.

Now clear a space on the workshop floor, and lay the batten down face up with the lines showing, and place the 5 in. block under the mark A.

Next measure a point on the batten midway between the two blocks, and at this point, and with the aid of a stout batten of wood or pole, shaw the batten down by wedging the pole or batten between this point and the roof of the workshop. Fig. 19 should make this quite clear.

The curve taken up by the marked batten is approximately the fore and aft curve or sheer of the bottom of the boat.

If the workshop floor is of wood it is as well to nail the two blocks down to it.

The next operation will be to get the stem post in position temporarily, and since this does not occupy a vertical position relative to the bottom it must be suitably shaped. In Fig. 15, it will be seen that the stem leans forward or overhangs and the extent of this overhang can be seen by the dimensions given. To thus prepare the post, cut the bottom off at an angle which when placed on the batten allows the post to overhang approximately the required amount. This is best done by making the angle slight at first, and then truing it up, increasing the angle but cutting away more wood until it is correct, when it can be temporarily fixed to the batten by a screw passed from underneath, which can be done by either removing the shaw or springing the batten up.

The correct location of the stem post will be when its rear edge is along the line A, the small edge, of course, facing forward.

The transom may now be set up in a similar manner, and it will be noticed that this also overhangs, but not to such a great extent as the stem post.

This is, of course, mounted centrally over the mark, so that the mark lies in the joint between the transom itself and its framing, needless to remark the batten must pass under the exact centre of the transom, and the centre batten slot will act as a guide here.

In order to get the angle for the overhang, the bottom of the transom must be bevelled with a plane, this bevel being carried right along the bottom from side to side as shown in Fig. 20. The transom may be temporarily secured by a screw in a similar manner to the stem post, but owing to its weight it will have to be supported by

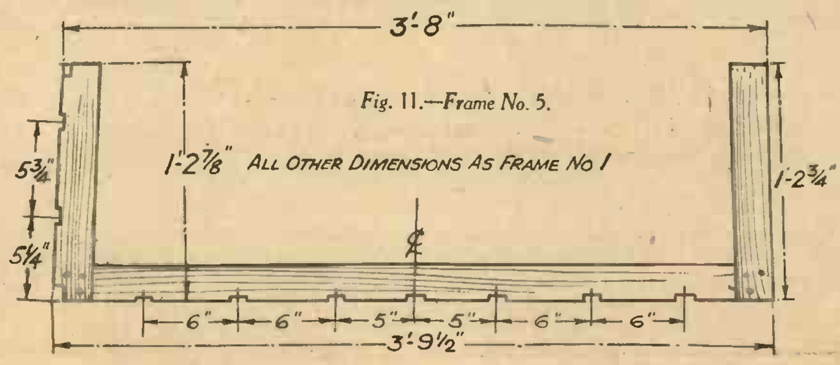


Fig. 11.—Frame No. 5.

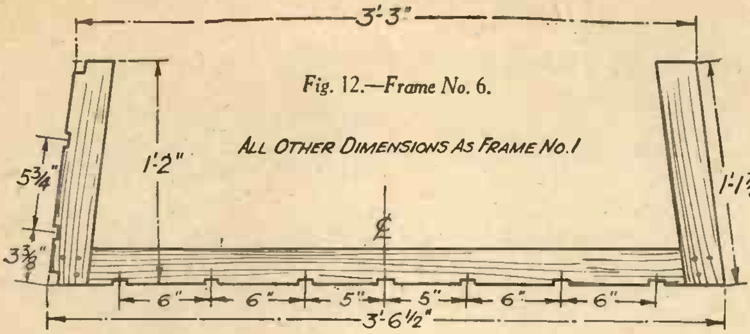


Fig. 12.—Frame No. 6.

further blocks, and a strut as shown in the diagram Fig. 20.

Having set up the transom we can now put our frames in their various positions, No. 1 frame occupying the position *B*, No. 2 *C*, and so on.

These can be secured by a single screw passed through the centre of the bottom or floor member of the frame into the batten. The hole thus made does not matter as we shall require it later on.

Great care must be taken to get the frames central, and here again the central batten slots can be used as a guide.

As an added precaution a piece of 1¼ in. × 5/16 in. deal batten could be run down the centre of the setting up batten. The frames would then fit exactly right as the central batten slots would fit over this guide batten.

A little extra labour is introduced of course, but it is worth doing as the frames will not only line up correctly, but will set firmer on the setting up batten. The extremities of the bottoms of each frame should be supported on wooden blocks making sure that they are the same height from the floor on each side and square with the setting up batten.

When all the frames are thus set up they can be braced together by means of temporary battens run round inside the frames, one on each side at the top, and one on each side at the bottom.

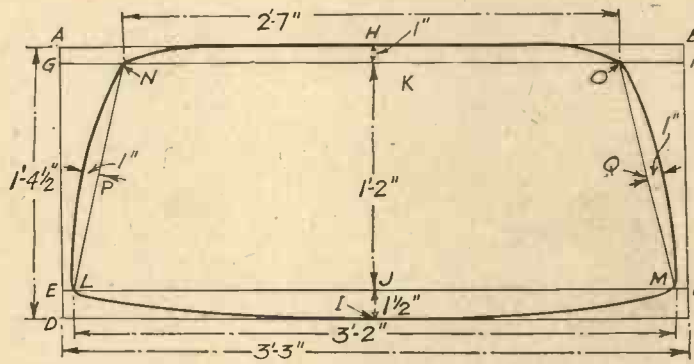
These battens may be of 1 in. × ½ in. deal, and lightly tacked with a small nail to each frame.

They are secured to the transom by tacking them inside the framing in a similar manner to the other frames. At the stem post they are tacked to the bevelled sides.

These battens together with the supports on transom and stem, further aided by the shaw, will hold the complete assembly sufficiently rigid for our purpose.

The complete arrangement is shown in Fig. 21. The blocks however supporting the extremities of the frames and transom are not shown in order to keep the sketch clear of complications.

Fig 13.—Details of the transom.



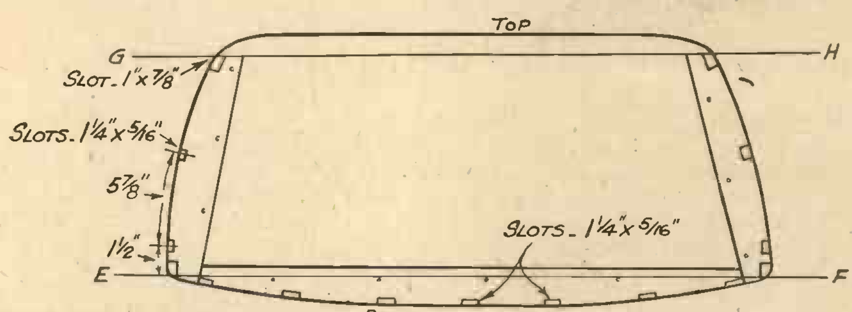


Fig. 14.—The inside of the transom facing forward

Slots At Similar Spacings To Frame No. 6, Framework Only Notched.

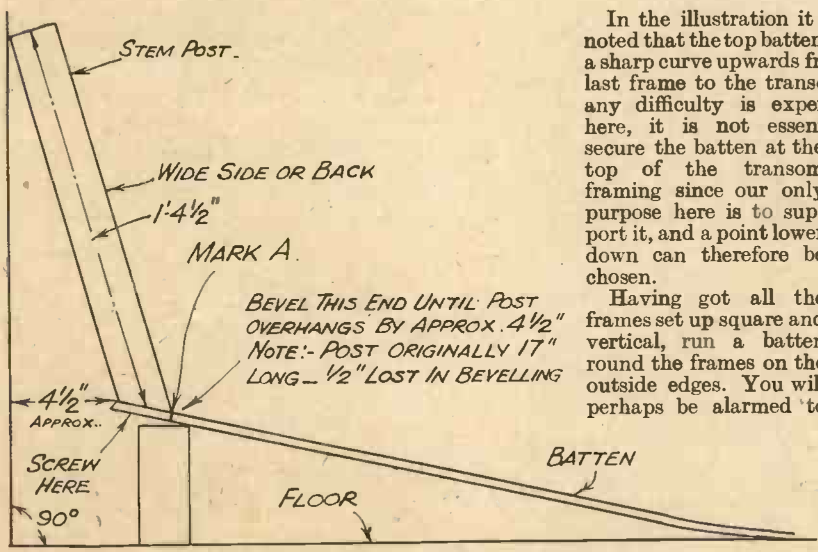


Fig. 15.—Temporary method of setting up the stem post.

In the illustration it will be noted that the top batten makes a sharp curve upwards from the last frame to the transom. If any difficulty is experienced here, it is not essential to secure the batten at the top of the transom framing since our only purpose here is to support it, and a point lower down can therefore be chosen.

Having got all the frames set up square and vertical, run a batten round the frames on the outside edges. You will perhaps be alarmed to note that where the batten touches each frame, it does not do so fairly, but only touches on the corners.

We must therefore bevel the frames to confirm with the run of the planking, which, at the moment, is represented by the batten.

The frames should be marked where they are to be bevelled and removed one at a time and dealt with.

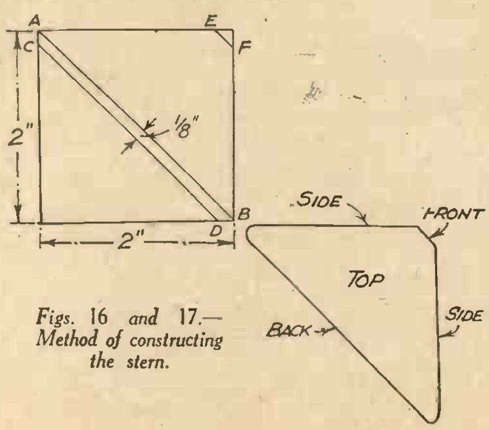
During the process of bevelling some of the slots will be reduced in depth and these must now be deepened to confirm with the bevel, that is to say the slots will also be cut on the bevel.

The transom, too, will have to have its sides bevelled, in a similar manner, and the slots adjusted accordingly. When this work has been completed we can start to assemble the job up.

It is true that we have not yet slotted the stem post, but this is done later.

Fitting the Chines and Seam Battens

First we shall take in hand the work of fitting the seam battens as these are easier and lighter than the chines or gunwales, and will add rigidity to the structure for the heavier work, later on.



Figs. 16 and 17.—Method of constructing the stern.

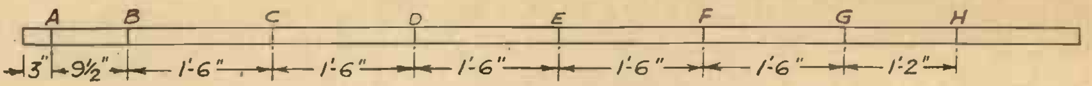


Fig. 18.—This sketch should be studied when setting up.

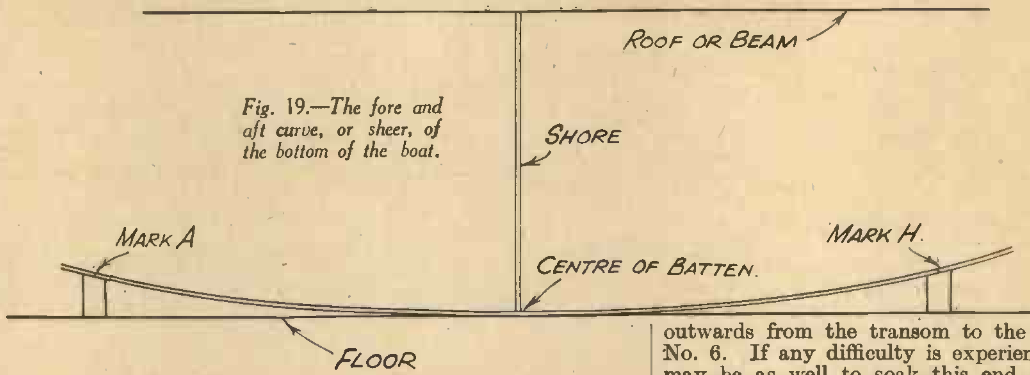


Fig. 19.—The fore and aft curve, or sheer, of the bottom of the boat.

The seam battens are made from $1\frac{1}{4}$ in. × $\frac{5}{16}$ in. mahogany, and we shall require four of these each 11 ft. long, planed finished sizes, also some brass pins or copper tacks, 1 in. long.

To fit these battens, square up one end, and tack it in the lower batten slot of the transom (this is of course the second slot up, the first is the chine slot). Now bend the batten round the frames tacking it into each frame notch.

If your work has been accurate the batten will go round with an easy sweep, and fit easily into each frame notch.

Should you have made any error, then you may have to cut the notch out a little larger, but this does not matter very much as you can easily fill in afterwards with a little plastic wood.

Having got the batten tacked to the last frame (which of course is No. 1, since you are working from the stern end), bend the batten round until it meets the stem post side, and, mark this point on the stem post, for this is where it must be slotted to receive the end of the batten.

Deal similarly with the lower batten on the other side, then the two top ones.

Never finish one side completely, always work batten for batten or plank for plank, building up the two sides together, for by working in this manner you keep the strains equal and avoid distortion.

When however you bring the second batten round to the stem post, see that the distance between it, and the lower one is the same as their distances on frame No. 1, also see that the battens on each side of the boat meet exactly opposite each other.

The positions of these battens must be clearly marked on the stem post ready for cutting out in a manner similar to the frames.

Assuming that the battens are now in place (with the exception of the fastenings to the stem post). The chines can now be fitted.

These are made from oak 1 in. × $\frac{7}{8}$ in. planed finished sizes, and each 11 ft. long, and are fitted in exactly the same manner as the seam battens, but care must be taken to see that the point where they meet the stem post, is the absolute bottom, so that when the slot is cut it will be partly in the side and partly in the bottom as it were.

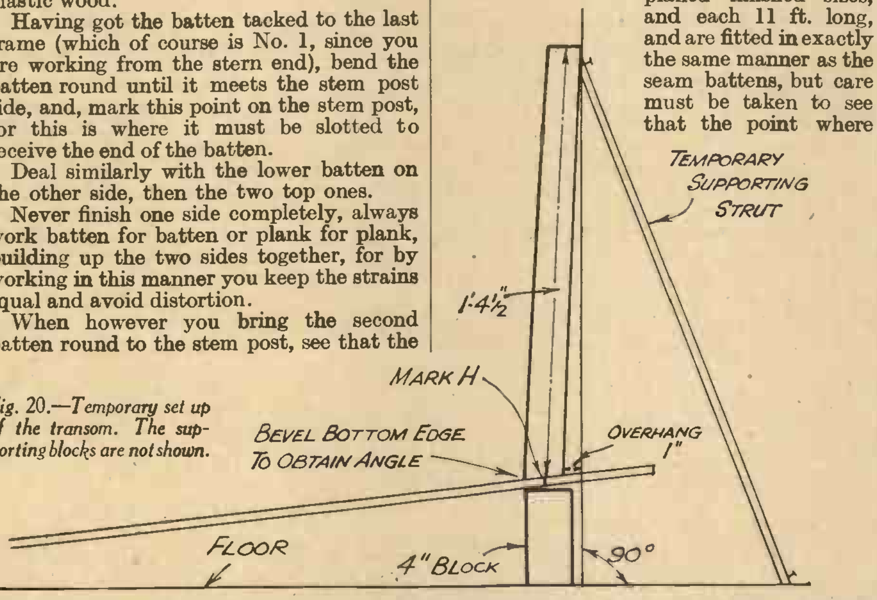


Fig. 20.—Temporary set up of the transom. The supporting blocks are not shown.

Next comes the gunwales, which of course are fitted in the slots at the top of the frames.

The method of fitting is similar, but a little difficulty may be experienced in making the rather sharp bend downwards and outwards from the transom to the frame No. 6. If any difficulty is experienced it may be as well to soak this end of the timber for a quarter of an hour in very hot water, or to apply steaming hot rags for an equal period; the bend should then be easy.

When the rail reaches the stem post do not attempt to bend the timber up to the top of it, but allow it to sweep round in its own natural curve. As the stem post is longer than necessary, some extra length being allowed for shaping. Mark off the position on the stem post as for the other rails.

The stem post now marked off may be removed from the setting up batten and notched in the following manner.

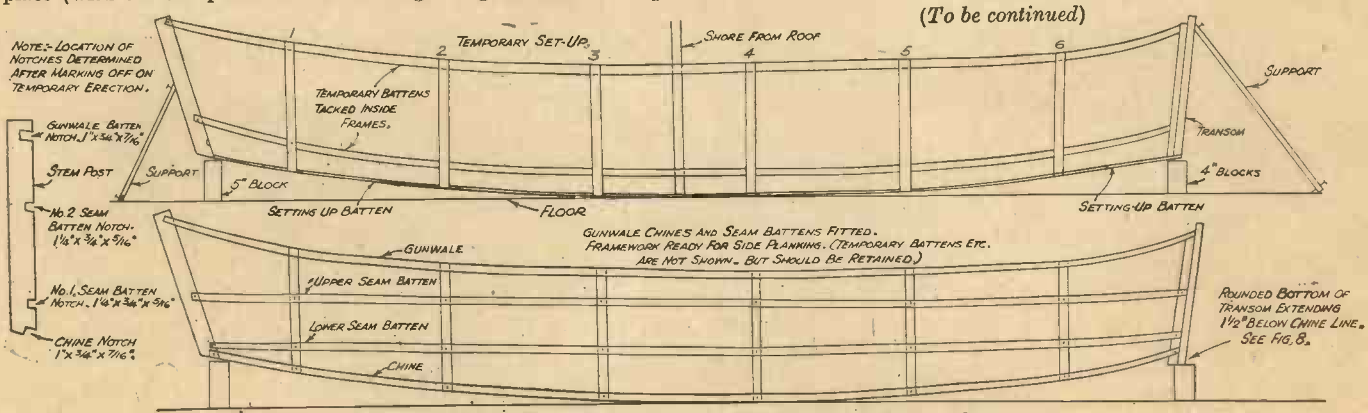
Where the seam battens are to be secured the post can be notched out 1 in. × $\frac{5}{16}$ in. for a distance of $\frac{3}{4}$ in., which will give sufficient landing.

The chines and gunwales are dealt with in a different manner. These, owing to their thickness must be half-jointed into the post, so that the slot will be 1 in. wide, but $\frac{7}{16}$ in. deep. A notch must be cut in the chines and gunwales $\frac{7}{16}$ in. deep, when they have been trimmed off to the required length on assembly, $\frac{3}{4}$ in. will be sufficient landing, so the slots in the post will be $\frac{3}{4}$ in. long, 1 in. wide, $\frac{7}{16}$ in. deep, whilst the rails will be notched $\frac{3}{4}$ in. × $\frac{7}{16}$ in. deep.

Fig. 22 shows the stem post ready for fitting. It is simply put back on the setting up batten, the rails cut off to the required length and secured in the case of the seam battens in a similar manner to the method used in fixing them to the frames. The chines and gunwales should be secured with $1\frac{1}{4}$ in. No. 6 brass screws well countersunk.

Although the main framing is now completed the temporary battens, shaw, and supports should not be removed until the sides are partly planked, which will be the next operation.

(To be continued)



Figs. 21 to 23.—Showing the position and details of the various frames and stem post.

Building a Synchronous Electric Clock

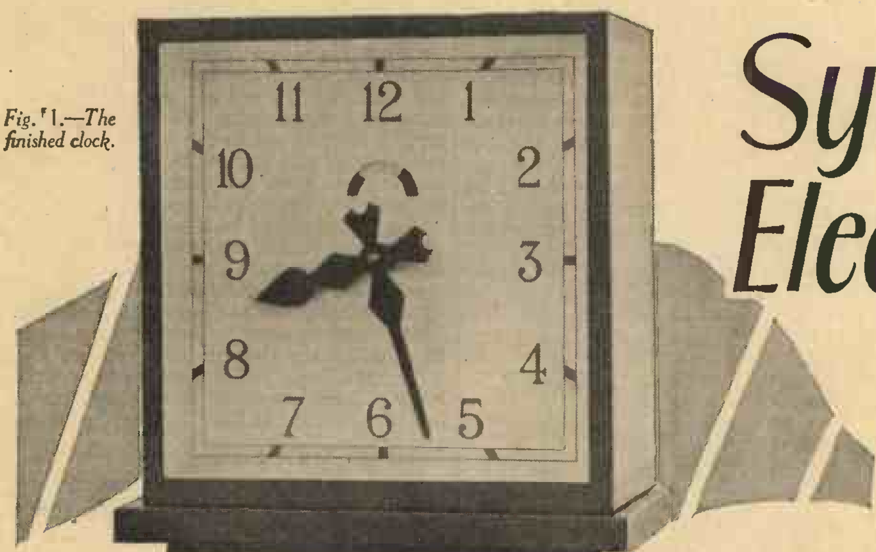


Fig. 1.—The finished clock.

The Construction of this Clock is Simple, and it is Built Without the Aid of a Lathe or Special Tools

By C. F. Lines, A.I.W.T.

WHEN the amateur model maker looks around for new subjects on which to exercise his skill, the building of an apparently intricate piece of apparatus, such as an electric clock, is passed over on the score of requiring special tools, such as a lathe, gear cutting appliances and other apparatus not usually possessed by amateurs. It will be found possible, however, to construct a highly satisfactory electric timepiece with perfect timekeeping capabilities, literally "on the kitchen table."

Unlike the spring driven clock, an electric clock, of the synchronous variety, does not depend, for its accuracy, on escapement of pendulum action. It is driven by a very small electric motor, having a minute consumption of power, controlled for speed by the frequency of the A.C. electric mains to which it is connected.

Now that the grid scheme is in operation, practically every power station in the country is synchronised from Greenwich, to deliver power at exactly 50 cycles per second, and, as the speed of the motor is entirely dependent on the frequency, the clock is, virtually, controlled from Greenwich.

The motor is not self starting and has to be rotated by hand until it is running at the speed at which it is designed to run.

The Rotor

In the timepiece shown on this page, the rotating part of the motor, generally called the "rotor," consists of a toothed iron disc which rotates in an alternating magnetic field, set up by a winding, between the poles of a specially shaped iron magnet system, hereafter called the "stator." Fig. 7 shows the shape of the rotor and stator and gives their dimensions.

List of Parts

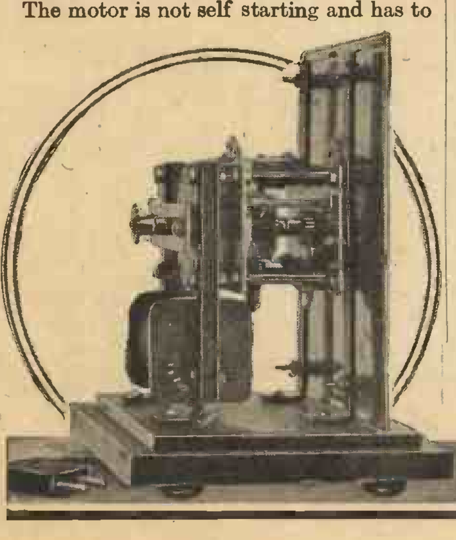
- 1 piece of Swedish iron $4\frac{1}{2}$ in. × $3\frac{1}{2}$ in. × $\frac{5}{32}$ in. thick.
- 1 piece of Swedish iron, $4\frac{1}{2}$ in. × 3 in. × $\frac{5}{32}$ in. thick.
- 1 strip of brass, 14 in. × $2\frac{1}{2}$ in. × $\frac{1}{16}$ in. thick.
- 1 length of angle brass, 6 in. × $\frac{1}{2}$ in. × $\frac{1}{2}$ in. × $\frac{1}{16}$ in. thick.
- 1 length of iron strip, 3 ft. × $\frac{1}{2}$ in. × $\frac{1}{8}$ in. thick.
- 1 piece of ebonite 4 in. × 2 in. × $\frac{3}{16}$ in. thick.
- 8 ounces of 36 S.W.G. double-silk-covered copper wire.
- 2 12 in. lengths of 2 B.A. screwed brass rod.
- 38 2 B.A. brass lock nuts and washers.
- 4 4 B.A. × $\frac{3}{4}$ in. cs. brass screws and hex. nuts.
- 18 6 B.A. × $\frac{1}{4}$ in. round head brass screws and washers.
- A few transformer core stampings. (See text.)
- 4 19-tooth pinions, $\frac{1}{2}$ in. dia. × $\frac{1}{4}$ in. face.
- 2 25-tooth pinions, $\frac{3}{4}$ in. dia. × $\frac{1}{4}$ in. face.
- 4 50-tooth gear wheels, $1\frac{1}{4}$ in. dia.
- 3 57-tooth gear wheels, $1\frac{1}{2}$ in. dia.
- 2 Worm drives.
- 6 Metal collars.
- 24 Plated washers.
- 15 $\frac{5}{32}$-in. grub screws.
- 2 $11\frac{1}{2}$ in. axle rods.
- 1 sprocket wheel, $1\frac{1}{2}$ in. dia.
- 1 sprocket wheel, $\frac{3}{4}$ in. dia.
- 1 Perforated flanged plate, $5\frac{1}{2}$ in. × $2\frac{1}{2}$ in. (Used for a template for drilling the holes.)
- Black enamel, celluloid lacquer, cardboard for dial, glass for case, etc.

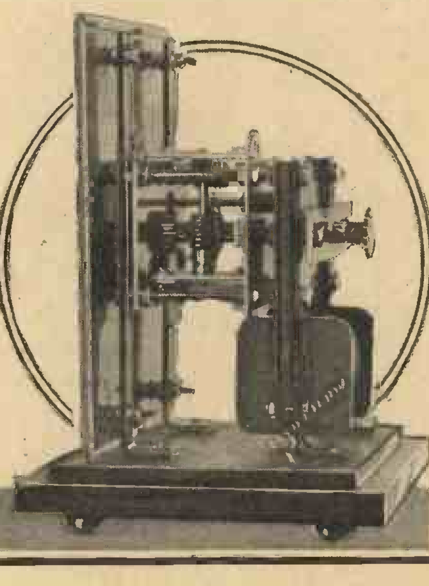
The rotor speed, in revs. per minute, is determined from the formula $\frac{2 f 60}{n}$ where f is frequency in cycles per second, sometimes called periods, and n is the number of teeth on the rotor. In this intance, the mains frequency was 50 c.p.s. and the rotor teeth 16 in number, giving a speed of 375 r.p.m. or 22,500 per hour. To reduce this speed to 1 per hour calls for a reduction gear of 22,500 to 1. This seemingly huge reduction is obtained, very simply, in four steps of 3 to 1, 3 to 1, 50 to 1, and 50 to 1, by employing gear wheels.

It is to be noted that the clock is rather larger than is usual with purchased ones. The overall size, including the case, is approximately 8 in. square × 6 in. back to front. These dimensions are occasioned by the size of the gear wheels employed. The large size is not considered a disadvantage as the more usual $3\frac{1}{2}$ in. dial is rather small to be read at a distance.

Materials

Commence construction by gathering together the material required as detailed in the list of parts. The gears, sprocket wheels, collars, plated washers, axle rod, perforated plate and grub screws can be obtained ready made. The Swedish iron plates and iron strip are obtainable from





Figs. 2 and 3.—Two further illustrations showing the construction from the rear.

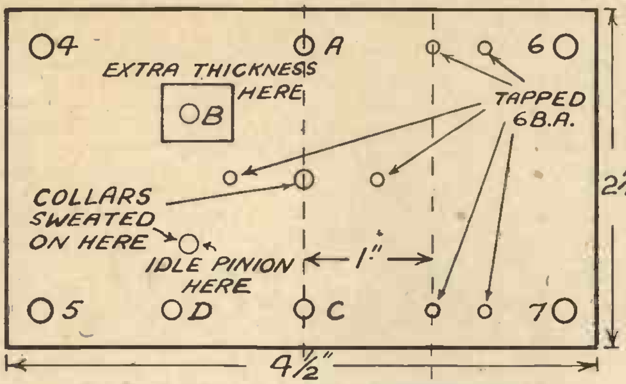


Fig. 4.—Details of the template for positioning the holes.

any good blacksmith or metal merchant. If Swedish iron is not readily obtainable, mild steel will do quite well. A good radio dealer will supply the D.S.C. wire, 2 B.A. screwed rods, nuts, washers, 4 B.A. and 6 B.A. screws, ebonite and transformer stampings.

Take the wider of the two iron plates and having polished off any rust and scale which may be adhering to it, scribe the line *AB* 1½ in. down from the long edge. (See Fig. 7.) On the line *AB* mark off hole 1 and drill with a 3/32-in. drill.

Drilling Operations

Drive a pin, cut from the axle rod, into this hole and use the pin to position the perforated plate which will guide the drill for drilling hole 2. Secure the plate firmly to hole 2, in a similar manner, and using it as a template, drill out holes 4, 5, 6, and 7. With the plate still in position, use the 5/32 in. drill to indent the centre of hole 3. Do not drill this hole right through at this stage.

Remove the template and using the indent for hole 3 as centre, scribe, with compasses, a circle of 1¼ in. radius. At the same time scribe a second circle of 1 17/64-in radius. By bisection, divide the circumference of the smaller circle into 16 equal parts, and, with a centre punch, mark each point of intersection. Using a drill of 1/16-in. diameter, drill pilot holes for the sixteen holes on the circumference of the circle. Hole 3 may now be drilled out 5/32-in. diameter. Great care must be taken to make these holes exactly in the correct position and dead square with the surface of the plate.

Before proceeding to enlarge the holes already drilled to their finished sizes, the narrower plate should be cleaned up and, with the aid of the perforated plate, holes to correspond to 1 and 2 drilled. These holes will permit the narrow plate to be secured to the back of the wide one. The wide plate now becomes a template, and drilling is continued until all holes but one are present in both plates. The exception is hole 3, which should only be indented, as it is used as a centre for scribing the finished size of the rotor, i.e. 1 15/64-in. radius.

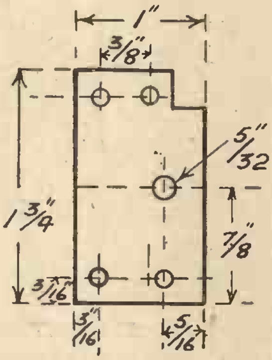


Fig. 5.—Horizontal bearing plates.

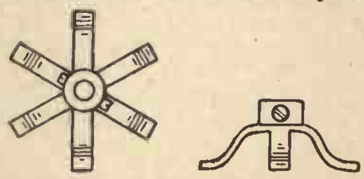


Fig. 6.—The six-arm star piece for adjusting the hands.

Having drilled out all the pilot holes in both plates, attention should be turned to the rear rotor bearing strip, which is of brass 4½ in. × ¾ in. × 1/16 in. (approx.).

It is essential that this bearing strip and the gear plates be of brass or other non-magnetic metal. If iron were used for them, they would short circuit the field between the stator poles.

The centres for the bearing and support holes can be marked off from the partly completed stator plate. The rear gear plate can be marked off in the same way. By adhering to this procedure of marking off all the parts from the stator plate, perfect alignment of the holes is assured.

Holes that are to be a bearing fit for the rod are best drilled out with the 5/32-in. drill and then "lapped" out with the aid of a small piece of the rod, tapered slightly to enter the hole, used as a lap in the hand drill. This procedure actually improves the bearings as the lap hardens and polishes the wearing surface. The hole in the centre of the rotor will require a little fine emery powder and oil as an aid to the "lapping" process.

Rotor and Stator Poles

When all the marking off, mentioned so far, is completed, the rotor and stator plates may be finished by opening all the holes out to their final sizes. (See Fig. 7.) With a hacksaw, cut out the rotor and stator pole pieces as near as possible to their finished shape, finishing them down to the dimensions given with files, taking care to keep the edges square and the concave faces of the pole pieces as true as possible. The shaping of the rotor demands especial care. It must be truly round. Any lumps on its circumference will necessitate increasing the gap between stator and rotor to prevent fouling as the rotor revolves. The gap should not exceed 1/32-in.

The rotor is completed by having a ½-in. diameter, ¼-in. face pinion sweated to it with the boss outwards. A short length of axle rod will hold the parts concentric during the sweating operation.

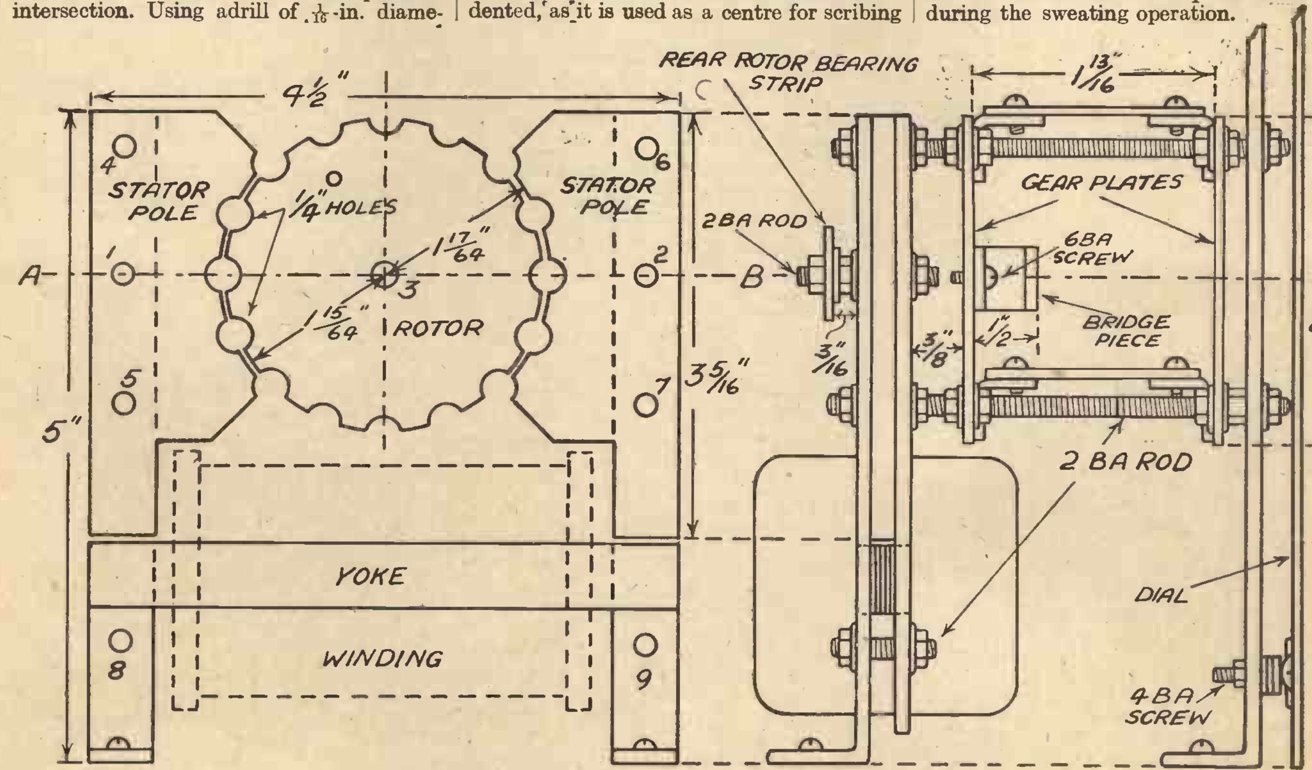


Fig. 7.—Showing the construction of the stator and rotor.

Care must be taken to prevent solder creeping between the teeth of the pinion.

If desired, the iron parts can be given a coat of quick drying black enamel. In addition to improving their appearance this will prevent them rusting.

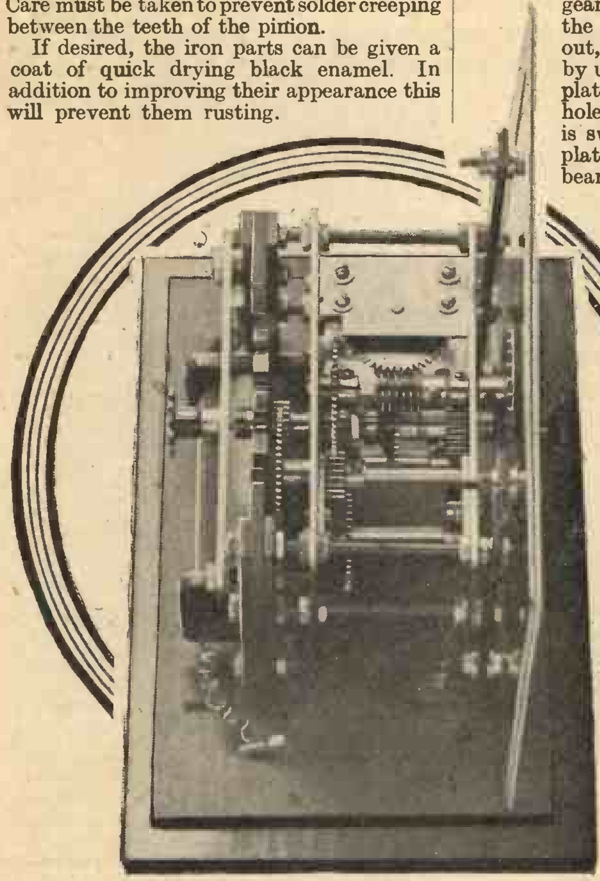


Fig. 8.—A plan view of the clock.

The next step is to fashion the stator pole supports, or legs, from the $\frac{1}{2}$-in. × $\frac{1}{8}$-in. iron strip. It is only necessary for the rearmost pair of strips to be bent to form feet. The strips which support the dial form the front pair of feet.

The Transformer Stampings

From the transformer stampings cut sufficient strips, $4\frac{1}{2}$ in. long by, at least $\frac{1}{2}$ in. wide, the exact width is not critical, to equal in thickness the stator pole pieces. Also cut two pieces of the $\frac{1}{2}$ by $\frac{1}{8}$ iron $3\frac{1}{2}$ in. long. The transformer iron strips and the $3\frac{1}{2}$ in. pieces, together, form the yoke over which is wound the winding for energising the motor. It is not recommended that this yoke be made from solid metal as its use in magnetic circuits introduces a loss of energy which has to be made good by increased consumption from the supply mains.

Having completed the iron work for the motor, attention can now be given to finishing the rear bearing strip. To provide a greater length of bearing for the rotor spindle, a collar is sweated to it. A short length of axle rod will facilitate the sweating process if it is used as suggested for sweating the pinion to the rotor. The collars, as purchased, have two tapped holes, but only one grub screw. The extra tapped hole will serve as an oil hole if it is positioned vertically and oil will not run out of the bearing if the screw is left in place. It must not, of course, be tightened up or it will grip the rotating spindle.

The drawing of the rear gear plate, Fig. 4, gives the position of all the bearing holes for the gear wheel spindles and their sizes. All the dimensions are not given, as, in some cases, greater accuracy in meshing the various wheels can be obtained by following the procedure outlined below. The front gear plate is almost identical with the rear one and it can be drilled out, with a minimum of labour, by using the rear plate as a template. Immediately above the hole for the rotor bearing (a collar is sweated to this hole when the plate is finished, as with the rear bearing strip), drill hole *A* with a $\frac{5}{32}$-in. drill, lapping out the hole to axle size, as detailed earlier. The exact distance from the rotor hole to hole *A* may be fixed by employing the perforated plate as a template. On temporary spindles, mount a $\frac{1}{2}$-in. pinion in the rotor hole and a similar pinion in hole *A*. Place a $1\frac{1}{2}$ in. gear wheel in mesh with both of these pinions, so that its centre takes up a position corresponding to hole *B*, and indent the centre of hole *B*. If a strip of thin writing paper, crimpled between two pinions, temporarily mounted on the perforated plate for the purpose of crimping, is inserted between the teeth of the three wheels, prior to marking hole *B*, sufficient clearance will be automatically allowed for any irregularities in the meshing of the wheel teeth. These same crimped paper strips should be used between any wheels whose centres are not marked off from the Meccano perforated plate.

Hole *B* is the bearing for the first reduction gear spindle, which runs at one-third rotor speed, and it is advised that it be increased in length by sweating a small square of brass over it, and the corresponding hole in the front plate, afterwards drilling right through the two thicknesses.

Angle Pieces

The next step is to cut off and clean up four $\frac{3}{4}$-in. pieces of brass angle strip. Each of these is drilled and tapped, using a No. 44 drill and 6 B.A. taper tap, to have two holes in each face, symmetrically placed, with $\frac{3}{8}$ in. between centres. These angle pieces are employed to carry horizontal brass plates, 1 in. wide by $1\frac{3}{4}$ in. long, between the front and rear gear plates. The horizontal plates are drilled with one hole each for a vertical spindle upon which is mounted a 50-tooth wheel and a worm. The position of the spindle holes is indicated in Fig. 5. A $\frac{1}{4}$ in. square is taken out of the corner of each plate to clear certain gear wheels. The cutting of these small squares is best left until the assembly is partly completed, when their purpose and position will be obvious. Each horizontal plate has, also, four $\frac{5}{32}$-in. holes through which 6 B.A. by $\frac{1}{4}$-in. round-headed brass screws are inserted to secure the plates to the angle pieces. These holes are deliberately made much larger in diameter, i.e. $\frac{5}{32}$-in., than is necessary. By so doing, and employing washers under the screw heads, the plates are given a fair amount of play which allows for adjustment of the meshing of a worm on the spindle in hole *A* and the 50-tooth wheel on the vertical spindle. The screws are, of course, tightened down after the meshing is satisfactory.

The position of the screw holes on the gear plates, to which the brass angle pieces are secured, is indicated in Fig. 4. They, also, are drilled $\frac{5}{32}$ in.

The Spindle for the Hands

This spindle, which is driven by a 50-tooth wheel secured to it, in a manner to be described later, is journalled in the centre hole of the front gear plate. This hole corresponds to the rotor bearing in the rear plate. The rotor bearing is, of course, occupied by the rotor spindle, so, to provide a rear bearing for the hands spindle, a small bridge is constructed, as illustrated, from a couple of small pieces of angle brass surmounted by a small strip soldered on. Two $\frac{5}{32}$-in. holes are drilled in the bridge feet, and corresponding tapped holes are made in the rear gear plate. By drilling large holes and using washers under the screw heads, as was done with the horizontal plates, lining up of the bearings is facilitated. This completes the drilling for the 22,500 to 1 reduction between the rotor and the spindle of the minute hand.

The hour hand, which is secured to the boss of a gear wheel mounted on, but free to rotate on, the minute hand spindle, is driven by a reduction gear consisting of a train of 2 to 1, 2 to 1, and 3 to 1, i.e. 12 to 1 in all. An idle pinion is introduced into this train of gears to provide a reversal of rotation. Without this idler the hour hand would revolve anti-clockwise.

A $\frac{3}{4}$-in. pinion is locked on the minute hand spindle. It drives a 50-tooth wheel on a spindle in hole *C*. This spindle also carries a $\frac{3}{4}$-in. pinion which meshes with another 50-tooth wheel on a spindle in hole

(*Continued on page* 602)

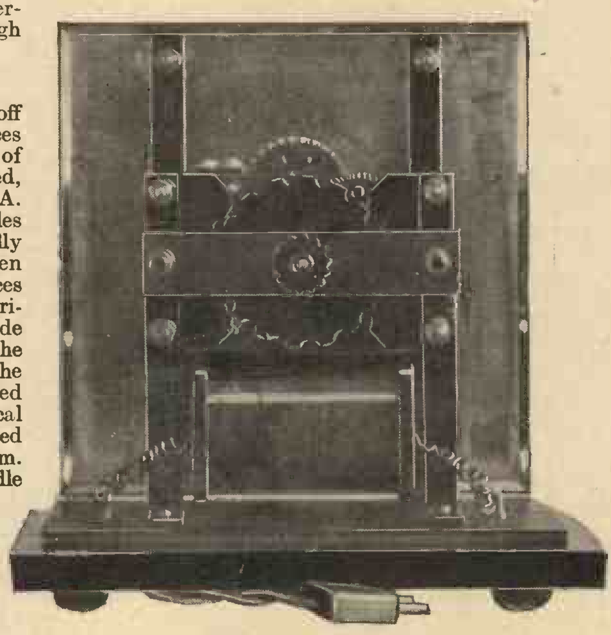
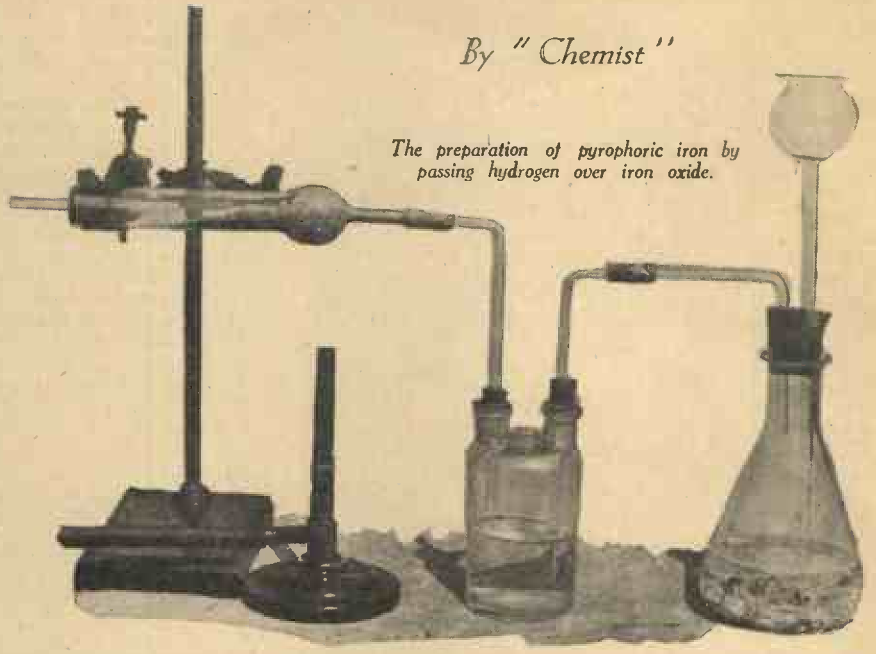


Fig. 9.—A rear view.

Making Self-Igniting Metals.

By "Chemist"



The preparation of pyrophoric iron by passing hydrogen over iron oxide.

How to Make Metal Powders which Become Incandescent When acted upon by Air.

It is not generally known that there exist a number of metals which can be prepared in so finely-divided a condition that they take fire and burn themselves away in a shower of sparks which scatter into the air. Such metals are said to be *pyrophoric* in nature. The best-known metals which can be prepared in this condition are iron, nickel, and lead.

Pyrophoric lead can be prepared with great ease. Take a moderately strong solution of lead acetate or lead nitrate, and add to it a strong solution of tartaric acid. A white precipitate of lead tartrate will instantly be formed. When it is clear that no further lead tartrate is being precipitated, filter the solution and retain the white lead tartrate. Wash this substance with a little cold water in order to swill away all traces of unchanged tartaric acid, and then dry it by gentle heat.

Lead Nitrate

If you cannot obtain supplies of the necessary lead acetate or lead nitrate you can make either of these salts for yourself. Lead nitrate is made by dissolving scrap lead in moderately strong nitric acid, whilst lead acetate is best made by dissolving litharge (lead oxide) in acetic acid. In either of these instances, you will have to crystallise the salt out in order to free it from traces of acid and then dissolve it in water so as to make up a moderately strong solution.

Having obtained a quantity of the necessary dry lead tartrate, a small amount of this material is placed in a test tube and heated *very gently* over the flame of a spirit lamp or bunsen burner. The tartrate will turn black and give off smoky fumes. Afterwards it will become grey in colour. Immediately this happens, remove the tube from the flame and cork it up firmly. The grey powder in the tube consists of metallic lead formed by the heat-decomposition of the lead tartrate. So fine is the lead powder that it shows the strongest possible affinity for the oxygen of the air, combining with it under the slightest provocation to form lead oxide.

Thus, for instance, if the contents of the tube are gently shaken to the ground, the metallic lead powder will become incandescent in it passage to the ground, giving rise to a trail of sparks and thereby providing a form of indoor fireworks.

Pyrophoric Lead Powder

Again, this pyrophoric lead powder, even if it is kept in an uncorked or unsealed test tube, will often spontaneously become red hot, owing to the combination of the lead with the oxygen of the air in the test tube. For this reason, it is very difficult to preserve pyrophoric lead or, indeed, pyrophoric metal powders of any description, even in a sealed tube or bottle, since the metal powder quickly abstracts the oxygen from the air contained in the bottle and turns itself into the metal oxide. The only way to preserve such metal powders would be to seal them in a vacuum or in an atmosphere of some inert gas.

In consequence of the above facts, care should be taken not to store away a bottle or tube of any pyrophoric metal powder in a drawer or among papers of any description, since a fire might easily arise owing to the spontaneously-ignitible nature of the powder.

Pyrophoric iron gives rather more brilliant spark showers than does pyrophoric lead, although it is somewhat more difficult to prepare than the latter substance. Iron in pyrophoric form is prepared by passing hydrogen gas over very gently heated iron oxide or iron oxalate. The hydrogen treatment of iron oxalate gives the most certain results. Iron oxalate can be made by adding a solution of oxalic acid to a solution of any iron salt, whilst iron oxide is formed by the addition of ammonia to the solution of an iron salt.

Iron Oxalate

In order to form the necessary iron salt for the preparation of iron oxalate or oxide, scrap iron can be dissolved in dilute sulphuric or hydrochloric acid. When all the acid has been used up, evaporate the residue to dryness, re-dissolve it in water and filter it. A solution of an iron salt suitable for the addition of oxalic acid or ammonia will thus be prepared.

Having acquired (or prepared) a quantity of dry iron oxalate or iron oxide, place it in a glass bulb-tube to which is attached a hydrogen-generating bottle.

A photograph of the apparatus is shown on this page. The flask on the right contains pieces of scrap zinc over which has been poured dilute sulphuric or hydrochloric acid. The hydrogen gas thus generated is made to bubble through a wash-bottle containing a little clean water in order to rid it of any acid fumes which may be carried over. This intervening wash-battle is not absolutely essential to the success of the experiment, but its use is desirable.

Having rigged up the necessary apparatus with the iron oxalate or oxide in the glass bulb-tube, allow the hydrogen gas to flow over the oxalate or oxide for two or three minutes in order to make sure that the hydrogen has expelled all the air from the interior of the apparatus. Then *very gently* heat the contents of the bulb-tube with a bunsen burner turned low or with a small spirit-lamp flame. Very quickly the powder in the bulb-tube will darken and within a few minutes it will have become completely black. This black substance is metallic iron in a very finely-divided state. Scatter a little of it to the ground and it will give rise to a brilliant trail of white sparks. Tip some of the pyrophoric iron on to a saucer. Within a minute or two it will have become red hot. If you wish to preserve any of the metal powder, you will find it necessary to seal it off in a small test tube, the tube being filled to the top with the powder in order to leave as little room for air as possible.

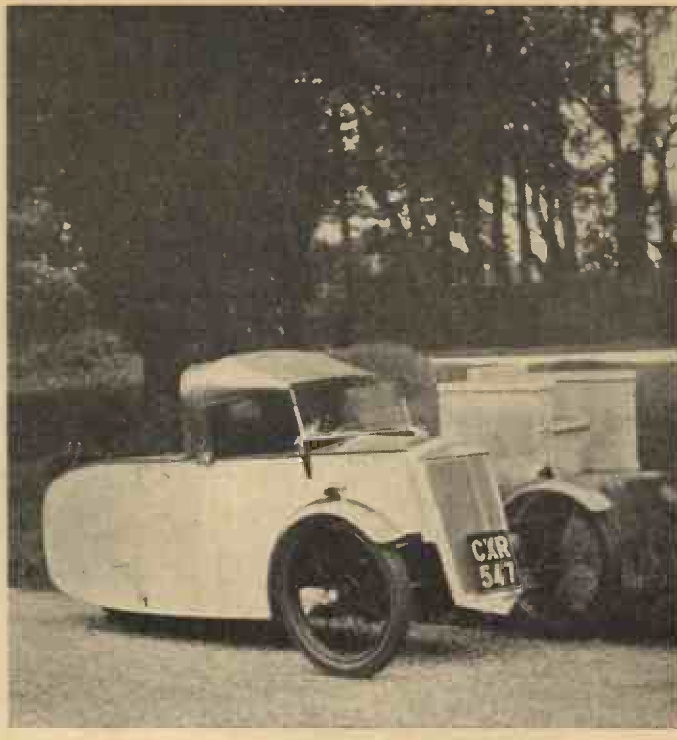
Nickel Powder

Pyrophoric nickel can be prepared by a similar process, employing nickel oxide instead of iron oxide. The nickel powder so produced is grey-black in colour and its self-igniting properties are similar to those of pyrophoric iron powder. Incidentally, if you cannot procure any nickel oxide, you can make it for yourself by adding ammonia to a solution of nickel salt and by heating the pale green precipitate of nickel hydroxide which is thereby formed.

One word of caution concerning all the above hydrogen experiments. Do NOT apply a flame to the issuing steam of hydrogen until you are *quite sure* that all the air has been swept out of the apparatus by the stream of hydrogen gas. Hydrogen and air form an explosive mixture and very likely the entire apparatus may be shattered to fragments by an explosion if the hydrogen gas is ignited before it is completely air-free. Generally speaking, a period of four or five minutes should elapse before any attempt is made to ignite the steam of hydrogen issuing from the extremity of the

(*Continued on page* 604)

This view of the finished £20 Car shows its very practical lines. This photograph also shows the designer, Mr. F. J. Camm.



This view shows the car with the Auster "one-hand" hood up. Note also the sports type mudguards.

OUR £20 CAR!

Further Notes on Construction and Adjustment

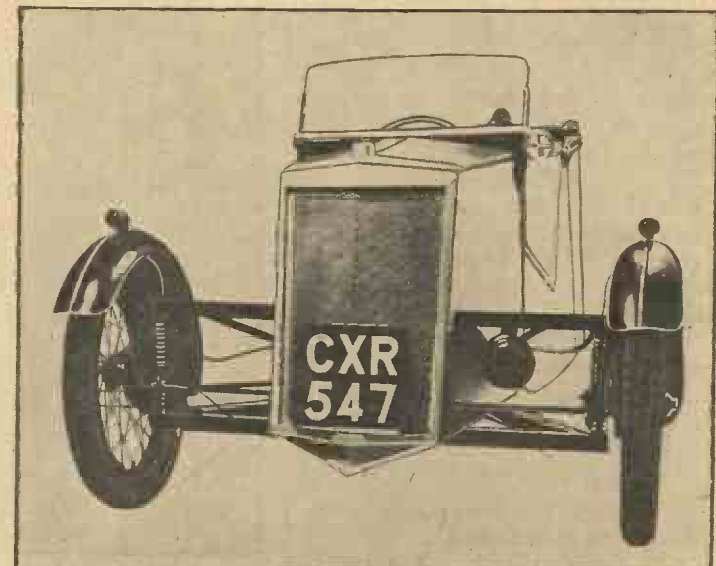
By F. J. Camm

THE articles given in the March, April, May, and June issues of this journal, and the drawings and photographs which accompanied them should enable any reader to complete the car without difficulty. So that readers who are in doubt about any point might have an opportunity of inspecting the original car, I approached Messrs. A. W. Gamage, Ltd., of Holborn, London, E.C.1, who generously co-operated with me by allowing the car to be on exhibition in their showrooms.

Photographs from Readers

Some hundreds of readers have already availed themselves of the opportunity thus afforded of making first-hand acquaintance with this little vehicle which has attracted so much attention throughout the country. The car will remain on exhibition there for a few weeks longer and, if you can spare the time, I recommend you to pay a visit to this well-known store.

Some hundreds of these cars are already in course of construction (some will be finished by the time this issue is off the press), and I have received promises of photographs of cars when my readers have completed them. I shall publish these in due course, but in the meantime, I reproduce some further pictures of the finished car so that you may judge its really attractive and modern lines. Since the last issue went to press I have put the car through some rigorous tests, and I have been unable to discover any snags or defects. The brakes are ample to stop the vehicle quickly from its maximum speed of



A front view, showing the axle and suspension.

about 50 miles an hour. The engine is immediately responsive to the accelerator, and the hand-brake which operates the two front wheel-brakes (unlike the hand-brakes fitted to most cars) is in itself quite adequate to bring the car rapidly and smoothly to a standstill. I have, *in toto*, journeyed some hundreds of miles in it, and find it a cosy and handy car, free from trouble, and reliable in every way. There is much to be said for the great simplicity of the single-cylinder engine, which once tuned up seems willing to work all day without signs of distress.

Petrol Consumption

The petrol consumption works out at 67 miles per gallon, and the acceleration is superior to most other three-wheelers which I have tried. It is good at hill-climbing and only the very steep hills demand a change down to second. In bottom gear the car will climb practically any hill met with in normal touring.

The reverse gear makes the car particularly manœuvrable in narrow roads, and the suspension is ideal. I think it would be difficult to find a more comfortable car at ten times the price.

I shall be pleased to arrange to take parties of readers to Messrs. A. W. Gamage, Ltd., on suitable days if readers will get into touch with me, naming the time and day at which they will be free. I can then arrange a programme to suit all readers.

Those readers who are unable to visit London and who would like to see the car should arrange themselves into local parties and let me know when they would like to see the car. If it can be arranged I will then drive it to their district.

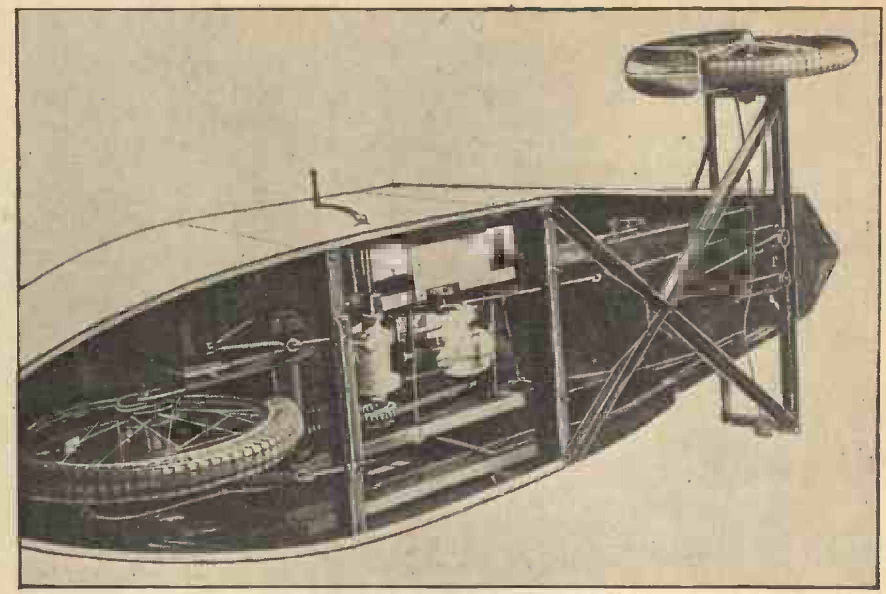
Blue-prints

Blue-prints for the car are ready, and can be supplied by return of post for 10*s*. 6*d*. a set of four sheets. Address letters containing postal orders to the Publisher, George Newnes, Ltd., 8/11 Southampton Street, Strand, W.C.2.

One of the photographs this month shows the angle-iron cross bracing between the bottom member of the front axle (also of angle-iron) and the body. This can consist of two members welded at the point of intersection, or it can consist of four members suitably fastened by means of fish plates. This bracing reduces any tendency for the chassis members to twist, and equalises the load on the front suspension springs.

In Gamage's Showrooms

Two of the photographs show the car in the showrooms of Messrs. A. W. Gamage, Ltd., and the others show the car on the road—one of them taken when the car was travelling at 45 miles an hour.



Underneath view, showing the angle-iron cross bracing.

One or two readers have raised the question of the fitting of a speedometer. This can most conveniently be arranged by taking a motor-cycle type of drive off one of the front wheels, and a suitable speedometer for this purpose is that made by the Cooper-Stewart Eng., Co., Ltd., 136 Long Acre, London, W.C.2. The instrument itself will, of course, be mounted on the dash. On my car the decompressor and the choke are mounted on the offside of the engine compartment for convenient operation when using the kick-starter.

A Dynamo and Starter Motor

If readers are going to the extra expense of fitting a dynamo and starter motor these controls will, of course, be brought by means of Bowden cables to the dash. Many engines will not have a decompressor fitted, but I find such a convenience when starting from cold. I have not fitted a headlamp as originally planned, for, owing to the low riding position and the use of 6-watt lamps mounted on the wings, I find the lighting quite adequate. If a dynamo is fitted you

Our £20 Car in the showrooms of Messrs. A. W. Gamage, Ltd.

will have ample current to supply other electrical needs such as a windscreen wiper, but you must fit a battery of at least 60 ampere-hours' capacity.

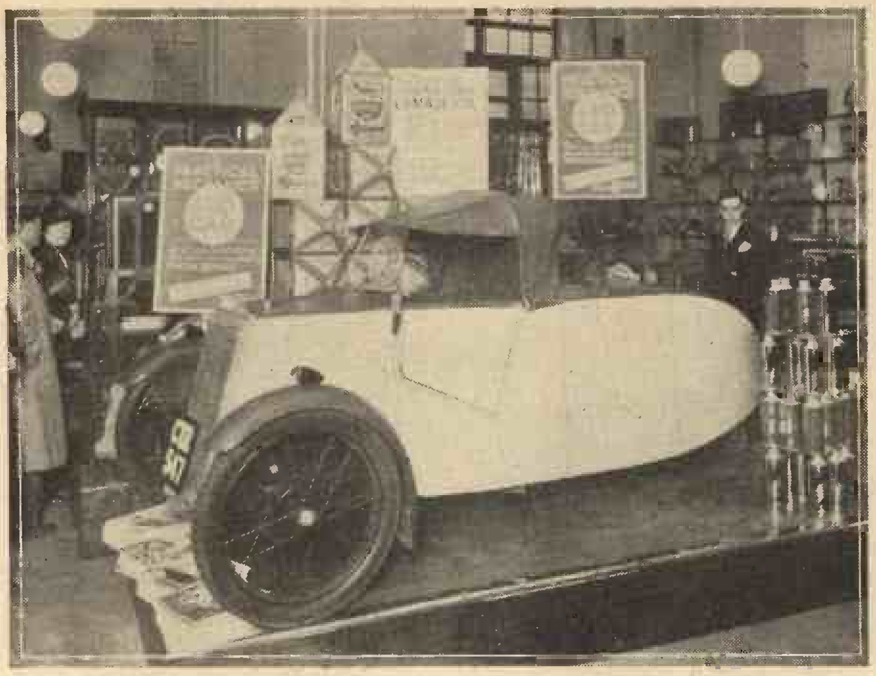
Accumulator

Do not make the mistake of buying a second-hand accumulator. Such may look perfect from the outside, but if it has been standing for any length of time the plates are certain to be sulphated, and possibly short-circuited by a sediment at the bottom. The plates may also be cracked, and the filling may have fallen away from them.

Do not forget to lubricate the rear-suspension pivots, the wheel bearings, and the front springs occasionally, and make quite sure that the oil pump is delivering at least 80 drips a minute.

Engine Timing

If you have purchased the unit separately you must time the engine so that with the lever in the "fully retard" position the spark occurs at top dead centre, on the compression stroke (both valves closed). See that the engine has a plentiful supply of oil if you are using a new one, and it is desirable to inject about an eggcupful in the crankcase before starting the engine. See that all steering joints are oiled, that the wheel bearings are packed with grease, and that the gearbox is filled with oil. Make sure that the oil tap is in the "on" position.

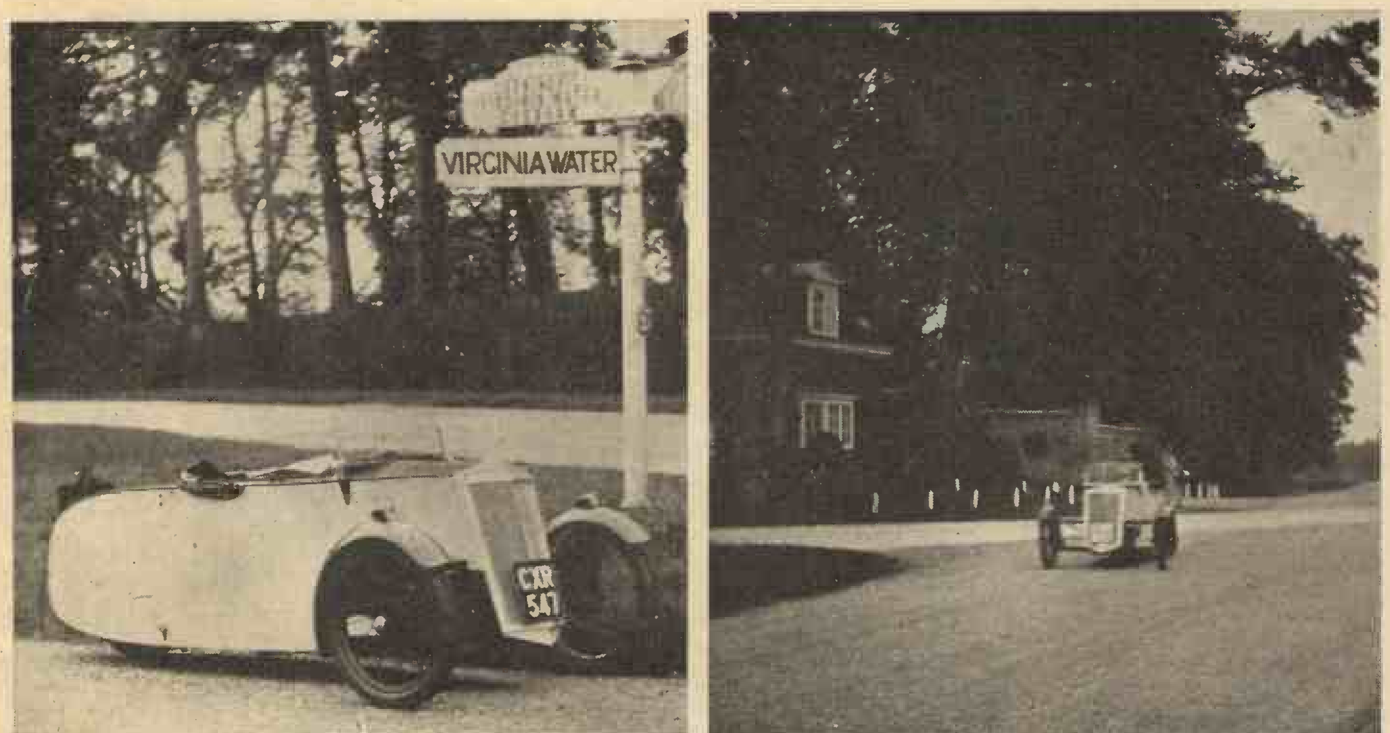


The photograph above shows our £20 Car in the showrooms of Messrs. A. W. Gamage, Ltd., Holborn, E.C.1. Hundreds of readers have already visited this famous store in order to inspect the car.

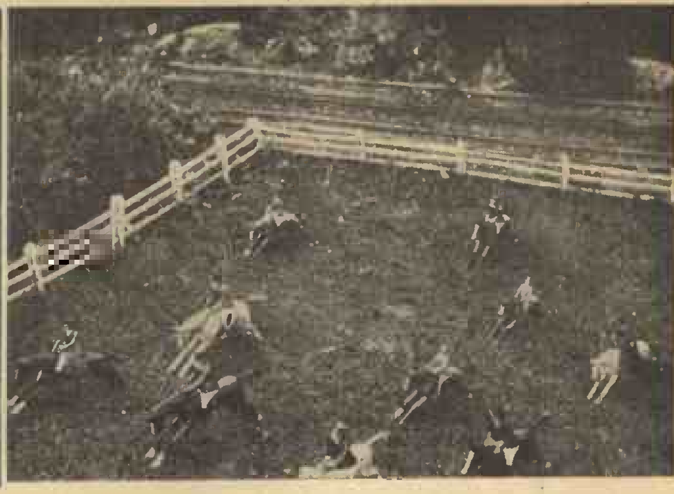
Testing the Car

Before testing the car it is wise to check the front wheels for toe-in—that is to say the front of the wheels measured between the tyres should be $\frac{3}{16}$ in. closer together than the rear of the wheels. Check over the alignment to make quite sure that the rear wheel is absolutely central with the front wheels. Inflate the front tyres to an equal degree of pressure, and the rear tyre slightly harder.

The hood supplied by Messrs. Auster, Ltd., has a front iron to which U-section sockets are attached. These slide over the outside edges of the screen and keep the hood in place. It will be necessary to fix chocks of wood to the sides of the body to receive the screen and the position of the latter should be adjusted to suit the hood. The back of the hood is nailed or screwed behind the back squab-rail first.



These two photographs emphasise the modern lines of our £20 Car and one shows it under way.

(Left)—Hay-making at Bekonscot, Beaconsfield, Bucks, and (Right)—A hunt at full gallop across one of the fields around the model town of Bekonscot.

A Township in Miniature

AT many places in the British Isles, one comes across all kinds of model railway systems. Some of these tiny services are more useful than one would think, and several, in addition to making amusement for crowds of sightseers, can also carry numbers of passengers. The Romney-Hythe & Dymchurch line is a case in point, for it also takes an important part in the local transport facilities. People use the railway regularly.

The Land of Lilliput

In Buckinghamshire, there exists a whole town of models, through which has been built the most fascinating railway. The place is known as Bekonscot, and it has gradually come into being over a number of years. It has chiefly been constructed by a Mr. Callingham and his gardener, in a beautiful rockery, and people come from all parts to visit this land of Lilliput. A fee of one shilling, or sixpence for kiddies, is charged for admission and many thousands of pounds have been collected for charities in this way. The grounds may be visited on the first Saturday afternoon of each month from April to October, or every Sunday afternoon, over the same period. Bekonscot is not merely a model railway, nor is it a collection of toys, for everything is permanent, and is largely actuated by electricity. The scale of one inch to the foot is adhered to as closely as possible, so that the visitor has a profound surprise when he sees it for the first time.

One enters the garden along a path which is arranged like a road. There are several 30 signs and de-restriction marks dotted at the wayside in true Belisha style. Two beautiful little stone churches may be seen in the garden, and one of these has reproduction-units concealed within, so that bells may be heard chiming in the belfry, followed by the strains of organ and choir, in the nave. An illuminated cross graces the foremost turret of the building, and the front end is embellished with real stained glass windows. Stunted yew trees surround the fine grass lawns of the enclosure and minute creepers cling to the flying buttresses. A little pathway leads to elaborate wrought-iron gates at the roadside.

> Built to a scale of 1 in. to the foot, this Miniature Town is not a collection of Toys, but everything is permanent, and is largely actuated by Electricity

Domestic Architecture

In the residential district of Bekonscot there are fine little specimens of domestic architecture. One sees houses and cottages of brick or stucco with half-timbered walls and eaves which support roofs which may be of slate, stone, tile or thatch. These villas are set in little gardens bordered by fences or little hedges with tiny gateways. Small rock-weeds and ice-plants make flowers for the beds, in correct proportion.

In the suburban roads there are 'phone kiosks, lamp-posts, Belisha beacons, pavements, kerbs, gutters and even drain grids. The populace consists of realistic wooden figures of people who are arranged at their various activities. Horses, waggons, cows, sheep and dogs are all to be seen and they set off the model buildings to a nicety. Bekonscot is always "up to the minute," and is changed with the seasons as well as from year to year.

The road leaves the suburbs and leads between fields until it climbs to a point above the harbour. As the visitor walks over a bridge, he can look down on to the railway track where locomotives are pulling a regular service of trains. He notices the care which has been lavished on the details of the permanent way. The metals are connected with fishplates and are set in steel chairs which are mounted on wooden sleepers in tar-bound stone chippings. It is so strongly made that the attendants tread on it without causing damage.

Electrified

The whole system is electrified and extends over 1,200 feet. All trains are regulated from the main control box and can be stopped, started and reversed at any point.

It is extremely fascinating to watch it working and to marvel at the ingenuity displayed in every particular of the scheme. On the main circuit, about four trains can be safely run at the same time. Rarely are the same four travelling together, however, for when an express runs to a standstill between main-line platforms, another train will emerge from a siding elsewhere in the circuit and take its place for a while. Traffic is then diverted through parallel platforms where there are no obstructions.

There are several stations, industrial sidings and halts, and there is also a connection to the dockside for shipping. At the terminus of the line there is a large station built of steel and glass, which contains everything down to subways and slot-machines. Along the edge of the track, one may see such items as watchmen's huts, signal wires and gradient signs. The line has several quite severe slants, but though their wheels often spin, the locomotives invariably keep on the move.

A "One Way" road leads close to the docks and wharves where large steamers are tied up. Every imaginable article of merchandise may be seen strewn about on the quays and towering cranes are installed for loading and unloading. A jetty stretches into the harbour and is terminated with a lighthouse which marks the dock entrance.

Windmill and Granary Siding

From this point, the rails climb steeply up to a windmill and granary siding, and the revolving vanes of this quaint little structure denote that business still flourishes. A pulley-jib protrudes aloft and sacks of flour are usually being lowered to a few "hands" who stand about and guide them into waiting railway trucks. Cattle and sheep graze on the surrounding uplands, but the town itself is seen across the harbour where big ships ride at their moorings. A few sailing

(*Continued on page* 604)

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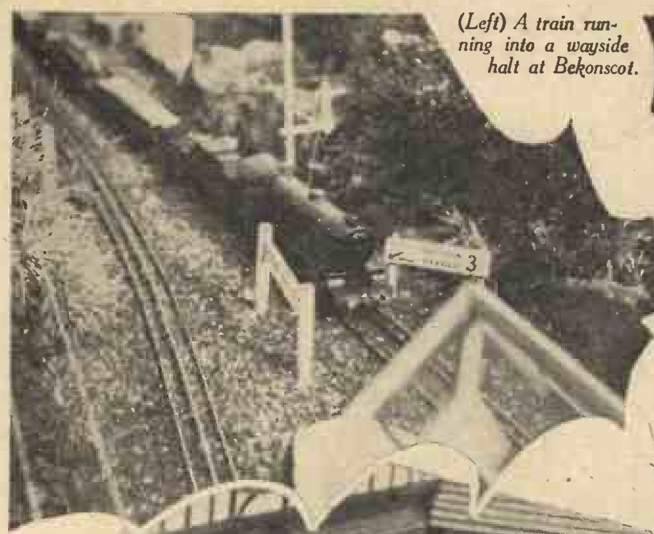
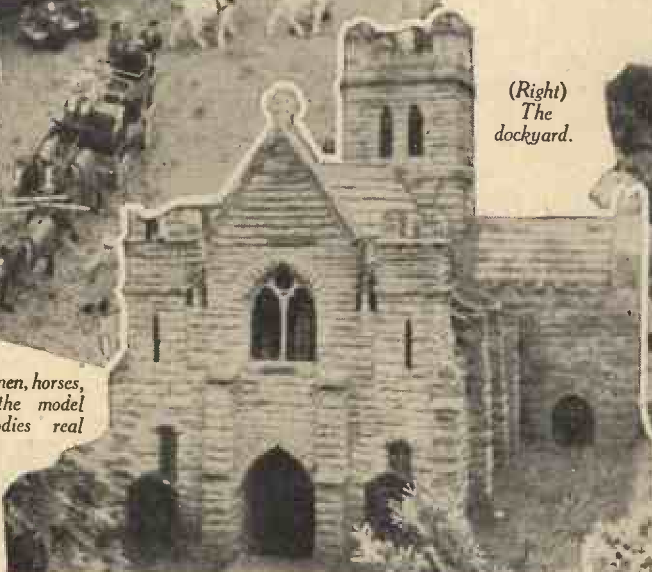
CAMEOS OF BEKONSCOT—The Model Village



(Left) A train running into a wayside halt at Bekonscot.

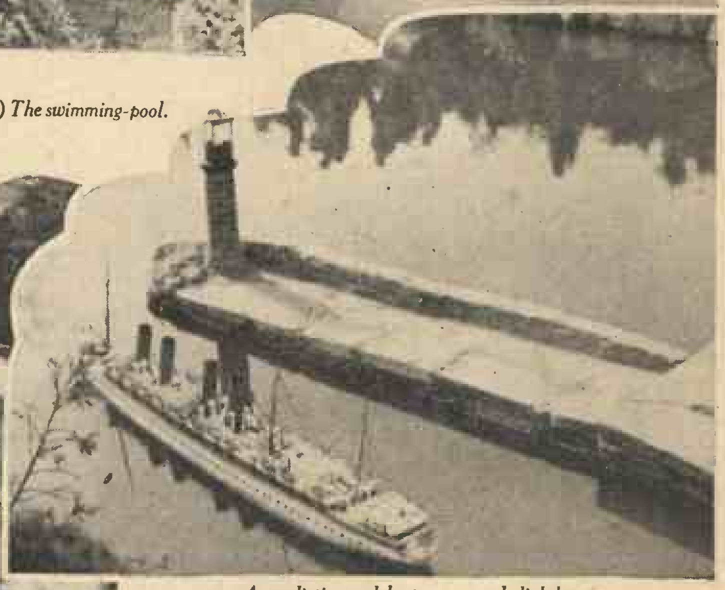
Huntsmen passing through the village.



(Above) Model coachmen, horses, etc., and (right) the model church which embodies real stained-glass windows, real stone, slate with lead linings, and a real peal of bells.

(Right) The dockyard.

(Left) The swimming-pool.



A realistic model steamer and lighthouse.

A Petrol-driven Low-wing Monoplane with Monocoque Fuselage

By C. E. Bowden

Fig. 6.—The model taking off under its own power

The Second Article of a Short Series Dealing with the Construction of an Interesting Type of Model Aeroplane

DRAW a longitudinal and central line along this plan view, again called "thrust line." Now take any "former" and carefully study Fig. 8. Measure half the width at the centre line in the plan view, and mark out to the left from where the "former" line cuts the "thrust line." Mark out a similar distance to the right. Now draw in the oval curves from the top line to the bottom line, so that the curves intersect the points where the two half widths of the fuselage end.

The operation is far more simple than the explanation and Fig. 8 will make the method clear.

Each former can be drawn in this manner, and as already explained, then traced on to the wood, either 3-ply or balsa, by means of carbon paper.

The wooden half formers can then be cut out.

No. 1 former is made in one piece from ¼-in. 5-ply wood. This former is a circle 2⅞-in. diameter and has a 1½-in. square cut out from the centre.

The engine is mounted on a cone mounting which will be described later. At the back of the engine mounting there is a raised square which fits into the cut-away square in No. 1 former. The engine and its mounting are thus detachable in the same way that the normal nosepiece is detachable in a rubber-driven model. On the engine mounting and No. 2 former, two wire hooks are bound with thread and glued. Thus the engine on its detachable nosepiece is held firmly to No. 1 former by elastic bands placed between the engine hooks and the fuselage hooks. Fig. 7 should be studied for details of this method of engine mounting, which permits the engine to be knocked off in the event of a bad landing, thus saving the engine and the fuselage from damage. If a rigid mounting of the engine is provided, damage is very likely to result, and a bent crankshaft is a very likely possibility. The forward end of the fuselage also usually suffers.

There is another great advantage in the detachable type of mounting. If the thrust line setting has to be altered in any direction, it is very easy to pack up the nosepiece with shavings of wood. Furthermore, it is only the matter of a second or two to remove the engine complete with its mounting when attention to engine details is desirable. Instead of bending over the fuselage in an awkward attitude, work may be comfortably carried out on the engine in any convenient place. Having glued both sides of the half ovals on to the back-bone and let them set firm the next thing to do is to add all the fuselage fittings.

There are two duralumin or brass under-carriage tubes to be fitted to Nos. 1 and 3 formers. These tubes should be of duralumin if possible as they are lighter. They are bound across the fuselage and eventually form anchorages for the detachable under-carriage legs.

It will be observed that the two formers to which these tubes are bound are both of 3-ply for strength.

Next, the several wire hooks for the elastic to retain the detachable engine and the detachable low wing up to the fuselage, must

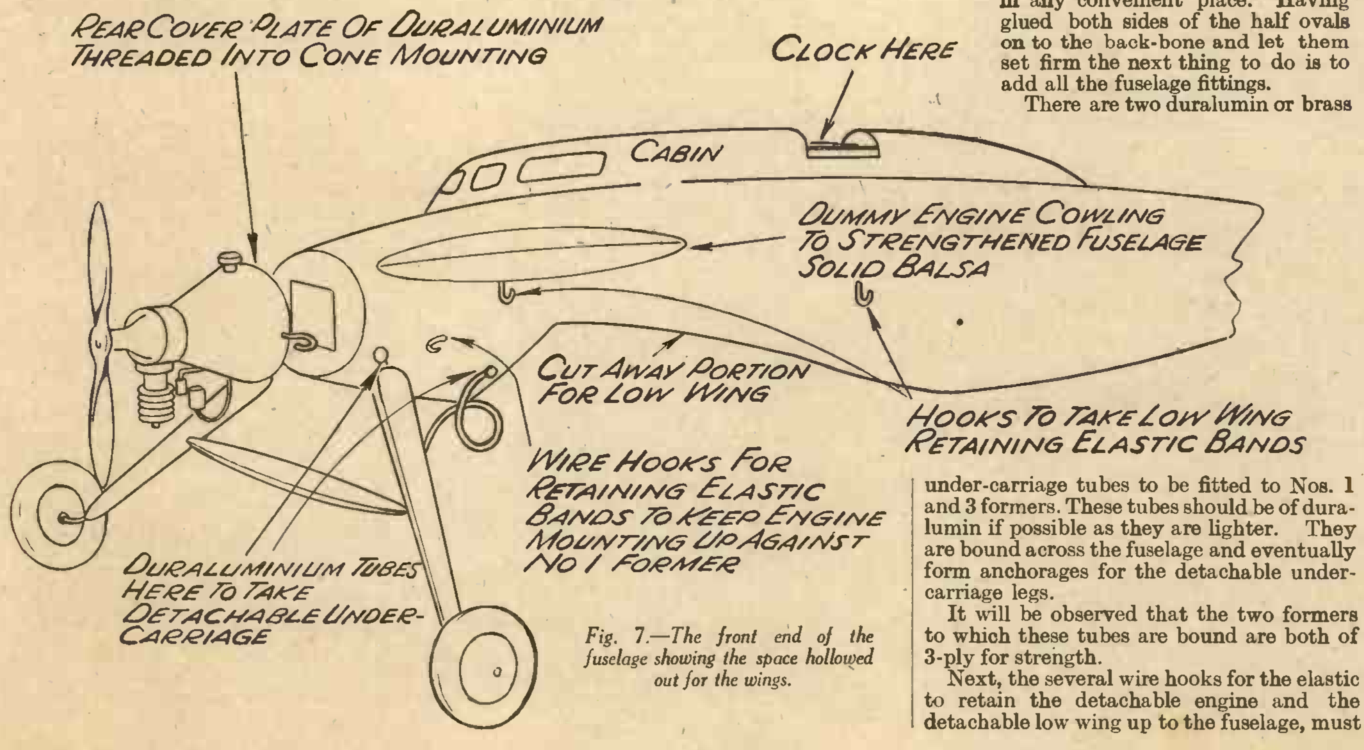


Fig. 7.—The front end of the fuselage showing the space hollowed out for the wings.

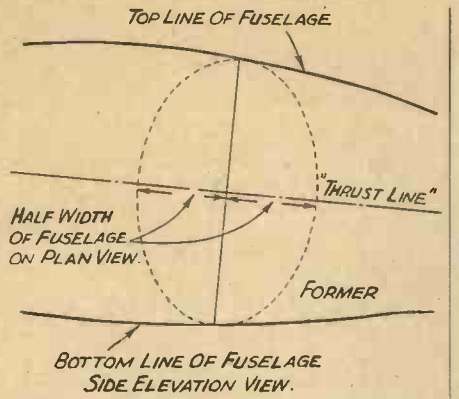


Fig. 8.—The method of drawing an oval former.

be fitted to their respective formers. These hooks are made from 18 S.W.G. wire and are bound firmly to their respective formers. Refer back to Fig. 7, and it should be made clear where these hooks are placed.

Fig. 5 is a sketch of the front end of the fuselage and shows how the front end is cut away underneath to form a platform for the location of the low wing. Owing to the angled shape of this cut-away, the low wing, although detachable and only reasonably tightly held up to the fuselage by its elastic bands, cannot readily move out of its correct position, either by engine vibration or slight blows. On the other hand, if a heavy blow is dealt the wing during a bad landing or crash, the elastic bands will give and the wing can give backwards and so save excessive damage.

After the hooks are fitted, the spaces between Nos. 1 and 3 formers should be filled in with solid balsa carved to the lines of the nose. This will strengthen up the front end enormously. The centre of these solid balsa insertions should be slightly hollowed out for lightness (see Fig. 10).

At the after end of the fuselage skeleton, at formers Nos. 15 and 16, two brass tubes to take 20 S.W.G. wire are bound across the fuselage and about one-third of the way up. These tubes form anchorages for the detachable tail wheel prongs in the same way as the two larger duralumin tubes at the fuselage nose take the undercarriage. A sketch of the undercarriage and tail wheel fittings will be given later when these two components are described in detail. At the extreme tail end of the fuselage a solid piece of balsa is shaped into a streamline point and glued on to the last balsa former.

The Second Phase of Construction

The fuselage is now ready for the second phase of construction in which the whole is covered with ⅛-in. square sectioned balsa wood stringers. These are positioned about ¼ in. apart. Some old model aeroplane elastic is wrapped lightly around the fuselage several times along its entire length. The ⅛ in. × ⅛ in. balsa lengths are then inserted under the elastic which keeps them hard up to the oval formers. It is a good plan to insert three at a time, and then ease them off to their correct distance of ¼ in. from each other.

If any slight mistakes have been made over the dimensions of the ovals of certain formers, then a tiny piece of balsa of the necessary thickness should be inserted, where necessary, between stringer and former until the stringers all present an even form. If this is not done, the final covered form will show an uneven skin.

Finally, lightly touch with glue, every point where the stringers contact with formers. Fig. 10 shows the strung fuselage, and also the solid balsa inserts at the nosepiece, already remarked upon.

Having completed the stringing with the ⅛ in. × ⅛ in. balsa lengths, the constructor should carefully go over it and make sure that there are no uneven ends or bumps. Then a 1-mm. thick 3-ply floor should be stuck to the cut-away underportion of the fuselage where the low wing will eventually be located. Whilst drying, elastic wrapped around the fuselage will keep this 3-ply in position. A 1-mm. 3-ply top should now be stuck on to the cut-away portion of the tail end of the fuselage. This will make a firm platform for the detachable tail unit (see Fig. 10).

Ignition Details

The next item is fitting the "Brown" ignition coil, condenser and necessary wiring. The coil and condenser are merely strapped down to the 1-mm. 3-ply floor inside the fuselage as near the front end of the low wing cut-away portion as possible.

The strapping is carried out with some light wire—a few stringers will have to be temporarily removed for this operation and then restuck into position. The wiring is carried to just behind the nosepiece No. 1 former and brought out through the stringing. The loose ends are temporarily marked with tickets. (See Fig. 9 for ignition details.)

One of the battery wires is taken up to the top of the fuselage and lead through the stringers behind former No. 8. It is broken here and left with two ends which later will be attached to the clock timing mechanism which controls the duration of flight. This wire is then carried back through the fuselage to the battery position.

The Battery Recess

The battery recess is now formed at the tail end of the low wing cut away portion of the fuselage, and is between formers Nos. 9 and 10. The stringers are removed by cutting away for the length of the 4-volt flat type pocket flash lamp battery used for ignition. Flat balsa pieces are then glued into the side of the fuselage so that a small recess is formed into which the flash lamp battery is pushed, with the two battery lead ends protruding. A little slack is allowed around the sides of the battery and a small piece of sponge rubber is wedged in after the battery has been inserted. In practice it has been found that the battery never moves or vibrates out. The rubber acts as a friction retainer.

The chief advantage is that the battery leads can be checked over after each flight and before the next flight.

I have found that if a battery is kept inside a fuselage with a trap door to gain access to it, a great deal of trouble has to be expended opening the trap door and inspecting the battery after each flight. Of course, the two battery leads are brought outside the fuselage.

Finally, as regards ignition I have fitted two ignition plugs flush with the side of the fuselage so that a large ground accumulator can be plugged in for starting up and running the engine. These plugs can then be withdrawn just prior to the flight. The wiring is so arranged that the pocket flash lamp battery comes into operation only when one closes a switch on the clock timing apparatus just prior to flight and before one removes the two external battery plugs. The two leads to the pocket flash lamp battery are brought out through the back of the battery recess and have two spring clips as used in wireless work. These clips spring out the brass contacts of the flash lamp battery.

(*To be continued*)

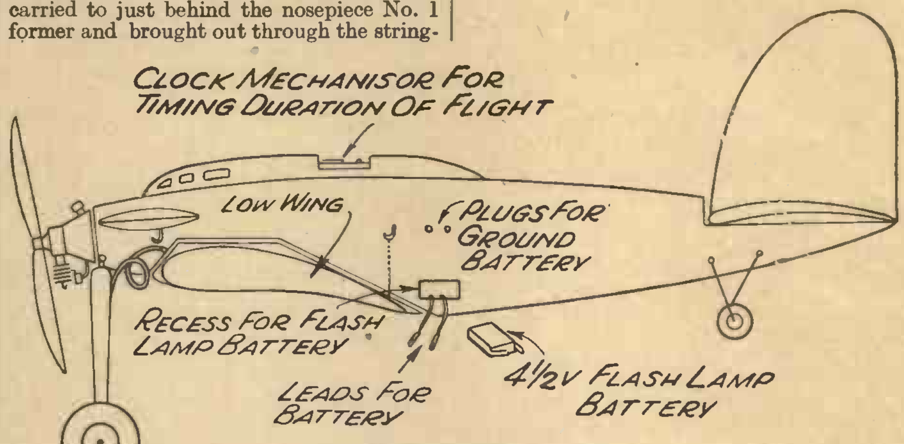
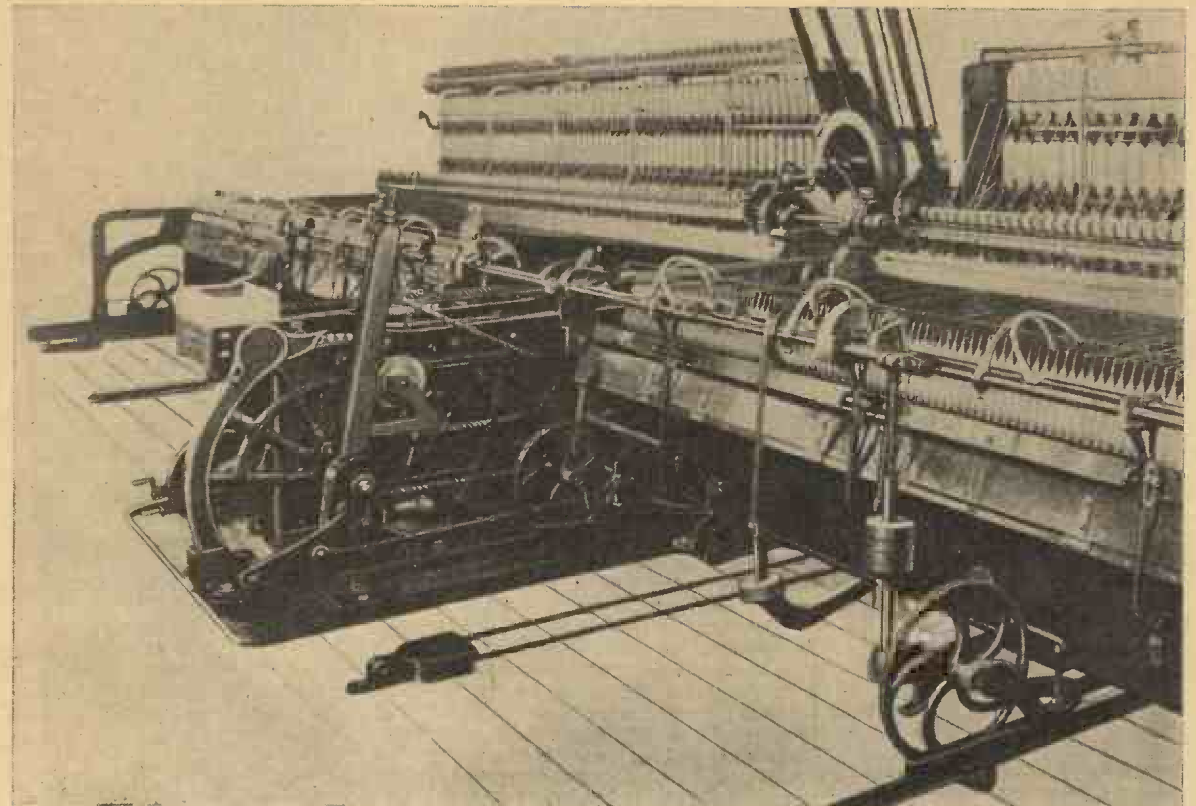


Fig. 9.—Details of the ignition.

Fig. 10.—The skeleton of the fuselage.

Masters of Mechanics



A modern version of Crompton's mule, a spinning mule made by Messrs. Dobson & Barlow, of Bolton. It is capable of turning out many miles of cotton thread per hour.

No. 11.—Samuel Crompton and the Story of the Spinning Mule

THE trials of an inventor are notoriously hard. In the whole history of invention, however, there are few chapters which relate a sadder story than that which sums up the life work of Samuel Crompton, of Bolton, the individual upon whose inventive ingenuity rests much of the former phenomenal success of the Lancashire cotton trade. Crompton's story constitutes one of the many important narrations of invention, for it deals with the origin and the rise of a mechanism which, to put it mildly, effected an almost instant revolution in industry.

On the outskirts of Bolton, Lancashire, situated high upon one of the surrounding moors, stands a quaint, secluded Elizabethan farm-mansion named "Hall i' th' Wood."

A Fitting Memorial

This farm-manison and the Lancashire cotton industry are inseparably associated. The mansion has now been acquired by the Bolton civic authorities, and it is being preserved for all time as a fitting memorial of an epoch-making invention which was produced within its walls more than a century and a half ago.

Bolton, now one of the most important of the Lancashire cotton towns was, in 1753—the year of Samuel Crompton's birth —a very small place known as *Bolton-in-the-Moors*. Crompton's people had been in possession of a small farm at Firewood, near Bolton, but misfortune had come upon them and the farm, after being mortgaged, was ultimately sold, the purchaser being a rich individual who, in addition to being the proprietor of various farm lands in the district, was also the owner of Hall i' th' Wood. In order to assist the hard-working Cromptons, this latter individual offered them the tenancy of Hall i' th' Wood, which was then unoccupied. The offer was accepted and it was not long before the Cromptons—father, mother and three children—settled down in their new home.

Work at an Early Age

When Samuel Crompton was a child of five, his father died at Hall i' th' Wood, and his mother was faced with the necessity of providing a livelihood for the family. This she did by marketing dairy produce and by following more assiduously than ever before the then very prevalent occupation of hand-loom weaver and home cotton-spinner. Needless to say, young Samuel and his sisters were pressed into cotton spinning and weaving occupations at a very early age in order to retrieve the family fortunes.

His First Home Produced Article

Improvements in methods of cotton preparation were slowly beginning to appear in Crompton's younger days. Hargreaves, in 1767, for instance, had invented his "spinning jenny," a machine which enormously facilitated the speed at which cotton could be spun into thread.

It was during this period that Crompton, now arisen to man's estate, constructed his first home-produced article—a violin. The success of his violin construction and the irritation created by the inefficiency of the spinning machine which had been erected at Hall i' th' Wood are the factors which seem to have turned Crompton's mind to matters mechanical. He was seized with a desire to build a spinning machine which would not only speed up production but which would also enable a much finer yarn to be spun than was at that time possible with existing machinery. Exactly how Crompton first obtained the notion of his Spinning Mule is not known. We do know, however, that for five long years, from 1774 until 1779, Crompton gave himself up in his spare time almost wholly to the construction of a new spinning machine. In almost every respect, he was severely handicapped. For one thing, the spinning machine construction had to be carried out in his spare time, which usually meant that Crompton had to work half through the night. Again, he possessed very few tools and, in order to acquire their necessary purchase money, the hard-working inventor actually took on the job of fiddle-playing at the Bolton Theatre for the princely sum of one and sixpence a night. But even here his handicaps did not cease. Crompton, previously, had had little experience with tools, and he found it necessary to teach himself the use of the various implements which he obtained. It was a long and a tedious process, but, ultimately, success came.

Unpopular Individuals

Inventors and machine-constructors in Crompton's day were decidedly unpopular individuals. They were looked upon with contempt and termed "conjurors," an epithet of dislike. For reasons based upon the above facts, Crompton had, from the beginnings of his spinning-mule construction, decided to keep the machine and its making a secret. During winter nights, however, when neighbours saw strange lights in the upper windows of Hall i' th' Wood, it became impossible for the inventor to keep his activities entirely hidden. At first, rumour got abroad that Hall i' th' Wood was haunted, but quickly the district discovered that the supposed hauntings were nothing more than Sam Crompton's "fashing hissel' o'er bits of wood and iron."

The old-time spinning wheel, the simple, homely device universally employed for spinning yarn previous to the invention of Crompton.

Soon after Crompton had finished the construction of his machine, he had to take it to pieces and hide the component parts for fear of the machine being wrecked by riotous bands of machinery destroying operatives in the neighbourhood. "Machinery," said the average humble homeweavers of Crompton's time, "destroys labour and takes away the means of subsistence. Let us, therefore, destroy all the new-fangled machines which we can find."

In time, however, the machinery riots in the district died down and Crompton reassembled his machine and produced his first yarn on it. Crompton's new spinning machine imitated the finger and arm movements of the hand spinner and, besides speeding up production, enabled thread of then unprecedented fineness to be spun. At the head of Crompton's machine, was fixed a bar or frame (called a "creel") upoe which were placed reels of the fibre to bn spun. In front of the creel, two pairs of rollers operated and these drew out the thread from the bobbins on the former. At some distance away was placed a sliding stand, known as a "carriage," upon which spindles were mounted. Mechanism enabled the thread to be drawn in fine filaments from the rollers, to be twisted in order to hold it together, and then to be wound continuously upon the spindles on the carriage.

Marketing the Yarns

When Crompton first marketed his fine yarns produced upon his new machine, the cotton merchants were astonished and Crompton made good prices for his cotton wares. It was during this period that he married and he and his wife set up the new machine in one of the upper rooms of Hall i' th' Wood.

It was very plain to the cotton merchants that Crompton was possessed of an extremely valuable and money-making secret. Since the machine's inventor refused to disclose the nature of his contrivance, interested persons of all descriptions made every attempt to get to know the working of the "Hall i' th' Wood Wheel," as Crompton's spinning machine was first called. Disguised persons endeavoured to get employment under Crompton. People peered in through the Hall 'i th' Wood windows, and, at nights, they ran ladders up against the sides of the old timbered house and looked in through even the upper windows in their endeavours to penetrate Crompton's secret. The renowned Sir Richard Arkwright, the successful inventor of the water frame and other cotton-producing machinery, with meanness which was characteristic of him, went to see Crompton ostensibly on a friendly visit, but, in truth, in the hopes of fathoming his secret.

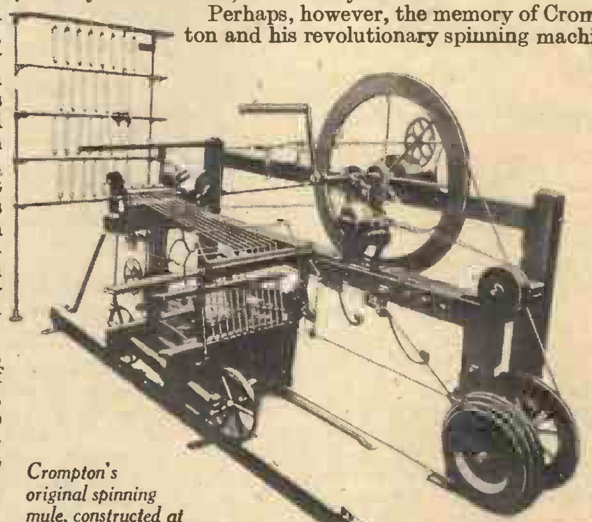
The Secret Disclosed

At last, tired out and distressed by these disturbances and importunancies, Crompton gave way to the crowd of enquirers and, acting upon so-called friendly advice, he revealed the secret of his machine to a number of cotton manufacturers on the understanding that he was to be given a substantial monetary return. "I found to my sorrow," said poor Crompton afterwards, when recounting his disappointments, "that I was not calculated to contend with men of the world, neither did I know there was such a thing as protection for me on earth. I found I was an unfitted for the task which was before me as a child of two years to contend with a disciplined army."

In return for the free gifts of his unpatented machine, all that Crompton received from his manufacturing "friends" was the marvellous sum of £67 6*s.* 6*d.* Many of the manufacturers who had taken Crompton's machine, refused point-blank to pay him anything and, upon Crompton persisting in his claims, he was rewarded with nothing more than violently abusive language.

Little wonder it is that Crompton, as he passed his middle age, became an embittered, solitary individual, a disappointed man who shunned sociability and who became, if anything, actually churlish.

From this time onwards, Crompton's life was one of repeated vexations, sorrow, and disappointments. True it is that there were influential individuals—Sir Robert Peel, for one—who endeavoured in some way to aid the ageing inventor, but Crompton's character and life-outlook had been ruined and, at times, he behaved with great incivility to his would-be helpers.



Crompton's original spinning mule, constructed at Hall i' th' Wood in 1779.

The increasing poverty of Crompton was made a matter of semi-public inquiry. It was, in 1812, proposed in Parliament to grant the inventor, whose spinning machine was now bringing untold riches to the cotton manufacturers of Lancashire, an honorarium amounting to £20,000. Unfortunately, the Prime Minister, Mr. Perceval, who had been favourably influenced in the proposal, was assassinated in the lobby of the House of Commons and Crompton's claim was forthwith dropped.

A £5,000 Grant

Eventually, however, Parliament granted Crompton the sum of £5,000, a small enough amount in very truth, since it was proved that Crompton's basic invention had enriched the country's revenue to the tune of no less than £350,000 per year. Crompton accepted the £5,000 and he forthwith proceeded to invest it in a bleaching concern at Darwen, not far from Bolton. Almost as soon as the latter concern had got on its feet, complicated litigation arose concerning certain problems of right and Crompton's £5,000 was quickly swallowed up.

Once again unsuccessful, Crompton returned to Bolton and re-entered the cotton spinning business in a very small way. But the former inventor was now too old to make headway for himself. Quickly he sank into greater and greater poverty and if it had not been for the purchase of an annuity of £63 which some of the firms operating his spinning mule made on his behalf, he would have ended his life in the workhouse.

Crompton enjoyed his annuity for two years. In June, 1827 he died, worn out with vexations and acute disappointments, some of which, in strict justice, it must be related, were of his own making.

As a master of mechanics, Crompton occupies the rare position of being an entirely self-taught engineer. His failure in life occurred in consequence of his lack of possession of that degree of self-assertion which is so necessary to the success of the pioneer.

Memory Honoured

Crompton's memory is to-day honoured in his native town of Bolton. A rich slab stands over his tomb and in one of Bolton's principal squares, the statue of the inventor rests upon a massive pedestal. Such; indeed, is the irony of Fate.

Perhaps, however, the memory of Crompton and his revolutionary spinning machine which would be dearest to the heart of the inventor is that association-saturated black and white timbered building which still stands quietly and undisturbed by the passage of time upon a moorland plateau above Bolton town. "Hall i' th' Wood" is more than a mere picturesque survival. It is, indeed, an existing embodiment of Samuel Crompton and his unfortunate struggles for recognition, as well as being the veritable birthplace of one of the biggest industries which the world has ever seen.

Where the railway crosses the drive in front of the house. The traction-engine is driven by Captain Holder's chief mechanic and chauffeur.

AN IDEAL GARDEN RAILWAY

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

A Visit to Captain Holder's 2-in. scale Garden Railway

SITUATED in one of the most beautiful spots in Hampshire, off the main road between Beaulieu and Lymington, is Captain J. A. Holder's new residence "Keeping."

Captain Holder has always been an outstanding figure in the model railway world and his previous home at Broome, near Stourbridge, contained the finest private passenger carrying garden railway ever constructed in this country.

His locomotive stock was varied and interesting, and his workshops finely equipped. After settling down at "Keeping," he could not resist the temptation to relay a portion of his $10\frac{1}{4}$-in. line on his new estate.

Space has prevented his installing such an elaborate system as at Broome, but it is none the less engrossing, and recently the writer visited "Keeping" and spent a very pleasant day filming and taking still pictures of the "high spots" of this attractive garden railway.

Captain Holder meets and conveys his guests from the station to "Keeping" in his historic De Dion motor-car, which dates back to 1909. The car is in excellent condition for its age, and lands its passengers safely outside his front door, after an invigorating drive, and from thence they can at once join the miniature train.

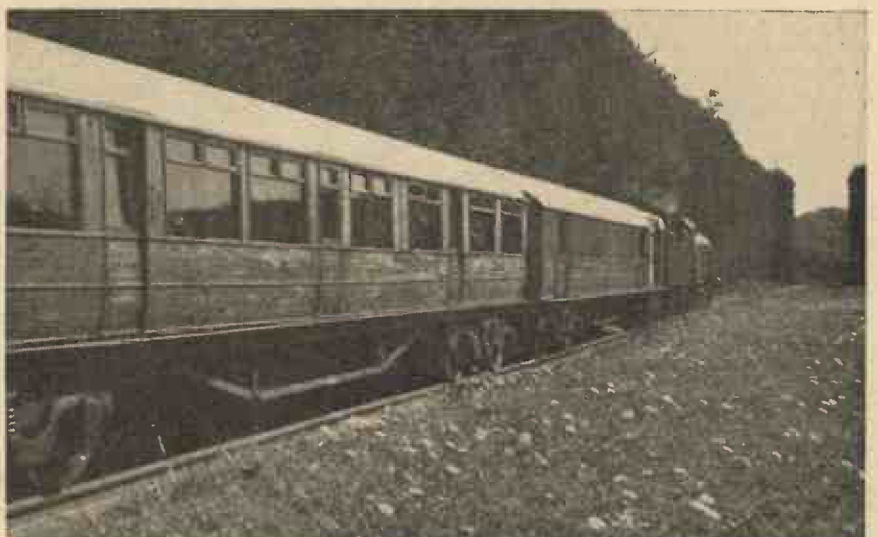
A Circular Route

The line is a circular route with points leading to the locomotive sheds. It is a simple and effective layout. At one point the line crosses a stream before reaching the front of the house, and this makes appropriate the well-designed lattice girder bridge which spans the water.

The main locomotive is "Audrey," which has been reconstructed since he left Broome and is a very powerful engine. It is a 4–6–2 tender engine, with cylinders $3\frac{1}{2}$ in. × $5\frac{1}{4}$ in., and coupled wheels of 14-in. diameter. The boiler is 14 in. diameter and 5 ft. 9 in., fitted with Duplex feed pump, has a working pressure of 150 pounds per square inch and the complete engine weighs $1\frac{1}{2}$ tons.

The second locomotive is the "Mary," a 4–6–4 tank with cylinders $3\frac{1}{2}$ in. × 5 in., and coupled wheels 12 in. diameter and wheel base 3 ft. 6 in. The boiler pressure is 120 lbs., the total length 10 ft., and the weight 1 ton.

Last and most treasured of all is the 2-in.



The rear of the 2-in. scale L.N.E.R. Express Passenger Train.

The 2-in. scale L.N.E.R. Express Passenger Train.

scale L.N.E.R. Atlantic type locomotive, originally built by Bassett-Lowke Ltd., of Northampton, and since altered to suit Captain Holder's gauge. He calls it the Royal locomotive, because, as far as it is possible to ascertain, this is the only model locomotive that ever hauled his late Majesty King George V. The occasion of this Royal ride was at the Wembley Exhibition in 1927, when this locomotive also carried Queen Mary and other distinguished members of the Royal Family, and was one of Treasure Island's most popular features.

Captain Holder has given this locomotive a further realistic appearance by adding to it a train of L.N.E.R. scale model coaches, which were originally built for a film production, and this train attains a fine speed on the track. The coaches are made throughout in hard wood, painted and lined in the correct colours of the L.N.E.R. and mounted on sprung four-wheel bogies.

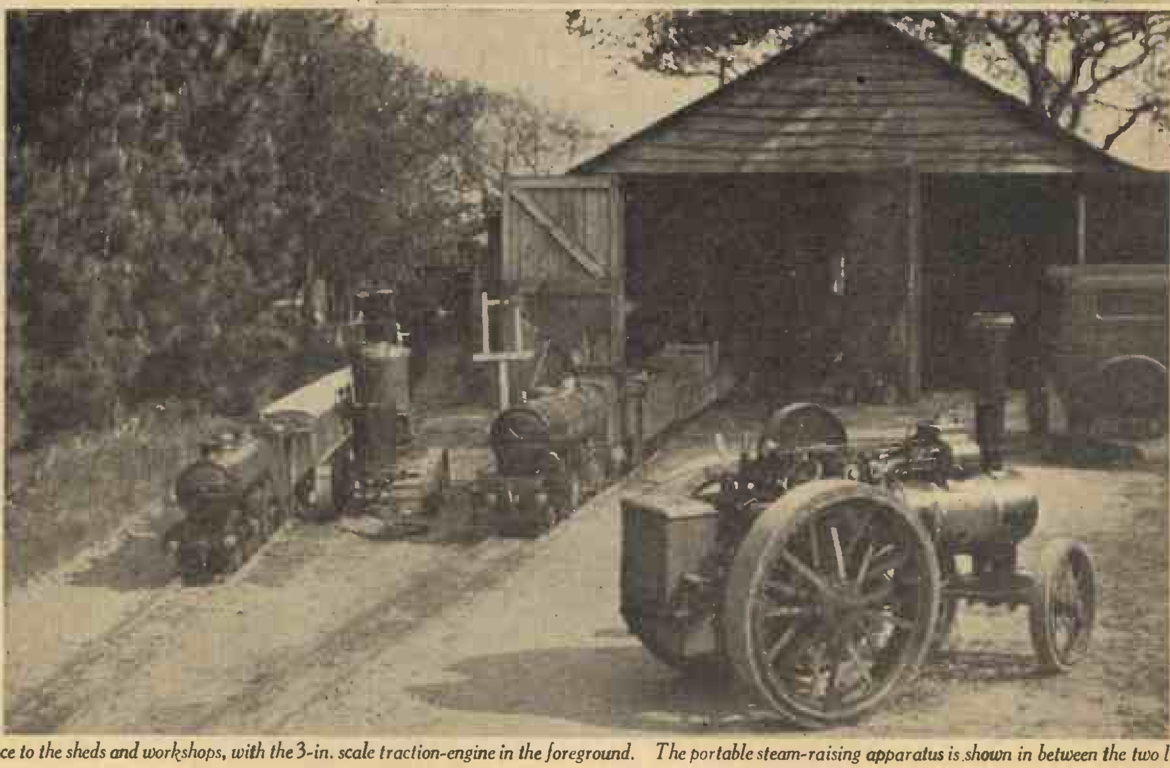
Raising Steam

Steam raising on all the models is achieved by a portable vertical engine and boiler blower. In his workshops there are models of all sorts and sizes undergoing reconstruction or building, and while looking round I saw an 0–4–2 $7\frac{1}{4}$-in. gauge tank which he had been reconditioning for a friend.

He has a very powerful 3-in. scale traction engine, which stands about 3 ft. 6 in. high and has cylinders 3 in. × 5 in. and driving wheels 2 ft. 6 in. in diameter. This engine is an excellent runabout, and also can be used as a stationary engine.

In addition to his hobby of model making, Captain Holder is also an enthusiastic amateur photographer and has filled a large album with photographs of various models he has constructed, and of distinguished visitors to his railways, either at Broome or "Keeping." He is hoping in the near future to acquire more land adjoining his estate so that he can still further extend his line.

(Below) The L.N.E.R. Passenger Express leaving the sheds.



The entrance to the sheds and workshops, with the 3-in. scale traction-engine in the foreground. The portable steam-raising apparatus is shown in between the two locomotives.

Equipment for Testing the Thrust of Airscrews

Methods of Testing Both Rubber-Driven and Petrol-Driven Propellers

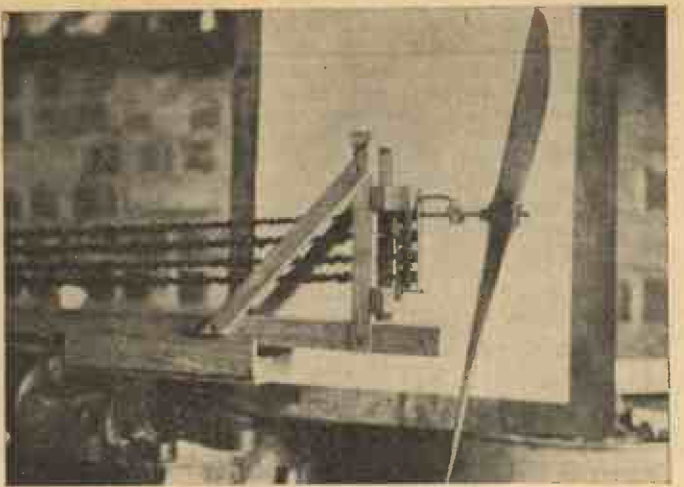


Fig. 1.—A photograph of the testing device.

DURING recent years, the development of large model aircraft powered by petrol engines has called for a change in propeller testing technique of no small importance. The reason for this is that whilst the rubber-driven propeller had transmitted to it a gradually decreasing amount of power; the petrol engine has given to the aeromodellist the considerable advantage of a reasonably constant-power output during flight.

Now the increase in size of machine, whether rubber driven or petrol engined, necessarily calls for more and more "bench" and "ground" testing, prior to launching the machine, since the larger the machine the more labour put into it, and the less inclined is the constructor to tempt fate by "trial and error" method. Consequently, advantage should be taken, wherever possible, of carrying out all tests, which, by their results, may prevent an unfortunate crash on perhaps the maiden flight. In regard to at least one very important part of any aircraft, the propeller, it is advisable to obtain as much information as is possible of its characteristics during different conditions of operation. The purpose of this article is to describe methods of testing both rubber-driven and petrol-driven propellers, from which full particulars of torque and thrust may be obtained.

Petrol-Engined Models

The petrol engine-driven propeller can be tested by driving it by an electric motor, when direct readings may be obtained of the

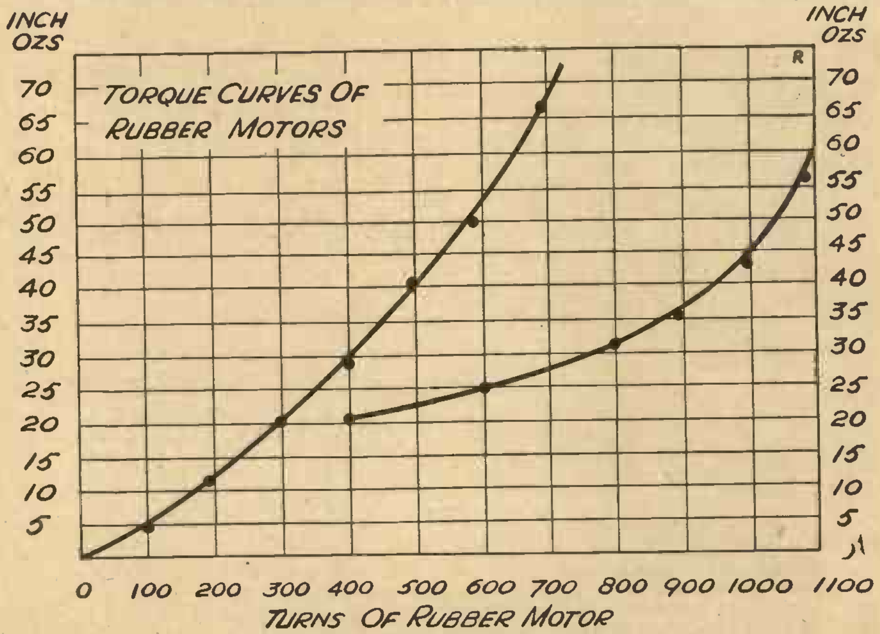


Fig. 2.—Two curves of different rubber motors.

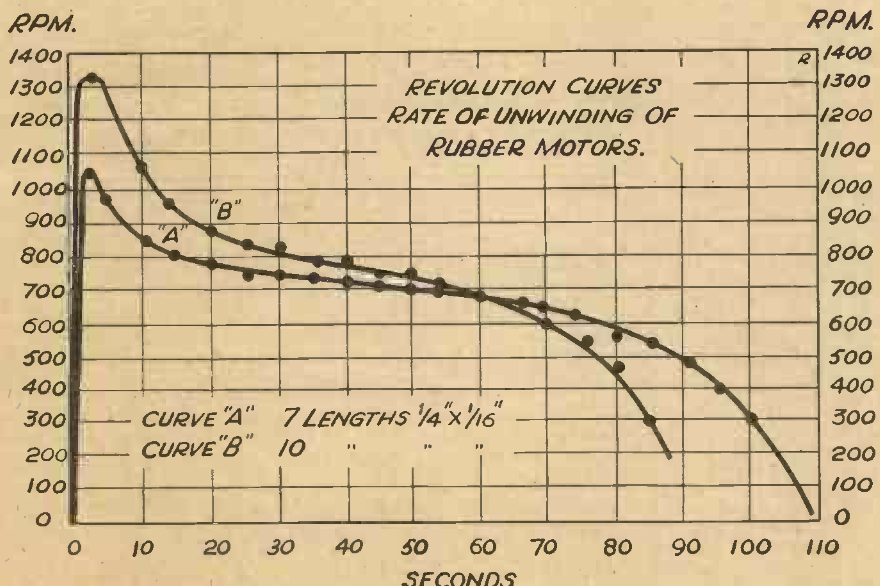


Fig. 3.—Graph of ascending propeller revolutions.

thrust. But with the rubber-driven propeller, however, the position is complicated by the fact that the power delivered by the twisted rubber is decreasing all the time. Now the tendency of rubber, when twisted, is to develop a torque which increases more rapidly than in direct proportion to the number of twists imparted to the rubber, and because of this, it is considered essential to test the rubber motor and propeller as one unit. The result of this rapid increase in torque as the number of twists increase often has the effect of producting a steep climb after the "take-off," culminating in a stall and crash to the ground with disastrous consequences.

A further reason, for treating the rubber motor and propeller as one unit, lies in the fact that for a duration flight, when time off the ground is a deciding factor, a long "flat" climb, with a consequent increase in length of time off the ground—can often be achieved by a careful arrangement of the length and number of strands of elastic. At the same time, the diameter and pitch of the propeller have to be taken into consideration, and therefore it is advisable

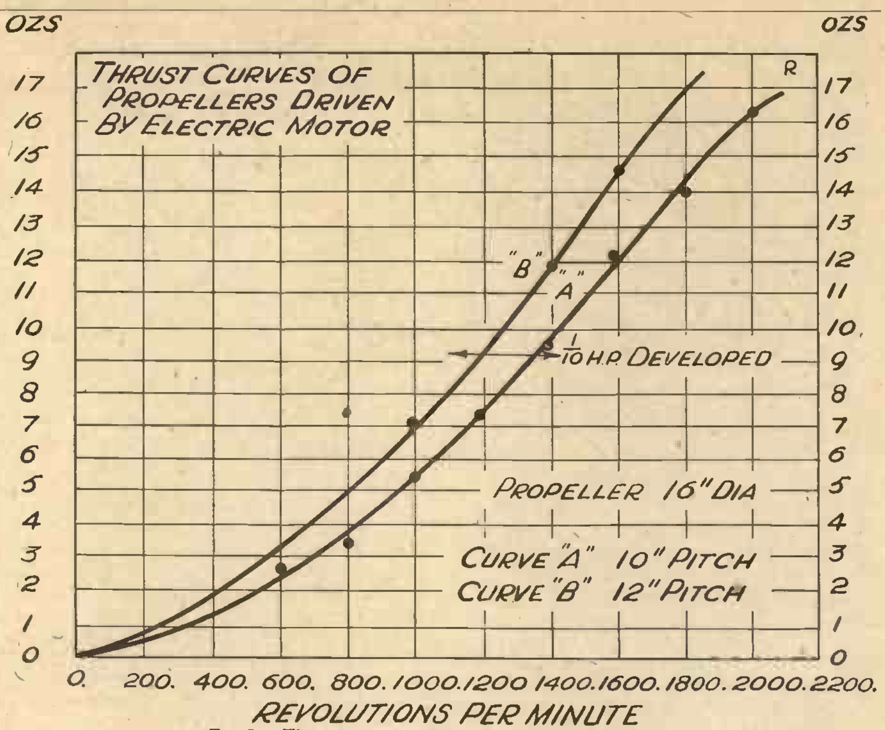


Fig. 5.—Thrust curves of electric motor-driven propellers.

that the motor and propeller should be tested as one unit.

Getting Large Machines off the Ground

There is, however, one advantage over petrol engines, to be derived from this very high initial torque developed by the rubber motor, and that is in getting machines off the ground. The "tractive resistance" can amount to as much as ¾ lb. in the case of a 4 lb. machine with rubber tyres on grass, and since this resistance gradually reduces to zero as the machine leaves the ground it is obvious that a very satisfactory "take-off" can be achieved if the initial falling off in power can be made to decrease *at the same rate* as the tractive resistance reduces as the machine rises from the ground.

It follows, then, that any tests which can be carried out which will enable these conditions to be met, will be well repaid—and before proceeding to a description of the necessary plant required, reference may be made to Figs. 2 and 3, which illustrate, in a very definite manner, the force of the arguments set forth in favour of testing the rubber motor and propeller as one unit.

Fig. 2 shows two curves of different motors—in which the rapid increase in torque as the number of turns increases is clearly shown. In Fig. 3 is shown two curves or propeller revolutions, obtained from (*a*) an arrangement of seven lengths of ¼ in. by $\frac{1}{16}$ in. rubber and (*b*) 10 lengths of ¼ in. × $\frac{1}{16}$ rubber. In each case, the rubber drives a 16 in. diameter propeller of 14in. pitch.

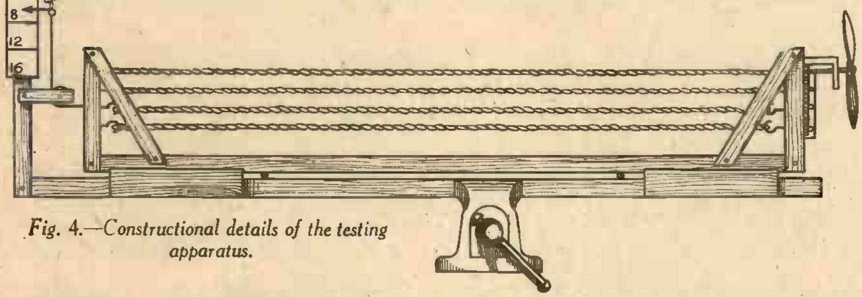
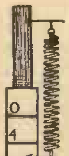



Fig. 4.—Constructional details of the testing apparatus.

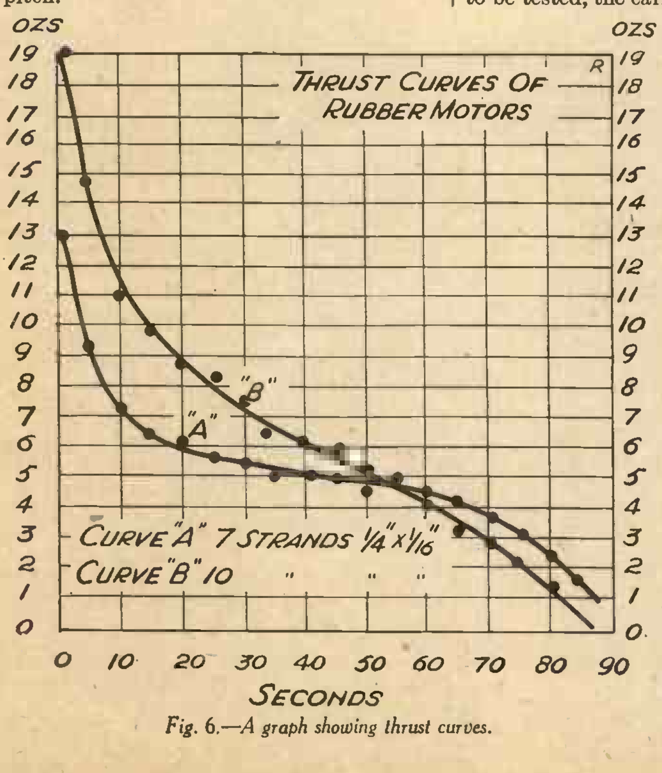


Fig. 6.—A graph showing thrust curves.

The Testing Apparatus

The sketch, Fig. 4, shows the plant on which the tests are carried out. Essentially, it consists of a carriage on which is mounted the rubber motor and propeller to be tested, the carriage being free to move on rollers in a fore and aft direction along the sloping runway. This runway is held for convenience in a bench vice, and is thus easily adjustable as to its angle of incline. When a given motor and propeller have been assembled, the runway is set so that the carriage will just *not* run down the incline. This has the effect of reducing the "tractive resistance" (in this case the friction of the rollers on which the carriage runs) to a negligible quantity.

To the back end of the carriage is attached a thread which passes under a pulley and up to the lower end of a vertically mounted spring which, up to a certain limit, has a constant rate of extension per ounce of added weight. To the lower end of the spring, where the thread joins it, is fixed a pointer which moves across a scale marked in ounces. (This scale has, of course, been previously calibrated by weights hung direct on to the spring.)

Propeller Thrust

In operation, after the motor and propeller to be tested have been mounted on the carriage and wound up, the thread is detached from the spring, and the runway adjusted as already described. The thread is then fixed to the spring and the motor released; immediately the carriage moves forward, the thrust in ounces being indicated by the pointer on the scale. As the power falls off, the spring pulls the carriage backwards until finally, when the motor has completely unwound, the pointer is back at zero.

During the test, 5 seconds (and with practice 3 seconds), readings are taken with the aid of a stop watch, and thus accurate curves may be drawn showing the rate at which the power falls off.

Details of the Motor

The 4-spindle motor shown in Fig. 1 is fitted with ball thrust bearings behind each gear wheel, and the propeller spindle is also equipped with roller bearings to take the radial thrust. Thus, the motor may be considered as practically frictionless, and the curves obtained can truly be said to indicate the power developed by the rubber motor and propeller unit. Readings are also taken with a revolution counter and the results compared with the thrust, and this information allows the rubber motor to be so arranged that it will (say for a duration flight) deliver as constant an output for as long as possible, at a figure just in excess of the minimum at which the machine will fly.

The Graphs

In Fig. 6, curve "A" shows an initial thrust of 13 oz. quickly falling off to about an average of 5 oz., which is suitable for a machine not too heavily loaded, which can rise off a good surface (it *must* take off within about three seconds) and from which a

(*Continued on page 604*)

This Month in the World of Science,

Continental Canals

EVERYONE visiting the Continent is amazed at the extent and development of Continental canals and commercial waterways. Recent figures state that in France alone over 50,000,000 tons of merchandise are moved by barge along 4,000 miles of waterways. Continental barges are much larger than those in use on English canals. The standard size is over 300 tons burden, 125 ft. in length, 16 ft. in beam, and drawing 6 ft. of water. The locks to take these are large in proportion. Where traffic is intense, they are duplicated, and have electrically-operated gates and sluicing pumps.

The barges are not self-propelled. The wash, which would be created in this way, is considered too great for the canal banks. Electric tractors operating on tram tracks along the banks are largely used. Over 150 barges per day pass through the busier sections of tractor-hauled canal in Northern France. Speeds of towing have been increased by making the canals wider and deeper. A barge travels easier in deep, wide waterways, than in narrow shallow cuts where the water would not slip easily between the barge and the banks and canal bottom.

Yet another development is the use of barge lifts for bridging vertical distances too great for a single lock. Thus, on the Rhine, one lifting over a height of 116 ft. has been recently opened. It consists of a trough 300 ft. long, 40 ft. wide, and 9 ft. deep. It is closed at its ends by watertight doors.

The barge is ferried in at the lower level, the gates are closed, and 300-h.p. motors raise the trough up an inclined track by a rack gear. At the top it engages with the other end of the system. Coincidence of the water levels in the trough is judged by a photo-electric ray and relay, which stops the trough at the right moment. Extension pieces are joined up and the sluices are opened for the barge to sail out on the new level.

The whole process is under push-button control. This is the modern engineers' solution of a problem which was met, up to quite recent times, by flighting up a stair of locks. On some English canal systems, stairs of as many as sixty locks in a single flight are still in use.

The World's Largest Gas-holder

THE Ford Motor Company have begun work at their Rouge factory on what is believed will be the largest gas-holder in the world. The holder, which will be constructed entirely of welded steel plates, will be 220 ft. in diameter and 344 ft. high. It will contain nearly 13,000,000 cubic feet of gas.

Gas and Coal

TALKING about gas, almost every reader must know that it comes from coal, but how many people know of the many "by-products" which are produced at the gas-works? For example, in addition to the 14,000 cubic feet of gas which is obtained from a single ton of coal, no less than 14 cwt. of coke is obtained besides 10 galls. of tar, 15 galls. of crude ammonia liquor, and 2 galls. of crude benzole.

Refinement of the coal-tar results eventually in the production of about 1,200 different dyes, creosote, synthetic resins, many different drugs, antiseptics, perfumes, varnishes, anæsthetics, saccharine, and many other products of similar nature.

The first large-scale attempt to discover whether Britain contains sufficient oil to satisfy her needs and to free her from almost total dependence on foreign supplies was inaugurated recently on Portsdown Hill, above Portsmouth Harbour, where drilling operations were begun. The plant is capable of driving a 2-ft. diameter bore to a depth of 3 miles, and the huge derrick 136 ft. high, forms a new landmark on the horizon.

From the ammonia liquor is derived sulphate of ammonia—a valuable fertiliser, ammonia for refrigerators and other purposes, ammonium carbonate for the making of baking powder, and sulphuric acid used in many industrial and other applications.

The benzol is refined and used as motor spirit, and even the flue dust from the gas works is collected and used for the manufacture of anti-corrosive paints and for liquid metal polish.

A Modern Marine Diesel Engine

SIMPLICITY of control is the keynote of a new power unit designed for the New Zealand mixed freighter M.S. *Mantua*. Twin Diesel engines, each of 3,000 h.p., drive separate screws. Their stroke is nearly 4 ft., the cylinder bore close on 2 ft. They rev. at only 120 r.p.m., and so can be connected directly to the propeller shafts. In this type, fuel is injected by a separate fuel pump. Reversing is effected without altering the set of the cams operating the pumps, by admitting air one side or other of top dead centre. The whole control for manœuvring is carried out by two levers, a fuel lever and the starting air lever.

The fuel lever is connected by eccentrics to control both the amount of the fuel and the timing of admission to suit the required power output. It is to be remembered that Diesel engines, just like steam engines, can make use of variable cut-off to obtain variation in power output. Control of individual cylinders is a feature of these marine giants. Indicating gear is fitted to each cylinder so that its working can be watched in running. If necessary, individual cylinders can be cut out for repair or adjustment without stopping the whole engine.

Petrol in Great Britain

IN an address to petroleum technologists, an oil expert recently stated that the drilling operations at present being undertaken in Great Britain are explorations of an entirely new character of the deep-seated strata of the British Isles. Seepage of oil in Midland coal mines and Scotch shale mines show signs of oil present. Their origin has never been traced. Certainly there are no signs of the relatively shallow "domes" of oil sands, which form the bulk of American oil reserves. These sands lie from 4,000 to 10,000 ft. under the surface. Present experimental bore holes in Great Britain will probably go well below the 10,000 mark. Who can say what geological secrets such exploration will show ?

Invention and Progress

Streamlined Trains

WHETHER or not the trains of this country will ever be properly streamlined is difficult to foretell, but the importance of stream-lining on high-speed expresses has been emphasised in a recent paper which points out that at 100 m.p.h. the air resistance amounts to 50 per cent. of the total drag on the train, while even at 60 m.p.h. it amounts to about 25 per cent. In this country, however, railways pay so little for their coal that it is doubtful whether the economy in fuel costs would justify the expense of streamlining.

Low Temperature Facts and Figures

DID you know that:

On the planet Neptune the temperature is so low that rubber would be as brittle as china and that mercury would make a suitable metal for hammers?

At the temperature of liquid air, fruits and vegetables are so brittle that they can be pulverised by a sharp blow?

That the Absolute Zero of temperature is 273·16° C., and *can never be reached*?

But that one scientist has got within ·002° of the Absolute Zero?

That all gases become liquids and then solids at very low temperatures. Helium, however, does not become liquid until its temperature is only 4·2° above Absolute Zero. It becomes a solid at less than 1° above Zero?

That liquid air is both magnetic and can conduct electricity?

Mississippi Alterations

A NUMBER of alterations to maps of North America have become necessary as the result of large-scale improvements to the course of the Mississippi River. The course of the river is a very tortuous one, and the wide shallow bed has been an unending source of trouble on account of the shifting banks of sand and mud.

Straightening and cutting is now in progress at many of the bends, which is resulting in bends of 10 to 20 miles being replaced by short-cuts of only 1 to 5 miles. Where the work has been completed, the flow is found to be faster and the river keeps its own bed clear with very little dredging. Not the least important blessing from the improvements is that the seasonal floods have been much reduced in severity.

Fault Detection in Metals

FRACTURES in iron or steel articles are frequently the result of some hidden fault in the body of the material. Such faults cannot be detected by inspection when the surface is undamaged, but a new method of magnetic detection has been developed by Metropolitan-Vickers, Ltd., which can detect even deep-seated faults. The principle depends upon the fact that in a uniform homogeneous material, lines of magnetic flux will be seriously distorted if any fault or fracture interrupts their path. Sensitive instruments are employed to detect any distortion of the magnetic field.

Some components, such as valve springs, for example, are unsuited by reason of their shape for examination in this way, and for such articles a method has been devised for the detection of minute surface cracks. A powerful current is passed through the article while immersed in a bath of finely powdered iron and oil. The iron powder clings to any surface crack, no matter how small, but does not adhere to any perfect area of the surface.

"Producer-gas" Transport

AN important stage in heavy motor transport has been marked by the development of a 4- to 5-ton lorry operating on "producer-gas,"—a gas which is derived from the partial combustion of air with water or steam and coke or anthracite.

The lorry has an ordinary internal combustion engine, but in addition to the usual petrol system, it is fitted with a "producer" which supplies the gas used for normal running. The petrol system is only used for manœuvering the lorry when it is not worth while lighting the producer which takes 3 to 5 minutes to get going. The cruising range of the lorry is stated to be 180-200 miles on one charge of fuel, and as an example of the very remarkable economies effected, it may be stated that one of these vehicles carrying a load of 4½ tons completed a journey of 93 miles at 23 m.p.h. with a total fuel consumption of only 157 lb. Assuming that the cost of fuel is 40*s.* per ton, the saving in fuel costs is over 70 per cent. compared with a petrol or Diesel oil vehicle.

Experimental work on vehicles of this type has been in progress for a number of years, but their disadvantage has been their lack of flexibility in traffic. The new vehicle, however, has an entirely new type of producer and is stated to be just as flexible as an ordinary car.

High-voltage Short Circuits

THE testing of switch gear and circuit breakers now supplied to the Grid connecting our network of power stations has become an onerous problem with electrical contracting companies.

The General Electric Company has tackled the problem of reproducing the effects of drastic short circuits by building itself a special turbo-alternator, capable of producing instantaneous currents of over 2,000,000 kilowatts. By this means switch gear and circuits can be tested and shorted at voltages of from 6,000 to 132,000 volts in the works before despatch. As a research unit, the installation is of incalculable value.

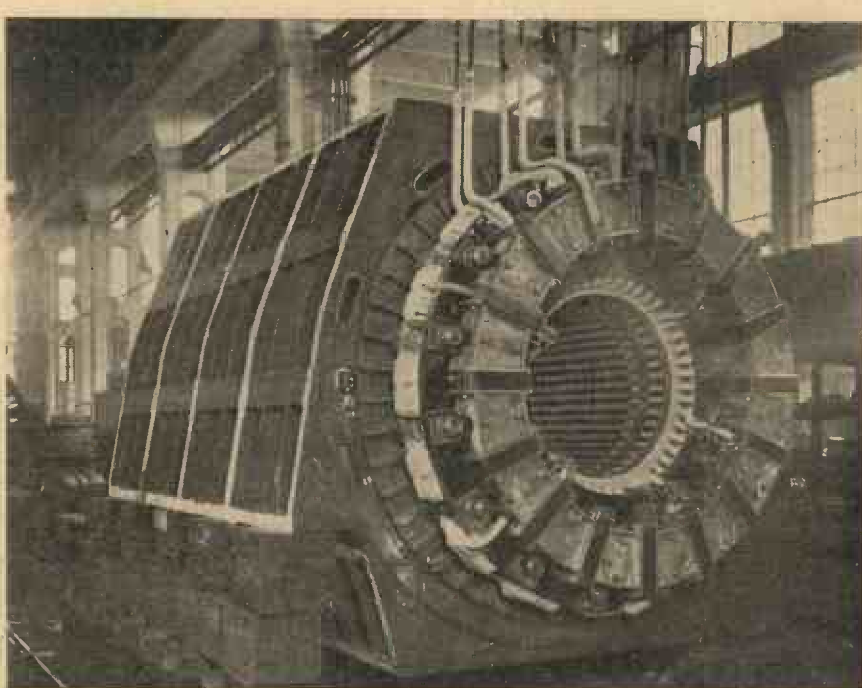
The alternator and turbine have to be of special construction to withstand the drastic effects of such gigantic short circuits. Their power is to be compared to the force of a lightning flash, and it is calculated that it will load up the alternator with forces of nearly 200 tons. To withstand these shock loads foundations and plant are of unusual strength. The stator casing, which is set by huge bolts on a deep-seated monolith of concrete sunk twelve feet in the ground, looks like the housing of a giant torpedo tube.

The bay containing the oil-immersed switch gear under test has to be specially guarded against fire. In emergency it can be isolated by a steel drop curtain and flooded with carbon-dioxide foam from fire-fighting appliances. To guard the delicate recording instruments from shock, they are isolated in a concrete blockhouse, built 30 yds. away from the main plant.

Gold Found in Wood

GOLD has been found in many places—in the heart of the earth, in sea-water and in river beds, and now from America we learn that it has been found in petrified wood.

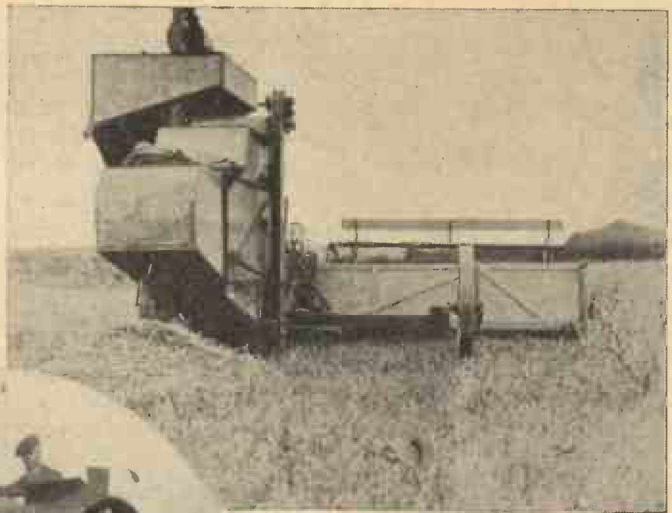
In Nevada is a small area where ancient logs have turned to crystalline silica and carbon by the action of hot vapours. Gold was evidently carried in solution at some period of volcanic activity, and it is now being extracted from the petrified wood where it had been deposited by a process of filtration.



(*Photo. by courtesy of General Electric Co.*)

This shows the sturdy construction of the stator housing to meet the shock of sudden short circuits.

A front view of a harvester-thresher.



A close-up of a giant harvester at rest.

A front view of a tractor pulling a harrow. It is of 20 h.p. and has three speeds, thus enabling more rapid movement when lighter work is being done.

The Mechanics of Agriculture

By G. Long, F.R.G.S.

Mechanical Inventions as applied to Agriculture and how they have Speeded up Harvesting for the Farmer

It is believed by those who do *not* know him, that the modern farmer is opposed to all new ideas and especially to mechanical inventions. As a matter of fact, agriculture was the parent of civilisation, since without it, settled life in villages or towns was impossible, and the nomad tribes were forced to follow their cattle from one grazing district to another. The storage of grain made it easy to supply the necessities of large communities, and with the growth of cities, came progress. Even primitive agriculture produced some simple tools, which have since developed into the mechanical marvels of to-day. The first farmer used a sort of hoe to break up the ground, scattered the grain by hand, and covered it in with a bundle of twigs, which he dragged along, for a harrow. Harvesting was done by means of a sickle, and this was known in the flint-axe age. In the Fayum district of Egypt, a wooden rod was found, which was fitted with flakes of flint for blades, and was used for reaping, while the Bronze Age developed it into an instrument of modern shape. There is a bronze sickle of 1000 B.C. in the British Museum which is exactly like those in use to-day.

Threshing the Grain

Threshing was the last harvesting operation to yield to modern progress. For untold centuries the grain was trodden out by oxen, using a flat piece of ground on a hill-top so that there was plenty of wind to carry away the chaff. The flail—consisting of two wooden rods hinged by a strap of leather—came much later, and is still in use in many lands.

The first important advance was the invention of the plough, which could be drawn by beasts. Pliny mentions a wheel plough in the first century B.C., and there are numerous references to ox-drawn ploughs in the Old Testament. There is little change in the horse-drawn plough even to-day, save for the fact that they are usually fitted with double shares, so that *one man and three horses* can cover as much ground as was formerly turned by *two men and four horses*. When steam or petrol engines were harnessed to the plough, the number of ploughshares was greatly increased to four, six, and even eight; but a new invention has been recently introduced which may ultimately make even the ploughshare obsolete. This is the "Gyrotiller" which works on a new principle, having *rotary tillers*, and is said to combine the work of both plough and harrow in a single operation. It is especially useful for breaking up virgin soil, and has been largely used in the recent reclamation of the Pontine Marshes near Rome. It is a large and expensive machine, and the largest size demands a 170-h.p. Diesel engine to operate it.

It is a strange fact that agricultural invention stood still until the eighteenth century, when the first drills and horse hoes were seen, and ploughing competitions began towards the end of the century. The first threshing machines came in soon after; they were usually horse-driven, but when a wind- or water-mill was available they were harnessed to it.

The Steam Engine

With the invention of the steam engine there was a rapid improvement of all agricultural machines, and by 1850 steam ploughing by cable was in full swing. This was the beginning of real power-driven agriculture. The engines are owned by contractors, who travel from farm to farm ploughing the soil by contract, and performing the same service for threshing in the autumn. Farmers are glad to use the steam plough when the ground is hard, as it can break up stiff ground that their own ploughs cannot tackle in dry summer weather, when the chemical action of the sun on the soil is best. It is also a boon to the farmer whose work is in arrears.

It was in the U.S.A. that mechanica invention developed first, and has gone farthest. This was largely due to the opening up of huge areas of virgin soil in the Middle West by the construction of the great transcontinental railways. When large areas of land have to be cultivated the tractor is supreme, as has been found in the U.S.S.R. during the development of the Five-year Plan. Huge areas of that vast country are now wholly tractor-tilled, and it is claimed that there is one single wheat-field of 16 square miles in area.

The Mechanical Harvester

Progress in the U.S.A. was greatly hastened by the Civil War of 1861-4 since food-stuffs were urgently needed and labour was short. The use of mechanical machinery was greatly extended, and new inventions were made, while earlier machines weer improved. The most striking of these was the Mechanical Harvester, or Self-binder.

which is the most important of all semi-modern discoveries. In many countries the harvesting of grain is sadly hampered by wet weather, and in the pre-mechanical days it was not uncommon for harvesting to drag through October into November; while old farmers have told me of a December gathering of belated sheaves. Wheat which had been exposed to the weather for two or three months would be worthless, except perhaps for cattle food. Much of it would germinate, and begin to grow, and still more would fall from the ears and be lost. In these days it is not unusual for corn harvest to be completed in Southern England in the month of August, and it is rare for any sheaves to remain in the fields after mid-September.

Saving Money

Statistics of the U.S. Department of Agriculture well illustrate the saving in money and increase in efficiency through mechanical aid. It is said that in 1830 the number of hours of labour required to produce 20 bushels of wheat was 61 hrs. 5 mins. at a labour cost of $4. In 1895 the time was reduced by machinery to 3 hrs. 19 mins., and the labour cost (on much higher wages) to $1·19.

In 1850, when the use of machinery began, the area of cultivated land to each worker was 30·4 acres, and it rose to 40·77 in 1920.

Not only was the amount of work increased so greatly, but a vast amount of monotonous toil was entirely eliminated. Threshing provides an excellent example of this. Before mechanised farming came in, the grain was stored in huge barns and was beaten out of the ear by hand flails during wet weather. This work was monotonous and toilsome to an extreme degree.

Mechanical invention governs every operation on the modern farm. The prime movers are three—electricity, petrol, and steam. The former is very useful on small mixed farms near towns, where power can be laid on at low rates In U.S.A. the Government are so anxious to electrify the farms that in some areas—notably the Tennessee Valley—they are supplying current to isolated farmsteads at the same rates as charged to dwellers in small towns and villages.

Much small machinery can be conveniently run by electric motors, such as milking machines, root cutters, sheep-shearers, separators, churns, sterilisers, and bottling machines.

A steam threshing tackle working on clover seed.

The Tractor

Electricity, however, lacks the *mobility* of its rivals, steam and petrol, so that a large amount of farm work must always depend on these. In countries where grain growing on large acreage is the rule, the tractor is supreme, and there are some mechanised farms in this country which concentrate mainly on grain, which are wholly mechanical and own no horses. In this connection it is interesting to mention that the saving in cost by mechanisation is just sufficient to turn a loss into a profit.

At the same time it is important to remember that many of the best authorities believe that *mixed farming* is the best policy on the relatively small areas available for cultivation in our densely populated country, and the smaller the agricultural unit the less the advantage to be derived from mechanisation. Thus it is cheapest to lift potatoes by hand on plots less than one acre in extent. Above one acre the horse plough scores, and on much larger fields it pays to install mechanical potato lifters. In the same way small plots of peas can only be hand picked, but on a large scale they are planted without sticks, harvested by machinery, separated from the haulm, and finally removed from the pod by machine. The peas are then graded in huge revolving hoppers, and run into the cans, from whence they pass along the canning line—untouched by human hands—till they emerge as sealed, sterilised, and finished tins of peas. Cotton is gathered by machinery also to-day, the device being very ingenious. A number of revolving spindles approach the plant, pluck the cotton by rapping it about them, recede to a chamber where it is removed, and automatically emerge again.

The Self-binder

In the same way the self-binder, whether horse or tractor drawn, is an absolute god-send to the worried agriculturist during a wet harvest. Quite apart from the saving in cost, the crop can be harvested in good condition before the rain comes and spoils it. The most remarkable feature about the self-binder is the knotting device. It is known as the Appleby Knotter, and has been the standard tying mechanism on all binders since 1879. The machine cuts the grain, binds it in neat bundles, and deposits the sheaves in rows.

The lastest improvement is the reaper-cum-thresher, which first cuts, and then threshes the grain, spreading the straw in neat rows along the field, and dropping out a filled and tied sack of grain at regular intervals. These machines have been in use in U.S.A. for about thirty years, and are now found to be on some English farms.

When first introduced they were open to the objection that the straw was wasted, since the reaper cut the crop just below the ear. This did not matter in these countries where there there was no market for straw, but in England good wheat straw is worth nearly as much as hay and certainly must not be wasted. The latest binder-threshers cut the straw at the normal length, leave it in rows on the field, whence it is harvested by horse-drawn sweeps, such as are used for hay-making.

When mechanisation first began in England there were serious difficulties in manning the machines. The old-fashioned ploughman was very efficient at ploughing, but could not handle a tractor; and the skilled mechanics who understood tractors, were not efficient ploughmen. To-day all this is being put right, and a race of keen and efficient mechanically-minded ploughmen is being trained.

(Right) A harvester-thresher at work, dropping a sack of grain.

(Left) A rear view of a tractor at work.

MODEL AERO TOPICS

By F. J. Camm

A Model of the Laird Super Solution.

The Elf Petrol Engine

CAPT. BOWDEN has sent me further details of the Elf Petrol Engine, to which I referred in these notes in a recent issue. He tells me that it weighs 4 oz., is of 2¼ c.c., and is made in America. As far as I have been able to trace, none of them has yet been delivered in England. I believe that in the very near future we shall have commercial engines of not more than 1 c.c. The manufacturers, as a result of the work of private experimenters, have plenty of data upon which to base their designs. Such miniature engines would enable model builders to construct machines of reasonable proportions and of light weight. There are many experienced modellers, however, who prefer a large model and the greater latitude it gives them in making special fittings, such as time control mechanisms, and which have to be excluded from lighter models.

A Free Lance Design

I SHOW a photograph of a model designed and made by Mr. G. F. Rogers, of Bryony, Berrow Road, Burnham-on-Sea, Somerset, who is only 14 years of age. It is of 42-in. span, has a tapered wing (thickness and cord), a circular fuselage, and a wire undercarriage. It is made entirely of Balsa and Jap tissue, the total weight being 3¾ oz. He tells me that it has made some very good flights of about 65 secs. duration.

The Hurlingham Speed Contest

THERE was a disappointing entry for the Speed Contest for the Flight Cup, held by the S.M.A.E. at Hurlingham, on May 31st, probably as the result of centralisation. The S.M.A.E. decided that in 1936 competitions should be experimental to find out whether centralised or decentralised competitions were best. Judging from the entries for the Gamage and Pilcher Cup competitions, the innovation of having decentralised competitions has been most enthusiastically received. I give the result of the Speed Contest herewith.

				m.p.h.
1.	H. E. White	Northern Heights	1st	42·61
2.	W. Worden	T.M.A.C.	2nd	22·04
3.	W. L. Henery	T.M.A.C.	3rd	16·4

There were 9 entries, and the time-keepers were L. A. Wood and H. W. Hawkins.

The Largest Ever

ON May 17th, the Society of Model Aeronautical Engineers held the biggest competition for Model Aeroplanes ever organised in England. There were 123 competitors, ranging from complete newcomers to the game to old hands of twenty or more years' standing. The day was hot with very little wind, this being a point in England's favour, as conditions approximated those of a bad model flying day in the United States.

Twenty time-keepers ably assisted in judging the competition.

Two models, whilst being got into trim for the competition, decided to leave the aerodrome and explore the countryside. These, however, were fortunately recovered before the competition started and therefore took their turn in the contest. Despite the large number of entries, the stewards and time-keepers managed to get through the large field of entries by 3.30 p.m., the winners being declared shortly afterwards.

		Seconds.
J. B. Allman, Esq.	Average	268·3
A. Greenhalgh, Jnr.	,,	220·5
H. Fairlie, Esq.	,,	215·3
H. A. Jones, Jnr.	,,	166·9
A. A. Judge, Esq.	,,	156·8
R. Copland, Esq.	,,	143·6

The Moffett trials commenced promptly at 4 p.m. according to schedule, there being 49 entries and the results being as follows:

H. Simmons, Esq.	199·75
A. Worley, Esq.	117·0
W. Worden, Esq.	106·0
A. Gibson, Esq.	105·5
G. Merrifield, Esq.	104·0
H. Francis, Esq.	102·4

This competition does not call for the average of three flights as does the Wakefield Cup, the time quoted being for the best of three flights. The Models chosen for the Moffett trophy will be taken to America by the Wakefield team and flown for their owners.

The S.M.A.E. still have a few Souvenir programmes of the event, which may be obtained 4½*d.* post free (showing the Wakefield Cup), from Mr. H. York, 2 Scutari Road, Dulwich, S.E.22.

The Wakefield Competition

BY the time this issue is in the readers' hands the Wakefield Team will be in America and probably (let us hope) in possession of the Wakefield Gold Cup. Mr. A. P. Thurston generously gave £50, and Mr. H. York £10, so that a press representative could accompany the team. Over £400 was subscribed by various people interested in aviation to defray the expenses of the visit. I should like to congratulate Mr. York on his energy and enthusiasm in promoting the Wakefield Subscription Fund.

Petrol Model Blue-prints

JUST a reminder that blue-prints of the Petrol-driven Model Monoplane of the mid-wing type, which I recently designed and described in these pages, are obtainable at 7*s.* 6*d.* the set. These blue-prints are, of course, full size. Back issues of the journal describing the construction are still available at 7½*d.* each from the publisher, George Newnes, Ltd., 8-11, Southampton Street, Strand, W.C.2.

The Baby Cyclone Engine

I HAVE received one of these engines from the makers, and hope in the next issue to give the result of my tests. The engine seems a well-made job, and it will be interesting to see how it compares with the famous little Brown Junior.

Mr. G. F. Rogers's Model, referred to on this page.

WHICH OF THESE IS YOUR PET SUBJECT?

CIVIL ENGINEERING GROUP
Specifications. Structural Design. Road Engineering. Structural Engineering. Hydraulics. Reinforced Concrete. Municipal Engineering. Sanitary Engineering. General Civil Engineering. Geology.

SURVEYING GROUP
Valuations. Surveying and Levelling. Heating and Ventilating. Building Construction. Clerk of Works.

COMMERCIAL ENGINEERING GROUP
Salesmanship. Commercial Engineering. Advertising. Cost Accounts. Languages.

MECHANICAL ENGINEERING GROUP
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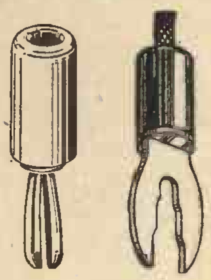

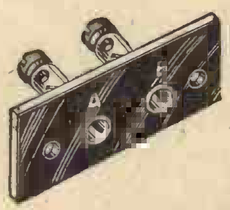

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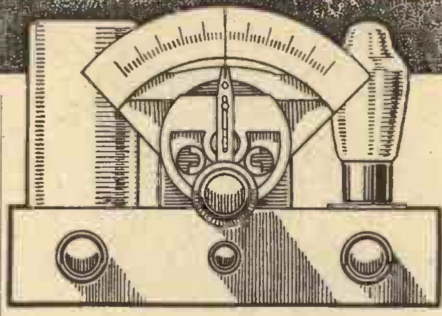


THE 1936 SHORT-WAVE THREE

An Ideal Three-valver Designed for Use on the Short-wave Band.

THE receiver described last month was intended for the listener who wishes to obtain reception only on the ordinary broadcasting bands, but, as no doubt many readers are aware, there is a vastly more interesting field to be explored on other wavelengths.

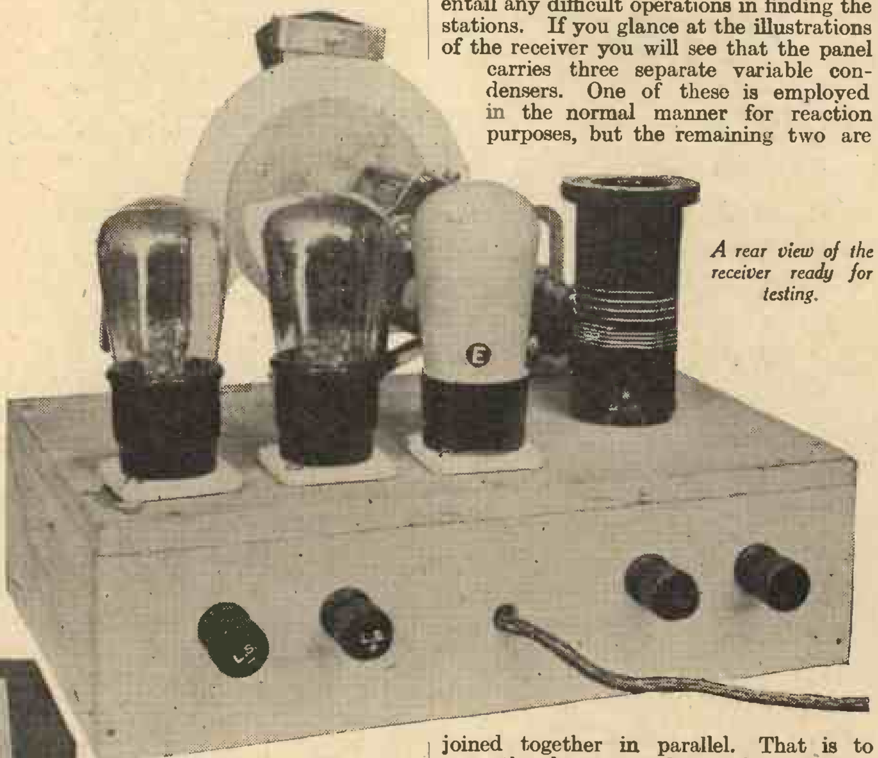
From 10 metres up to, say, 100 metres there may be heard the tongues of every nation, broadcasting, not only programmes of a musical nature, but also radiating special talks for colonial inhabitants, experimenters carrying out interesting tests and trials, and on certain wavebands there may be heard the thrills of the police radio cars in the United States of America.

Tuning Possibilities

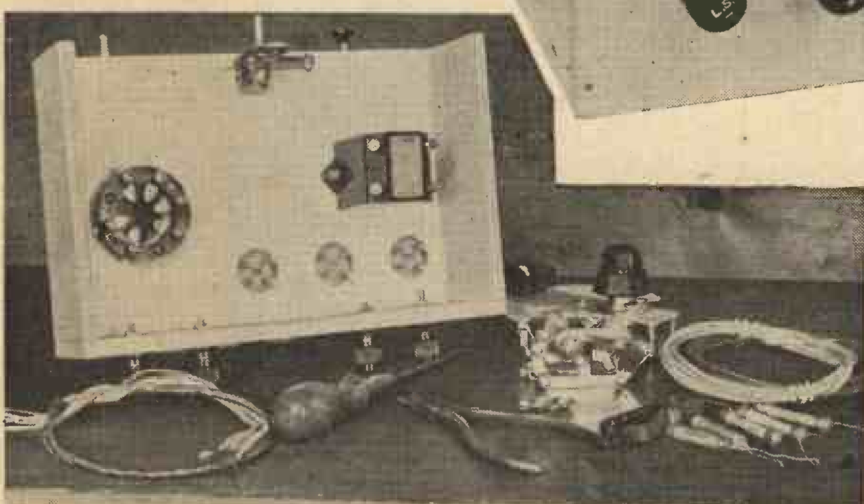
Unfortunately, the average listener has become so used to experiments carried out on unsuitable apparatus that he has found that short-wave tuning is difficult, and the word has been passed along that short-wave work is not worth while. Why is it that bad news always travels so widely, whilst good news never gets passed along? However, when a correctly-designed short-wave receiver is employed it will be found that it is no more difficult to tune than a standard broadcast receiver, and there are one or two artifices which may be employed in the design of such a set which will make it even easier to operate. There are, however, certain vagaries in the short-wave sphere which render it necessary to use a short-wave set with discretion. For instance, the sun and darkness can affect the short-wave signal, whereas a standard signal on a wavelength of 500 metres or so is not so affected. Thus, certain wavelengths will be found to be " dead " during the hours of daylight, whilst during the hours of darkness it will be found that these wavelengths travel over immense distances in spite of the small power used, and signals which could formerly be heard in the daylight will no longer be received. By designing the short-wave receiver with an adjustable tuning circuit however, it is possible to obtain a number of separate tuning elements which will permit of the receiver being used under all conditions, and thus there is a much wider field obtainable.

The Circuit

Dealing firstly with the tuning arrangements, it is admitted that a very small movement of a normal tuning condenser is required in order accurately to locate a station, although the reason for this will not be gone into here. But practically every listener is familiar with a vernier adjustment, and it is possible to employ a scheme which amounts almost to a micrometer adjustment of the tuning circuits of a short-wave receiver, and yet does not entail any difficult operations in finding the stations. If you glance at the illustrations of the receiver you will see that the panel carries three separate variable condensers. One of these is employed in the normal manner for reaction purposes, but the remaining two are joined together in parallel. That is to say, the larger condenser has its two terminals joined to two terminals on a very small condenser mounted near to it. The size or capacity of this smaller condenser has been so chosen that it covers only an extremely small range, very little more, in fact, than is obtained when the main tuning condenser is turned through one small degree. Thus the main condenser may be turned through this small distance, and the smaller condenser then turned through a complete revolution; this spreads out the stations which are covered by the larger condenser. From this spreading-out action, the combination of the two tuning condensers is known as a " band-spread tuner," and it brings to the short-wave receiver all the advantages of normal tuning. To make everything quite simple for the operator the main tuning condenser in



A rear view of the receiver ready for testing.



This illustration shows the simplicity of the constructional work.

the receiver is fitted with a slow-motion knob, and it is thus possible to explore every part of the tuning scale in the most accurate manner and it is almost impossible to miss a station which is within range of the receiver.

A Well-tried Arrangement

The actual valve conbination in the receiver follows the well-tried detector and two L.F. arrangement, and it has been found that this is productive of really excellent results under all normal conditions. The coil which is used is of the six-pin type and a special holder is employed so that any other six-pin coil may be inserted. The listener may acquire a complete set of these coils to cover all his requirements. Coupling between the first and second valve is by means of what is known as resistance-capacity-coupling, and this ensures good quality, whilst an L.F. transformer of sound design is employed between the second and third valves. Thus a really good signal may be expected at the loud-speaker, free from any circuit distortion and of sufficient power to provide good entertainment value. A five-way battery cable is employed and a separate H.T. voltage is provided so that the most suitable operating conditions of the detector stage may be located.

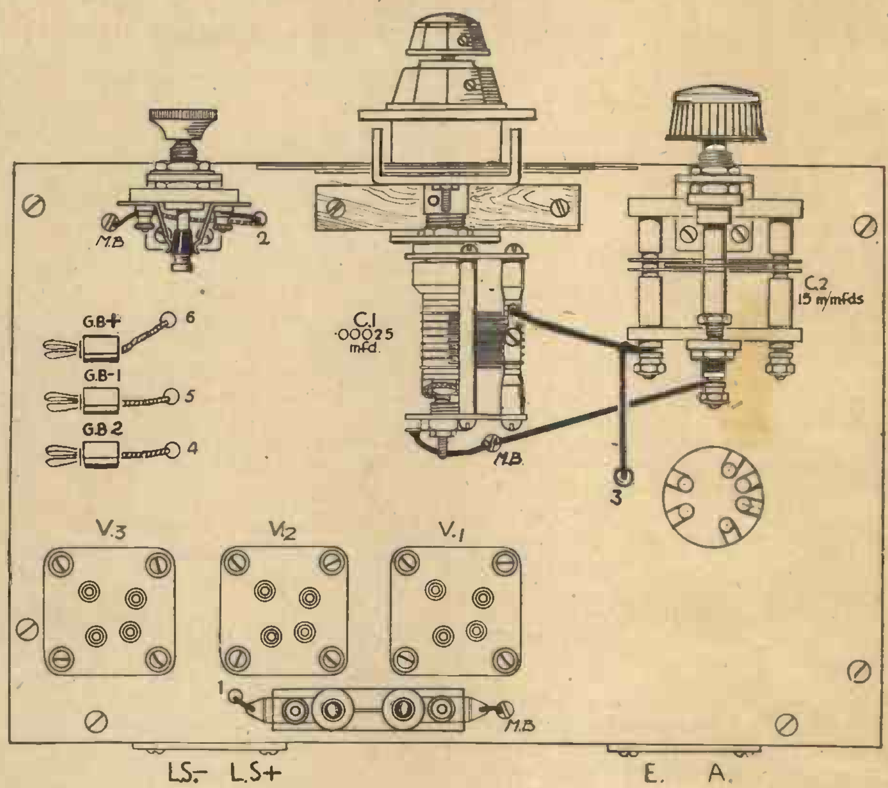
LIST OF COMPONENTS FOR THE 1936 SHORT-WAVE THREE.

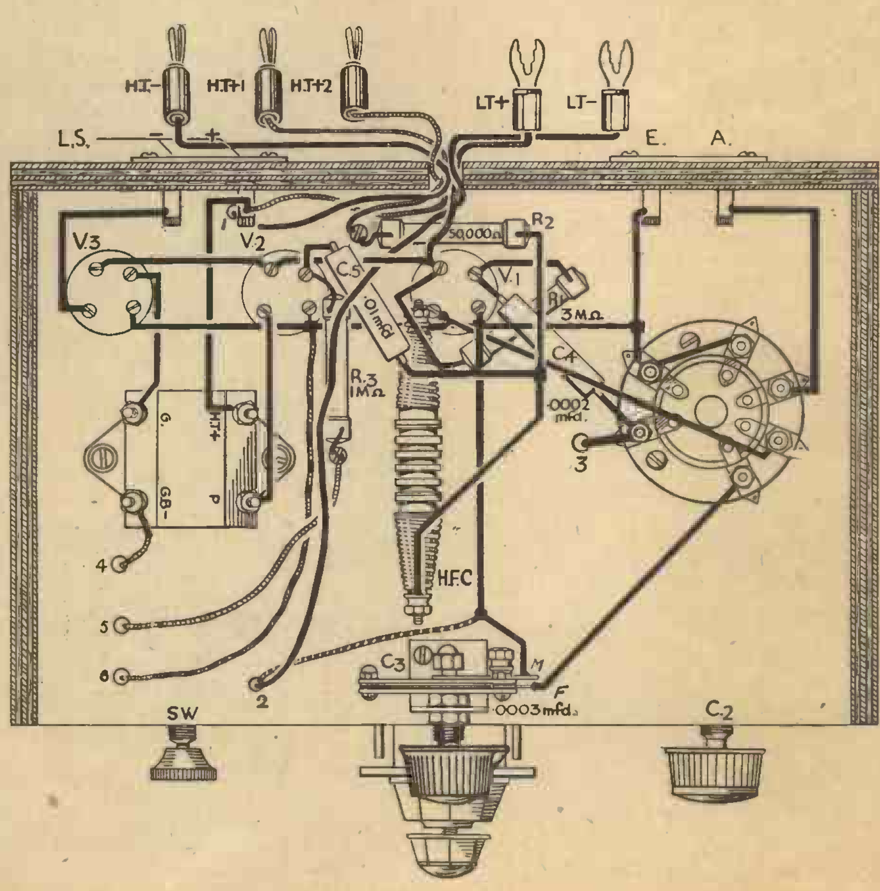
One 6-pin S.W. coil type S.P.C. (B.T.S.).
One ·00025 popular log tuning condenser, type 1040 (J.B.).
One dual-ratio S.M. Drive, type 2092 (J.B.).
One 15 m.mfd. band spread condenser, type 2140 (J.B.).
One ·0003 mfd. Dilecon reaction condenser (J.B.).
One Niclet L.F. transformer (ratio 1:5), type D.P. 22 (Varley).
Three 4-pin valve-holders, type U.H./4 (B.T.S.).
One 6-pin S.W. coil base, type S.P.B. (B.T.S.).
Two fixed condensers (·0002 mfd. and ·01 mfd), type 300 (T.C.C.).
Three 1-watt resistances (50,000 ohms, 1 megohm, and 3 megohms) (Dubilier).
One S.W. choke, type H.F.3 (Wearite).
One 60 m/A. Microfuse and holder (Microfuse).
Two Socket Strips (Aerial, Earth and L.S.— and L.S.+), (Clix).
One 5-way battery cord (30-in.).
Three wander plugs (G.B.+, G.B.1 and G.B.2).
Two Spades (L.T.+, L.T.—), (Clix).
One pair G.B. battery clips, type No. 5 (Bulgin).
Three component mounting brackets (Peto-Scott).
One Metaplex chassis (10 in. × 6½ in. with 2½ in. runners), (Peto-Scott).
Three valves (D210, L210 and P125), (Hivac).

ACCESSORIES.

One 120-volt Drydex Super-life H.T. battery.
One 9-volt G.B. battery type H.1001.
One 2-volt L.T. accumulator Type D.M.G.—C (Exide).
One W.B. Stentorian 36/J loud-speaker and pair of headphones.
One Cabinet.

THE TOP AND UNDERNEATH WIRING PLAN OF THE 1936 SHORT-WAVE THREE





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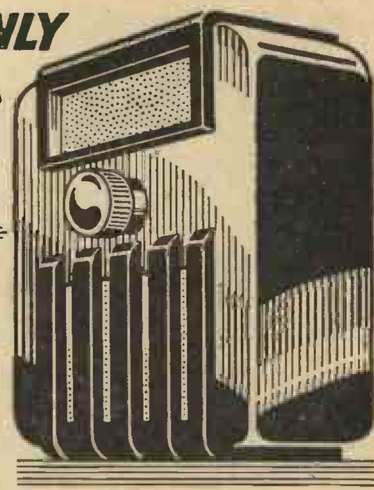

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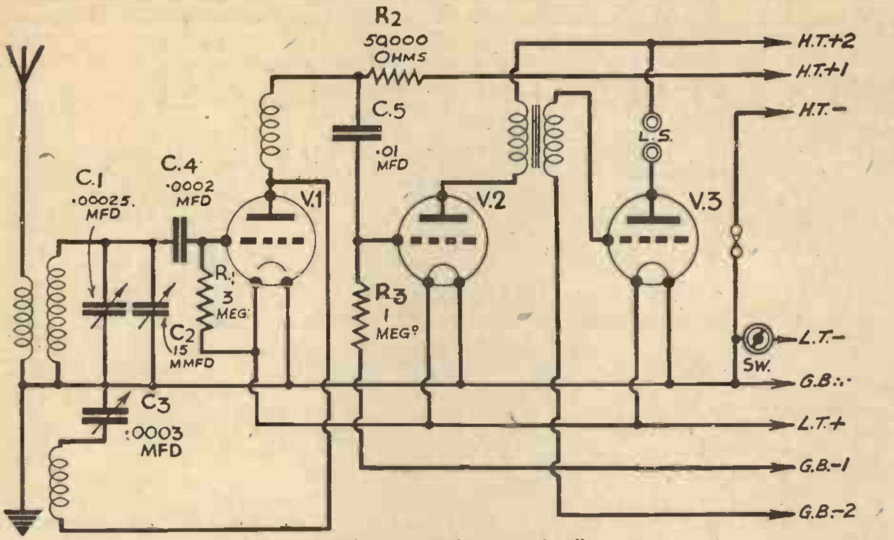


All the essential features may be seen in this illustration.

It will be noticed by experienced amateurs that no aerial condenser has been fitted, and the reason for this is that the receiver has been designed for the beginner to short-wave reception. Where it is desired to employ this receiver in conjunction with a standard broadcast aerial of large dimensions, it will be necessary to fit a condenser between the aerial lead and the aerial terminal, in order to obtain smooth reaction and to provide good signal strength. An air-spaced condenser should be used for this purpose, and it should be mounted on a bracket fitted inside the rear of the cabinet. The control knob may then be adjusted as required for various wavelengths to provide the required degree of aerial damping.

Constructional Work

The actual construction of this receiver is extremely simple, and it may be undertaken by the youngest member of the family. The chassis is of metallised plywood and may be obtained from Messrs. Peto-Scott.

It measures only 10 in. long by 6½ in. wide, and is provided with two runners at the sides measuring 2½ in. in height. To complete the chassis a further strip of the same wood is placed across the rear, upon which the sockets are mounted. At the front no wooden strip is employed, but the reaction condenser which is mounted in this position is fitted to a special metal component mounting bracket.

Having obtained the chassis, the constructional work may be commenced, and the first task is to drill four large holes upon which to mount the valve-holders and the coil holder. For the latter a hole 1¼ in. in diameter is required, and for the valve-holders the hole must be 1 in. in diameter. The positions of these holes may be ascertained from the wiring diagram. The centre holes for the valve-holders may be positioned as follows: V3 is 1¼ in. from the edge of the chassis and 2 in. from the rear edge. The remaining two holders are exactly 2 in. apart. The centre of the coil-holder hole is 3¼ in. from the rear edge and 2 in. from the side of the chassis. When these holes have been drilled a ⅛ in. drill should be used to drill the six holes in the upper surface of the chassis, and ⅜ in. slots should be cut in the rear strip for the terminals. Finally, a ⅜ in. hole should be drilled in the centre of the rear strip through which to pass the battery cords.

Mounting the Components

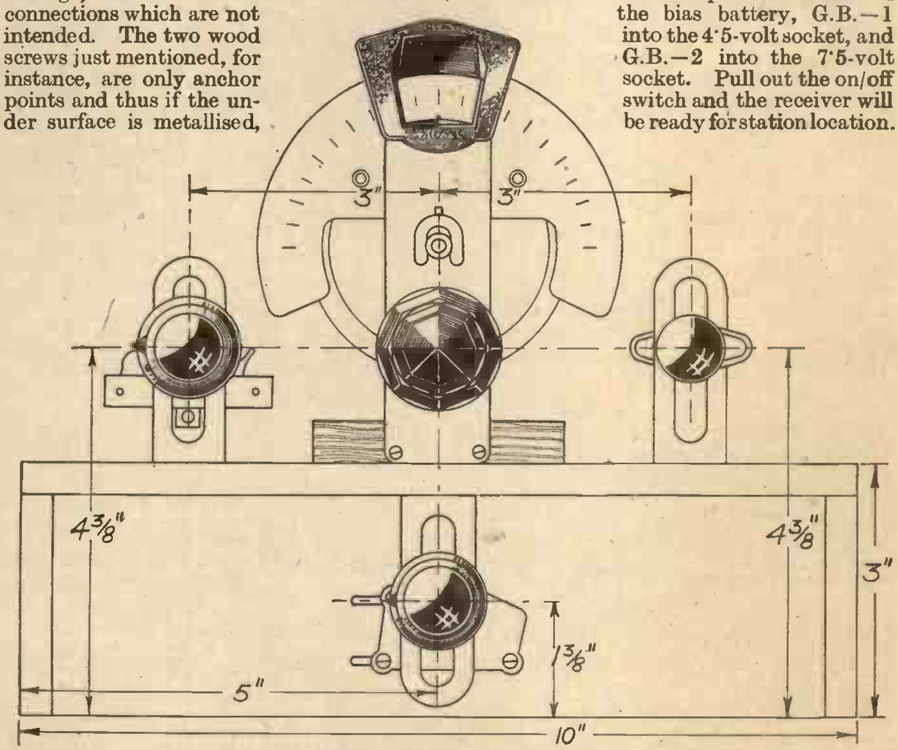
Before placing the component mounting brackets in position, the coil holder should be attached on the *under side* of the chassis, taking care that the sockets are centrally disposed in the hole. Next, the three valveholders should be screwed in position, again making quite certain that the sockets clear all the edges of the chassis to avoid difficulties at a later stage. Now lay the chassis upside down on the table or work-bench, and screw the Niclet transformer in its approximate position. There is no need to measure the exact position of this, and it may be placed anywhere near the position indicated in the wiring diagram. Next obtain two ½ in. countersunk No. 4 screws (or similar dimensions) and screw these into the under surface of the chassis. It should be noted particularly that the wooden chassis which are employed in our receivers are only metallised on the upper surface, and if you endeavour to employ a metal chassis or make up one, there is every possibility of doing damage, due to short-circuits and inter-connections which are not intended. The two wood screws just mentioned, for instance, are only anchor points and thus if the under surface is metallised, these screws become joined together. The same thing will apply if the screws are long enough to project to the metallised surface on the other side of the chassis, and thus they should not be any longer than ½ in. One of these screws is attached close to the valveholder for valve No. V2, whilst the other is placed close to the L.F. transformer fixing screw. Three similar screws are now attached to the upper side of the chassis, one next to the Microfuse holder, one next to the bracket which supports the on/off switch, and one in approximately the centre of the upper surface. These screws are marked M.B. on the wiring diagram and simply indicate that wires attached to them are in contact with the metal surface.

Next screw the bracket to the centre of the front edge of the chassis on the under-side and mount the Dilecon reaction condenser on this bracket, locking it in position when the spindle is in from the lower edge, as indicated on the front of panel layout, below. Finish mounting the components and wire up from the diagram on page 588.

Now screw the two component brackets into position for the switch and band-spread condenser, and attach the holder for the Microfuse. The variable condenser is attached to the J.B. slow-motion dial, and in the ordinary way this should be held in position on the front of the cabinet. If, however, it is desired to make this a fixture to the chassis, a strip of wood must be cut and recessed to hold down the slow-motion dial. This may be cut from any old piece of wood so long as it effectively holds the dial in position.

Testing Out

Plug in the coil which is specified for this receiver, and which covers a wave-band from 24 to 52 metres, plug in the three valves as follows: D210 in V1, L210 in V2, and P215 in V3, and connect the H.T. battery plugs into the H.T. battery with H.T.2 in the 120-volt socket, and H.T.1 in the 60-volt socket. G.B.+ is now inserted into the positive socket of the bias battery, G.B.−1 into the 4·5-volt socket, and G.B.−2 into the 7·5-volt socket. Pull out the on/off switch and the receiver will be ready for station location.



These dimensions will enable you to drill the cabinet front or the panel. The maker's template should be employed when marking out the hole for the escutcheon.

Working Model Steam Engines

Concluded from page 520 of last month's issue

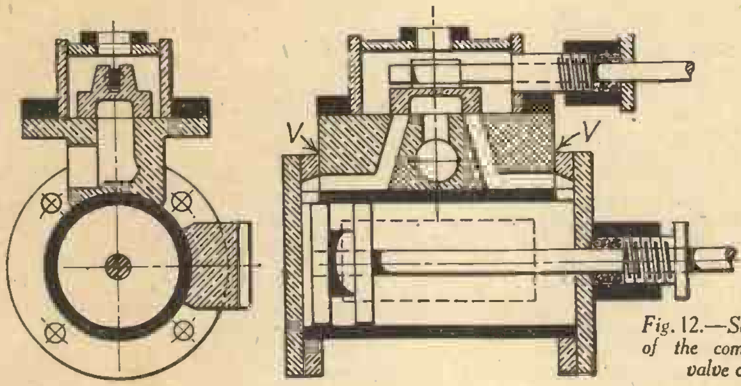


Fig. 12.—Sectional views of the completed slide-valve cylinder.

CAREFULLY file the ends of the tube square till it is exactly 1⅜ in. long, and then clean the inside of the tube with the aid of a piece of fine emery cloth wrapped round a piece of dowel rod of suitable size. File out a slot in each end of the tube, as at *M*, *N* (Fig. 11, June issue), and then well clean the outside of the tube.

For the cylinder flanges two brass washers can be used, which must be a good fit on the ends of the cylinder tube. If these washers cannot readily be obtained they must be cut out and filed to shape from sheet brass of the required thickness.

File a slot, *O*, in each washer, the same width as those in the cylinder barrel, the upper parts of the slots being filed at an angle, as shown at *P*, Fig. 11. Press the washers on to the cylinder tube so that the slots coincide, adjust so that they are quite square with the tube, and then solder them in place.

The Steam-port Block

This part, details of which are given in Figs. 12 and 13, can be shaped from a piece of stick brass 1 in. wide and ½ in. thick. Cut away as indicated at *Q* and *R*, with the aid of a hacksaw and file, and with a half-round file, proceed to shape the under part *S*, which must be made a good fit to the cylinder barrel. File the sides and ends of the block square so that it just fits between the washers, or flanges, as in Fig. 12. Clean the top face of the block and carefully mark out the steam and exhaust ports to the dimensions given. The ports can be first drilled and then chipped out with a small cold chisel. It will be noticed that the two steam ports through the block are cut at an angle so as to clear the exhaust port. The hole, *T*, in the side of the block can be tapped to take the screwed end of the exhaust pipe which is $\frac{7}{32}$ in. diameter.

Now take the cylinder barrel and well "tin" the surface between the slots *M* and *N* on which the concave surface of the steam-block rests. This surface should be treated in the same way, and also the two ends of the block, and part of the inside face of each flange, as at *V*, *V*, Fig. 12. Press the steam-block between the flanges so that the steam-ways in the underside of the block are in alignment with the slots *M* and *N*. Hold the parts firmly in a small screw clamp, and sweat well together by holding them over the flame of a gas ring.

It will be as well at this stage, to fix the holding-down lug in place. This can be filed to shape from a small block of brass to the dimensions given at *W*, Fig. 13. The underside must be bedded down on the cylinder barrel in the same way as the steam-port block, after which two holes must be drilled and tapped $\frac{3}{32}$ in. at a distance of $\frac{3}{16}$ in. from each end. This lug can then be sweated on to the cylinder barrel at right angles to the steam block, as shown in Fig. 12, and on the opposite side to the hole for the exhaust pipe.

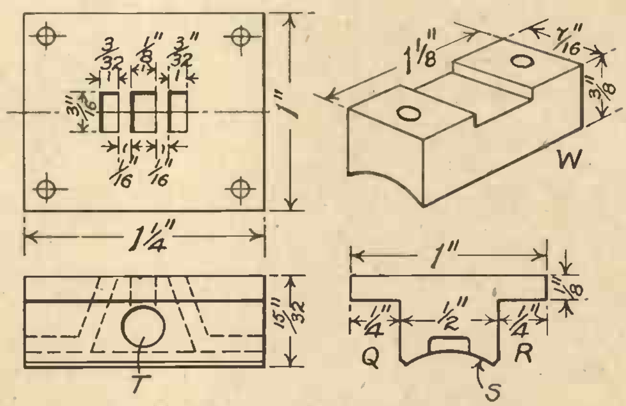


Fig. 13.—Details of steam-port block, and cylinder fixing lug.

The Steam Chest

To make the steam chest, take a piece of sheet brass $\frac{1}{16}$ in. thick and file it square to the size given in Fig. 14. Mark three lines across the strip, spaced as indicated, and then with a fine-cut three-cornered file, file nearly through the metal along each of the lines. Now bend the strip to form a hollow box, as at *X*, hold it in a clamp, and well sweat the four corners from the inside. Drill a $\frac{3}{16}$-in. hole in the centre of one of the narrow sides to take the valve-rod gland.

The steam-chest flange can be cut out of a piece of flat sheet brass $\frac{3}{32}$ in. thick, the rectangular hole being drilled out and filed till it is a good fit round the sides of the steam chest. Adjust the flange so that the bottom face is flush with the edges of the steam chest, and well solder the joint. Four $\frac{3}{32}$-in. holes—one at each corner—can be drilled to take the fixing screws.

Cylinder Covers

Two flat brass discs $\frac{3}{32}$ in. thick, and 1⅛ in. diameter, will be required for the cylinder covers, four $\frac{3}{32}$-in. holes being drilled in each, in the positions indicated in Fig. 12. In the centre of the disc to be used for the front cover, drill a ⅛-in. hole, and slightly countersink on one side of the disc, round this central hole, by using a ⅜-in. flat drill bit.

To make the stuffing box for this cover, take a short length of brass tubing of ¼-in. bore and about ⅜-in. outside diameter, and tap a thread inside one end to a depth of ⅜ in. Cut off this piece of tubing, and with a small screw clamp hold it firmly in place on the cover. Adjust it so that the hole in the cover is exactly central with the tapped hole in the stuffing box, and then solder it in place. For the gland, get a piece of brass tubing $\frac{5}{32}$-in. outside diameter, the bore of which must be a nice sliding fit to the piston rod (⅛-in. diameter). With a screwplate, cut a thread on one end for about ¼ in. along the tube, corresponding to the thread tapped in the stuffing box.

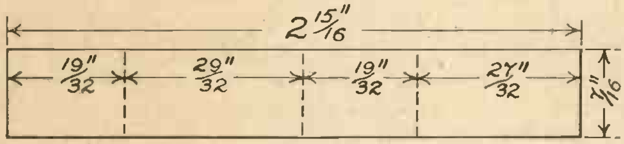
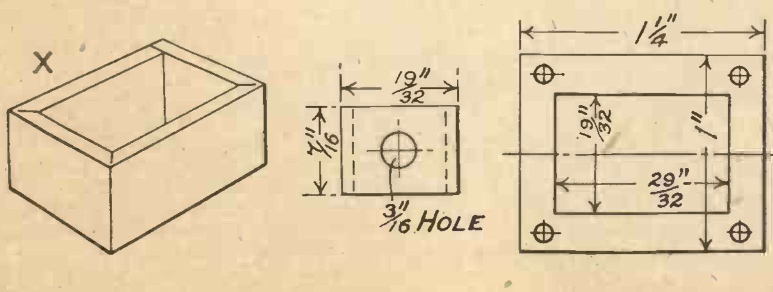


Fig. 14.—Marking out the parts for forming the steam-chest.



This piece can then be cut off. Now take a small brass washer, which should be $\frac{3}{8}$-in. diameter and $\frac{3}{32}$ in. thick, with a $\frac{1}{8}$-in. hole in the centre. Hold this washer and the small screwed gland in a clamp and, after carefully adjusting, sweat well together. The stuffing box and gland for the valve rod are made in a similar way, but their positions are reversed, the gland being soldered into the steam chest. It will also be noticed that slightly different sizes of tubing are used. (See Fig. 12.)

Piston and Rod

To make the piston, obtain two brass discs $\frac{3}{32}$ in. thick which fit nicely into the bore of the cylinder, and one smaller one $\frac{1}{8}$ in. thick and $\frac{3}{8}$ in. diameter. Each of these discs should have a central hole $\frac{3}{32}$ in. diameter drilled through them. Sweat the discs together, so that the holes register, and tap a $\frac{1}{8}$-in. thread right through. For the piston rod use a piece of German-silver rod, $\frac{1}{8}$ in. diameter and $2\frac{1}{4}$ in. long, and cut a thread on each end to fit the tapped hole in the piston, and the crosshead respectively.

The slide valve can be filed to shape out of a piece of stick brass, the cavity being chipped out with a small cold chisel. The width and length of this cavity in relation to the steam and exhaust ports is indicated in Fig. 12. The valve rod can be of German silver, one end being filed with a flat on each side where it engages in the slot in the slide valve.

The holes can now be drilled and tapped in the cylinder flanges for the fixing screws for the covers. The positions of the four holes must, of course, exactly correspond with those already drilled in the covers. Each hole is to be tapped to take $\frac{3}{32}$-in. screws.

The piston can be packed with asbestos string or hemp saturated with Russian tallow. Before screwing down the cylinder covers, cut two circles of thin brown paper the diameter of the cylinder flange and soak well in linseed oil. These are placed between the flanges and the covers when the latter are screwed down, to make a steam-tight joint.

The steam-chest top is simply a piece of sheet brass $\frac{1}{16}$ in. thick cut to fit the inside of the steam chest (see Fig. 12). In the middle of this brass plate sweat on a small brass washer, mark the centre and drill a $\frac{3}{32}$-in. hole, while can be tapped to take the screwed end of the steam pipe. Now take the plate and press it down so that its surface is a little below the top of steam chest, and then well solder all round.

Packing and Lagging

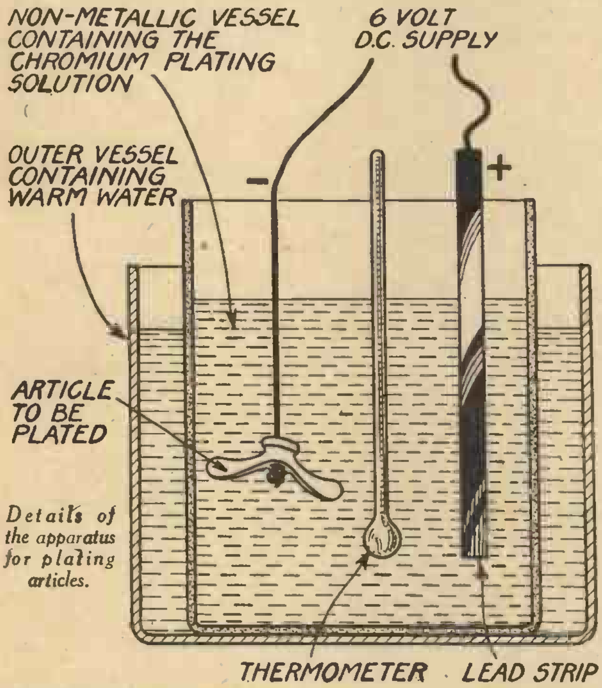
The steam chest can now be screwed down after packing the joint in the same way as the cylinder covers. The stuffing-boxes can be packed with the same sort of material used for the piston.

The finished cylinder can be lagged with asbestos and covered with a piece of Russian iron plate; as indicated in the general drawings, Figs. 1 and 2 (June issue).

In assembling the various parts of the engine the cylinder should be fixed in position first, as this has to be screwed to the bedplate before the latter is finally screwed down on the plinth. The eccentric must be fixed to the shaft at an angle of 90 degrees in advance of the crank-pin, as in Fig. 1, so that when the crank and connecting rod are in the positions shown, the rear end of the cylinder is getting full steam admission.

Chromium Plating at Home

Useful Hints for the Handyman



Details of the apparatus for plating articles.

MANY experimenters have endeavoured to set up chromium-plating plants in the home workroom, but not always with success, for, truth to tell, efficient chromium plating is an operation which requires considerable skill and experience. However, for the sake of amateurs who desire to carry out experiments in this type of electroplating the following directions are given. If they are carefully adhered to, they will lead to success.

Two chromium-plating baths are available for amateur use :

Bath A

Bath A

Chromic acid .	.125 grammes
Chromium sulphate .	1.5 grammes
Water . . .	1 pint

Bath B

Chromic acid .	.125 grammes
Sulphuric acid .	1 gramme (or c.c.)
Water . . .	1 pint

Bath *A* gives, perhaps, the better results, but bath *B* is somewhat less expensive to make up. Both baths should be used at a temperature of 100° F. Hence it is necessary to surround the plating bath with an outer vessel into which warm water of the correct temperature can be poured. Chromium-plating baths are highly corrosive. They must be contained in porcelain, earthenware or other non-metallic vessels and care should be taken not to allow the liquid to come into contact with the skin. Furthermore, any spray which arises from the bath during the process of plating should on no account be breathed.

The Poles

The cathode or negative electrode of the bath consists of the article which is to be plated. For the anode or positive pole, it is best to use a strip of freshly-cleaned lead. Better still is it if the lead strip has previously been made the anode of a dilute sulphuric acid bath in order that it may have acquired a thin coating of lead peroxide on its surface. However, if this condition cannot be granted, an ordinary bright strip of lead will suffice as the anode of the chromium-plating bath.

The current supply should not exceed about 6 volts D.C., but a very heavy current must be used. If a D.C. power supply can be got down to 6 volts by means of a resistance, well and good. Otherwise, it will be necessary to employ three or four accumulators arranged in parallel in order that a heavy current may be sent through the bath. At a push, ordinary dry batteries might be used, but heavy demands could not be made on them.

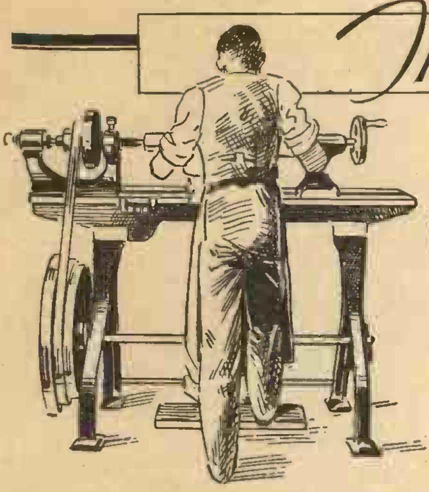
The current should flow through the bath for about half an hour, during which time the liquid in the bath should frequently be stirred.

Types of Chromium Deposit

If the right current conditions have been employed, the chromium layer deposited on the article will be bright and shining, and will require no further polishing. Note, however, that it is possible to get three distinct types of chromium deposit. If the current is too weak, the chromium deposit will be dull and " milky." Current of the correct strength gives the desired and characteristic brilliant deposit, while a still more intense current produces a chromium deposit which is greyish and dull. These varying deposits are also effected by altering the solution strength and the temperature of the plating bath. Hence, for success in the art of chromium plating, it is very necessary to adhere closely to the conditions laid down for the production of the bright and hard chromium deposit.

Articles to be chromium plated must, of course, be scrupulously clean and free from grease before they are entered into the bath. If anything is lacking in this respect, the chromium deposit will not adhere to the base metal. Note, also, that the brighter the polish on the surface of the base metal, the more lustrous will be the chromium deposit.

Copper, silver, brass, and electro-plated articles can be chromium plated directly. For iron and steel articles, however, it is advisable to effect a preliminary light copper or nickel plating of their surfaces in order to form a more suitable underlay of metal upon which to deposit the chromium. Chromium, of course, *can* be deposited directly upon iron or steel articles, but the result is seldom satisfactory.



The Beginner's Guide to Woodturning

By "Home Mechanic"

IN the preceding article the processes of setting-up the wood in the lathe, turning it to a cylindrical shape and smoothing off were detailed. The article was concluded by explaining the method of marking out the work preparatory to turning it down to the desired shape. Actually, before the marking-out can be done, the required shape must be decided upon, and it is a wise plan to make a drawing of the object before proceeding to the next stage. As a fairly simple example, we might consider a small candlestick similar to that shown in Fig. 1. Suitable dimensions are given, and the shape is one which does not give much difficulty to the beginner, but it does provide an exercise in most of the preliminary turning operations.

Making a Simple Candlestick

Let us see how this little candlestick would be made, tracing each step in turn. Naturally, the first thing is to set up in the lathe a piece of wood about 6 in. long, and either 4½ in. square or of circular section with a diameter of about 4½ in. Next, it must be turned to a true cylindrical form as described in the previous article, and made exactly 4 in. in diameter. Then the various lengths (shown in Fig. 1) must be marked on, after which the wood is ready for shaping. This work must be carried out in proper sequence, and this is indicated by the broken lines which are numbered. First the wood should be hollowed out from the point marked *B* to that marked *E*, so that the diameter at *E* is slightly larger than that finally required at *D*.

This is done by using the large gouge, and working from *B* towards *E*; in no circumstances must the chisel be operated in the opposite direction, for that would cause the wood to split and probably result in an extremely rough surface due to working "against the grain." The method of holding the gouge is the same as was described before, except that it must be tilted to rather a greater angle. In other words, the "back" of the gouge must be slightly higher. This step is suggested by the broken line marked 1 in Fig. 1.

> In this Concluding Article the Writer Deals with Hollowing, Rounding and the Use of the Face Plate

Cutting to Length

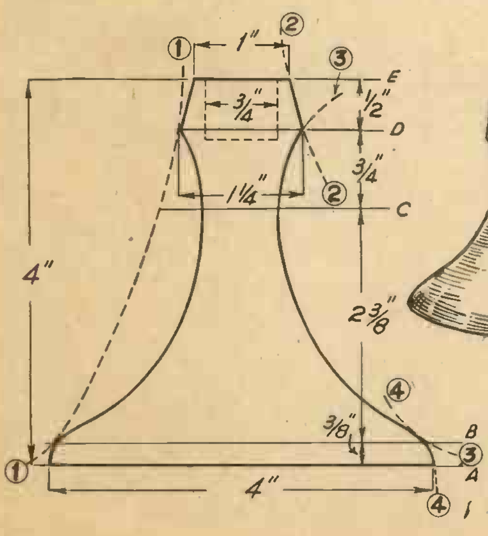
The next step is roughly to bring the wood to correct length by making cuts at the two lines marked *A* and *E*. This is done by mens of the smaller chisel (about ⅝ in.) as shown in Fig. 2. The point to notice is that the pointed corner of the chisel is used, and that the tool is turned to such an angle that the bevelled face which is towards the "wanted" portion of the wood is at right-angles to the axis. The method is to make a shallow cut just outside the line, and then to move the chisel about ⅛ in. further away and make another cut running into the first. The result is that a V-cut is formed, and this provides more room for using the chisel and going deeper. The end cuts must not be made very deep at this stage, because it is not desired to weaken the wood any more than is necessary.

Bevelling

After the length has been properly set in this manner, the bevel at the "holder" end should be formed. This is done with the ⅝-in. chisel by working from line *D* to line *E*—the chisel must not be moved in the opposite direction for the reason given above, since it is always essential to work from the long to the short fibres of the grain. The chisel is held in the same manner as the larger one was held when smoothing the surface, but it is operated from the wrist, instead of keeping these and the elbows rigid as was done before.

Hollowing

After the diameters at *D* and *E* have been made correct, the large hollow between *B* and *D* can be formed. This is actually a very simple operation, and is carried out by means of the middle-sized gouge. All that is necessary is to work from *B* to *C* and from *D* to *C*, continuing until the diameter at *C* is slightly greater than is required when the work is finished. The experienced turner would then smooth the hollow with the chisel, but the beginner is almost sure to find a good deal of difficulty in this, and might ruin the work. Consequently, it is better in the earlier stages to finish off with coarse, and then fine, glass-paper. This can be held in the fingers, care being taken to apply the paper to the wood at the side opposite to the T-rest.



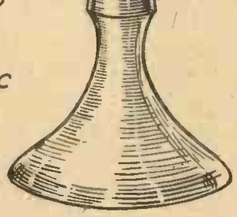


Fig. 1.—Details of a simple candlestick which provides good practice in various types of turning work. Broken lines with numbers attached indicate the order in which the principal operations are performed.

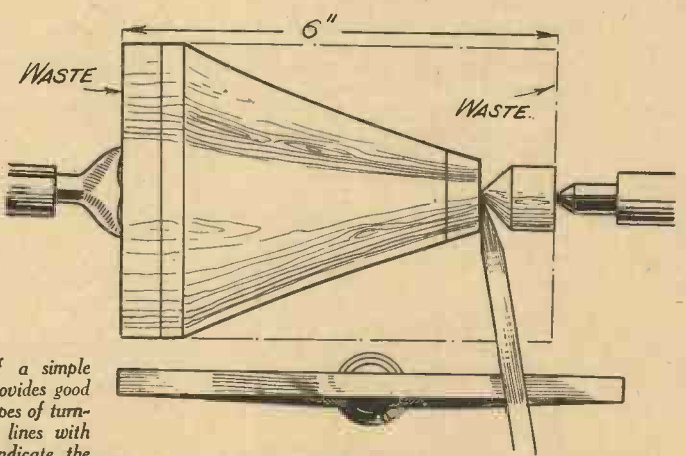
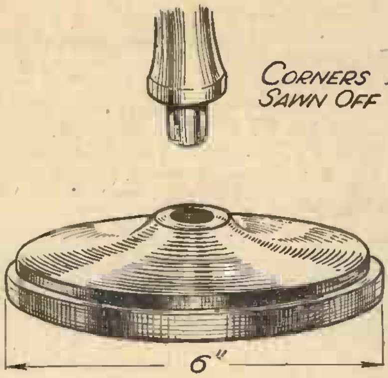


Fig. 2.—The method of cutting down the ends of the work to separate the waste wood.



Should any difficulty be encountered in working to a particular shape, due to the fact that the shape cannot well be visualised, it is a good plan to make a cardboard template by tracing through the drawing made like that in Fig. 1. The template should be cut to the shape of the outside of the object, so that it can simply be applied to the work and a proper comparison made. Like the glass-paper, the card must be applied to the wood on the side opposite to the rest.

Rounding

The final shaping operation is in connection with the round curve between *A* and *B*, and this is the most difficult part of the whole work. Shaping must be done with the ⅜-in. chisel, which should be worked from the end *A* towards *B*. Proceed in a similar manner as between *D* and *E*, but "rolling" the chisel and using the hands—pressed firmly against the rest—as a pivot. If the turning has been well carried out, glass-papering should be totally unnecessary, but the beginner will probably have to use this method of smoothing until a good deal of dexterity has been acquired.

Cutting Off the Waste

The principal operations having been performed, the ends of the wood can be finished preparatory to taking it out of the lathe. Start at the larger-diameter end by cutting, a little at a time, as described above, but instead of making the cut exactly at right-angles to the axis of the wood, attempt to make the base slightly concave by working inward. This will prevent the finished candlestick from rocking when placed on a flat surface. Provided that about 1 in. of spare wood has been left between the foot of the candlestick and the live or fork centre it should be possible to cut down to a diameter of not more than ½ in. The cut should not be deeper than this, however, until the other end has ben reduced to ½ in. or so, for if it were the wood might break off sooner than was anticipated. When the end towards the dead centre has been reduced to ½ in., the other one can be cut down to a similar diameter, after which the lathe can be stopped and the wood removed. The two pieces of waste wood can then be broken off quite easily, and a hole bored to take the candle by means of a brace and auger bit, the candlestick being held by an assistant. It might be mentioned that some workers prefer to bore this hole before the wood is ever placed in the lathe, the idea being that boring is simplified when the wood is in the form of a rough square-section block. If this method is followed, the dead centre will pass into the hole, which must be made rather deeper than is eventually required, because allowance must be made for squaring the end of the wood.

After having made this candlestick, the beginner will have obtained a good deal of experience in simple turning, and there are numerous articles which he can easily make. A few examples of suitable subjects are shown in Fig. 6, and many others will come to mind—necessity being the mother of invention.

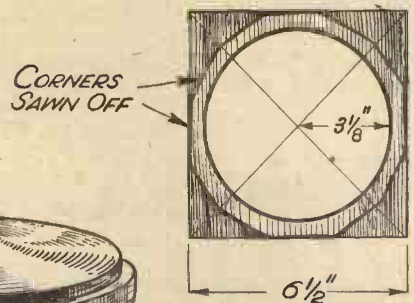


Fig. 3.—A base for a table lamp. This provides good practice in face-plate working.

Use of the Face Plate

Just as in metal-turning, all forms of work cannot be done between centres, and a face plate takes the place of the chuck used for metal. A face plate is required when turning an object which is to be of comparatively large diameter whilst being short or thin. An example is the base of a large candlestick or table lamp, the upright of which is to be fixed by means of a dowel. An example of a table-lamp base is shown in Fig. 3, along with the method of preparing the wood for turning. The first step is to obtain a square piece of suitable material about 1/16 in. thicker than finally required, and about ½ in. greater in width than the diameter of the finished job. Plane one side of the wood (because it cannot be smoothed down properly at a later stage), find the centre by drawing diagonals and then draw a circle ½ in. greater in radius than that of the required base. The next step is to saw off the corners of the wood just outside the circle, and so make the wood roughly circular. In some cases, depending on the thickness and hardness of the wood, it might be better to cut exactly to the circle with a fret-saw, but this is rarely practicable.

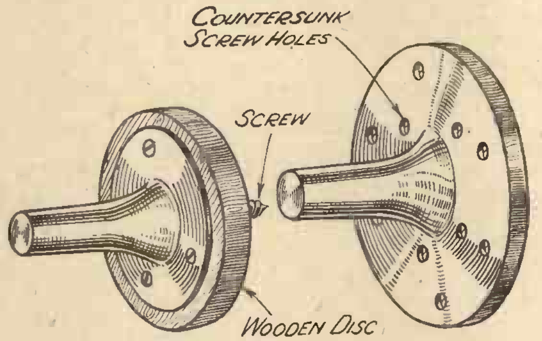


Fig. 4.—Two types of facing plate. In one case the wood is held by a single screw (attached to the plate) and in the other by three wood screws.

Next, the wood must be fitted to the face plate, of which two example are shown in Fig. 4. One consists simply of a disc of wood, with a coach bolt passed through the centre, attached to a flanged spindle which replaces the fork centre; in the other example there is simply a large flanged spindle. The first-mentioned type is suitable only when the wood to be turned is of a diameter up to about 4 in., since the wood has to be rotated by means of the threaded portion of the coach bolt. The second type can be obtained in various diameters for wood of any size.

Face-plate Turning

When using the simpler type it is necessary only to make a hole in the centre of the wood with a bradawl and then to screw the wood on to the face plate. In the second instance, a circle must be drawn on the wood equal in diameter to that of the plate, after which the latter should be laid over it and attached by means of three screws passed through convenient holes in the flange—taking care, of course, that these are not long enough to project through the turned face after it has been cut down with the gouge.

When the wood has been attached to the face plate, the fork centre should be removed and the plate fitted in its place. After this, the T-rest should be set almost parallel to the face and slightly higher than the centre of the wood. Turning can then be carried out by means of the gouge, working from the centre towards the edge. Later, the rest should be turned to an angle of about 45 degrees with the axis and the edge of the wood curved over as required, still using the large gouge and working towards the face plate. If any work is done with the chisel great care must be taken that the tool is perfectly sharp and that it is worked towards the long fibres of the wood—the outside of the circle.

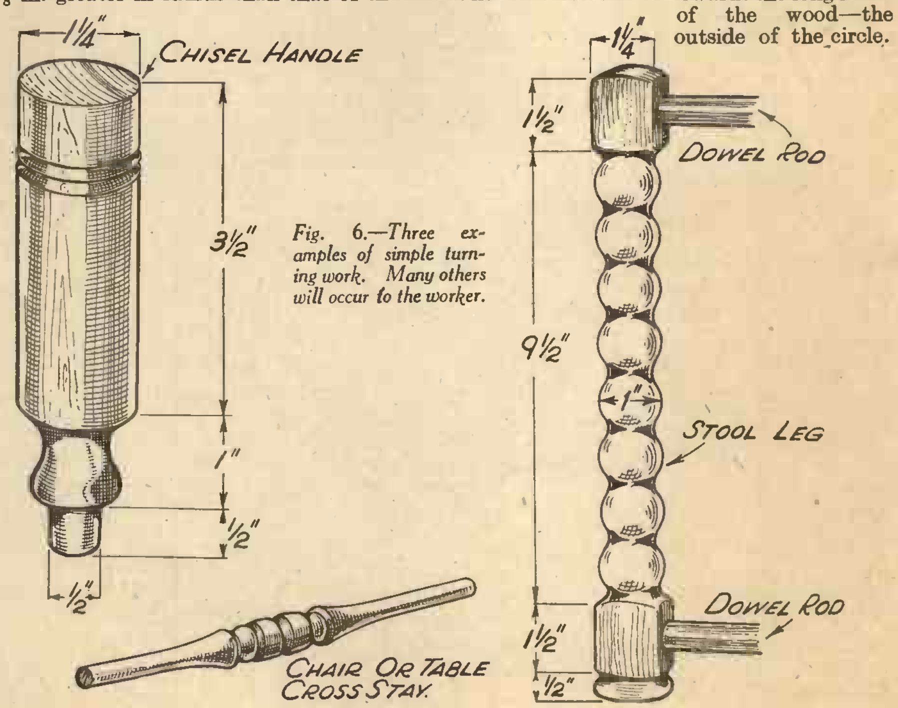


Fig. 6.—Three examples of simple turning work. Many others will occur to the worker.

Poison Gases And Their Nature

A Description of the various Gases and other Poisonous Substances used in Modern Warfare

POISON gases, despite their truly horrible and ghastly nature, seem undoubtedly to have come to stay in modern military and offensive operations. Time was when warfare was regarded more or less as a gentleman's occupation. Nowadays, however, it is a savage scientific fight in which are brought into fullest use all the applications of science which can serve a destructive and annihilating purpose.

Since the Germans first used a simple poison gas at Loos in the spring of 1915, the development of poisonous materials and their application to destructive purpose has proceeded apace. During the Great War no fewer than some fifty different poisonous gases were employed by the belligerents, although, of this number, only a few were found to serve a practical purpose. After the war, the study of poison gases and their effects upon the living organism has still gone on, with the result that, at the present day, there is not a civilised nation which has not got up its sleeve a chemical stick in the way of poison gases with which it hopes to beat any future enemy.

Scientific or Diabolical ?

The science of poison gases is not a difficult one to follow. In some respects, indeed, it forms an interesting study, although whether its interest is wholly scientific or partly diabolical, we shall leave the individual reader to decide.

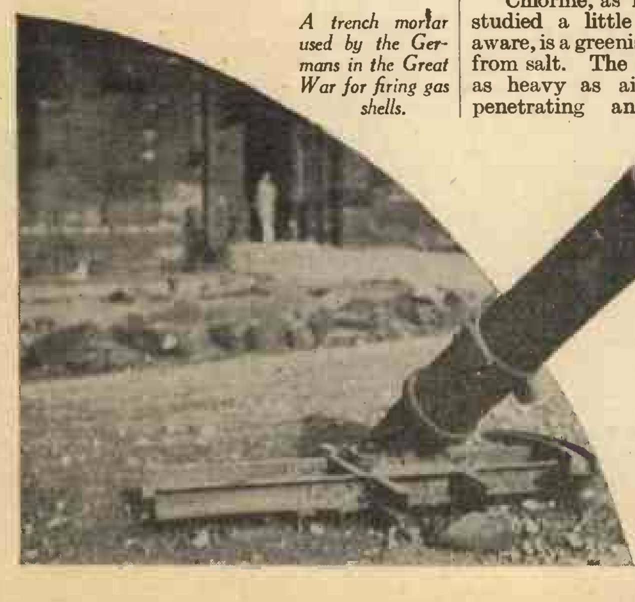
Warfare gases may be divided into several different groups or categories. These may be enumerated briefly as follows :

1. Asphyxiant, or Suffocating Gases.
2. Lachrymators, or " Tear Gases."
3. Sternutators, or " Sneezing Gases."
4. Vesicants, or " Blistering Gases."
5. Vomiting Gases.
6. Stink gases and other miscellaneous substances.

During the last war, it was not uncommon to find that many gases of different types were being used together. Thus, the enemy would throw over a mixture of vomiting gas and asphyxiant gas. Traces of vomiting gas penetrating an inefficient gas-mask, caused the soldier to become sick, with the result that he tore away his mask and, in consequence, succumbed to the asphyxiant gas. Again, the Germans had a practice of pouring over on to the British lines quantities of " stink gas," a gas which had an appalling smell but which was fairly harmless. As a consequence, our men became fairly used to the overbearing odour and treated it lightly. Unexpectedly, however, the enemy would mix powerful poisonous gases with their stink gases. Thus, being taken by surprise, serious casualties occurred in the Allied ranks.

Asphyxiant Gases

The chief asphyxiant gases used in modern warfare are chlorine, phosgene and chlorpicrin, the latter constituting, also, a powerful vomiting gas. Chlorine alone, however, is seldom employed for military purposes, for it is too easily neutralised and dissipated Nevertheless, it was the first poisonous gas used by the Germans in the spring of 1915, and it caused numerous losses in the unprepared ranks of the British soldiers.



A trench mortar used by the Germans in the Great War for firing gas shells.

Chlorine, as most individuals who have studied a little chemistry at school are aware, is a greenish-yellow gas which is made from salt. The gas is two and a half times as heavy as air and has an extremely penetrating and irritating smell. If breathed in any quantity it causes great injury to the lungs and breathing passages and quickly causes death.

A more subtle asphyxiant, or lethal gas, is made by combining chlorine with carbon monoxide, which, as is well known, is an extremely poisonous gas. The product of this combination is a gas known as *carbonyl chloride*, or "phosgene." The gas has a faint smell resembling musty hay and, if anything, its odour is slightly pleasant. But the poisonous properties of phosgene are terrible. Breathed in any quantity it causes rapid unconsciousness, followed by death. Even when phosgene is present to the extent of only a few parts per hundred-thousand of air, it produces a very bad effect upon any individual who is unfortunate enough to breathe it, causing breathlessness and making the heart liable to fail even when the slightest strain is put upon it.

A typical gas mask.

Liquid Gas

Chlorpicrin, or nitro-chloroform, like many of the so-called " gases " used in warfare, is not a gas at all, but a liquid which is fired in shells into the enemy's ranks and thus dissipated in the form of a fine spray over the heads of the unfortunates. Chlorpicrin is made by distilling a mixture of bleaching powder, lime, and picric acid. This substance is not so poisonous as phosgene, but it is heavier and is less liable to be blown away by the winds. Consequently, chlorpicrin is a very effective substance for " staying put " in any required locality.

As we have seen, chlorpicrin, besides being an asphyxiant substance, constitutes, also, a " vomiting gas." It will find out the slightest weakness or inefficiency in a respirator and, passing through the filtering medium of the respirator, will make the wearer of the latter violently sick.

Many chemical amateurs have wondered why greater use has not been made of prussic acid gas in warfare, since its exceedingly poisonous nature is made use of in fumigating ships and buildings. As a matter of fact, prussic acid (hydrocyanic acid) gas was used experimentally during the Great War, but the gas is so easily neutralised and so quickly dissipated in the open air that little success was obtained with it. Moreover, prussic acid is very dangerous stuff to handle in factories and in packing depots and, compared with some of the more complex gases, its sphere of usefulness in military operations is limited. As direct poisons, or suffocants, therefore, phosgene and chlorpicrin occupy a premier place among the chemical weapons of the modern scientific army.

Coming now to the other classes of gases, the tear, sneezing, and blistering gases, most, if not all of these, are in reality, liquids, but, as already noted, they are fired over the enemy's lines in shells, the heat of the shell's explosion dissipating the contained liquid as a fine spray which, descending to the ground, acts in every way as a gas and mixes intimately with the surrounding air.

Mustard Gas

The most terrible by far of these gas-liquids is the vesicant or blistering substance known as "mustard gas." Chemically, this is called *di-chlor-di-ethyl-sulphide*. Dramatically, it has been called the "Dew of Death" in consequence of the habit of mustard gas of slowly volatilising from areas around which it has been sprayed and of penetrating, burning up, scorching, and corroding everything with which it makes contact.

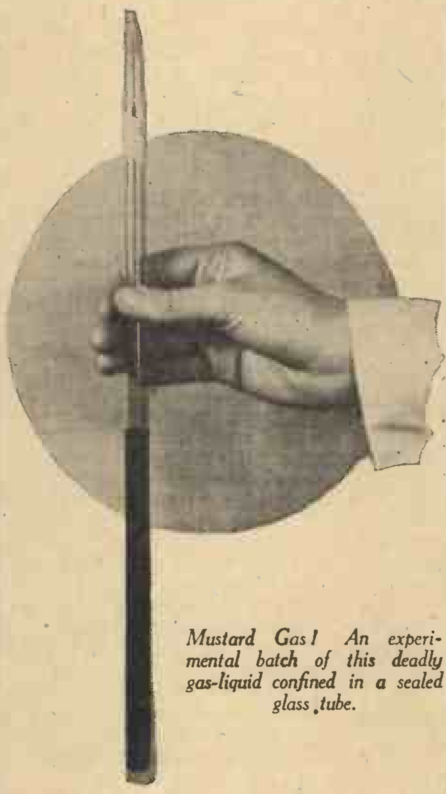
Mustard gas, or dichlordiethylsulphide, was, originally, a British discovery. It was first made by an individual named Guthrie, a laboratory chemist, in 1860. But Guthrie found it too dangerous to experiment with, and during the long years intervening between Guthrie's discovery of this substance and its use in the latter stages of the 1914-18 war, it remained a mere chemical curiosity, a mere entry in the standard chemical dictionaries.

The raw materials of mustard gas are chlorine, sulphur, and alcohol. The alcohol is converted into ethylene, a sweet-smelling gas, whilst the chlorine is passed into molten sulphur, thereby producing a substance of pungent and rancid odour, sulphur monochloride. By a series of chemical operations, the sulphur monochloride and the ethylene gas are made to interact and the final result is—dichlordiethylsulphide, mustard gas, or, if you have a partiality for chemical formulæ $(C_2H_4Cl)_2S$.

Tear and Sneezing Gases

Mustard gas is by far the most evil-working chemical substance which has been produced in gas warfare, for it attacks all parts of the body, causing large, red inflamed and un-healing blisters and wounds. Breathed in any quantity it causes bronchitis and pneumonia. It is fatal to life of all kinds. Trees, shrubs, vegetation of all types are quickly shrivelled up by it and the gas-liquid sinks imperceptibly into the sub-soil, poisoning any water supplies with which it may come into contact.

The remaining gases—the tear gases and the sneezing gases—are not exceptionally poisonous in nature. Their employment in warfare is mainly for the motive of harassing troops and of preventing them from carrying out their duties efficiently. The best-known sternutator, or "Sneeze Gas," is undoubtedly a substance known to chemists as *di-phenyl-chlor-arsine*. This, when breathed in even small amounts, causes severe irritation of the membranes



Mustard Gas! An experimental batch of this deadly gas-liquid confined in a sealed glass tube.

of the nose and throat. It sets up violent sneezing which may even do serious damage to the individual and which, even when the person affected is removed from the gas, may persist for many hours afterwards.

Benzyl bromide, *xylyl bromide* and *phenylcaryblamine-chloride* constitute the main lachrymators, or tear gases. In small quantities they set up a violent irritation of the eyes and cause copious and uncontrollable weeping. In larger amounts, they cause the eyeballs to burn with an intense smarting pain and, occasionally, they may bring about actual blindness, temporary or permanent. It is quite impossible for any soldier to make any headway in an atmosphere containing even small traces of a tear gas. The warrior so caught becomes almost helpless immediately and he flounders about in an effort to gain his bearings.

Most of the gas-liquids used in war are contained in small shells which are fired from trench-mortars. The firing-direction of the mortar is not very accurately determined, for the shells themselves are not made to propel themselves over to the enemy's lines in any true path. So long as the gas shells fall within a given area, the military object is fulfilled.

Gas Projectiles

When chlorine was used as a suffocating and toxic gas, it was sent over to the British lines from strong steel cylinders in which the gas was compressed in a liquid state. The liberated gas flowed from batteries of cylinders into leaden pipes, from the exists of which it coursed slowly over to the British trenches in a greenish cloud.

Not unfrequently it was the practice to fire with gas shells a number of shells containing compounds such as phosphorus and tin chloride. The burning phosphorus and the tin chloride (when the latter comes in contact with moist air) emit clouds of white "smoke" through which an individual finds it difficult to make his way in an effort to escape from the poisonous gases accompanying the white fumes.

Before concluding this article a word or two must be written on the subject of the protective respirators which are employed to combat the menace of poison gases. At the commencement of gas warfare, handkerchiefs dipped in water was one of the methods of gas-protection which our soldiers had. Very quickly, however, gas-masks composed of chemically-treated fabric which covered the entire head were issued to the armies in the field.

The Modern Respirator

This embodies a mouthpiece and a clip for the nose. Air is drawn in via a non-return valve attached to the mouthpiece. The air, before entering the mouth of the wearer passes through a cannister, or filtering-chamber containing layers of absorbent coconut-shell charcoal and other materials, such as soda lime, permanganate of potash, iron and nickel salts. In passing through this filtering medium, the poisonous vapours and gases are either absorbed, neutralised, or oxidised and only uncontaminated air passes to the mouth of the breather. Respirators of this type remain efficient over considerable periods, but, naturally, they require re-charging with chemical materials from time to time.

There is but one pleasant aspect of poison-gas science and that is reflected in the fact that there is no known gas which cannot be absorbed or neutralised by an efficiently working respirator. Science may, indeed, be made to bring into being other and still more poisonous gases, but, at the same time, it will also be charged with the task of discovering neutralising materials for these gases. Such is, perhaps, the only scrap of comfort for the onlooker who clearly perceives the prevailing trend of poison-gas technology.

Magnesia from the Sea

AMERICAN chemical engineers have blossomed forth in a new enterprise. Bromine for petrol anti-knocks is already won from sea-water on a manufacturing scale. This time it is magnesia.

Apparently the national sources of magnesia are not equal to demand. Magnesia is used in ever-increasing quantities as a raw material for the manufacture of the metal, magnesium. Insulating cements consist of 80 per cent. magnesia, but the strangest use is a consumption of over 5,000 gallons of milk of magnesia a day by the American population. A vast miscellaneous bulk is used for such pharmaceutical purposes as toothpaste manufacture, etc.

To meet this rather varied demand, chemical engineers have turned to the sea as a source, but the amount of magnesia in sea water is about one-tenth of its salt content. It is not much, but it seems sufficient. Practically the whole of it can be precipitated by careful dosing with lime. Coagulation and filtration of the precipitate follows. Then dehydration and calcining give several grades of a fine flour of magnesia which is said to obtain a high price in the market.

The plant is what is called in technical slang, a "pipe-fitters' paradise." It is under push-button control, and run by three men per shift, but about ten times this number of fitters is needed to keep it in running order. However, it is enterprise in the right direction. British chemists are still content to get their magnesia from the Dead Sea by age-old methods of solar crystallisation in salt pans.

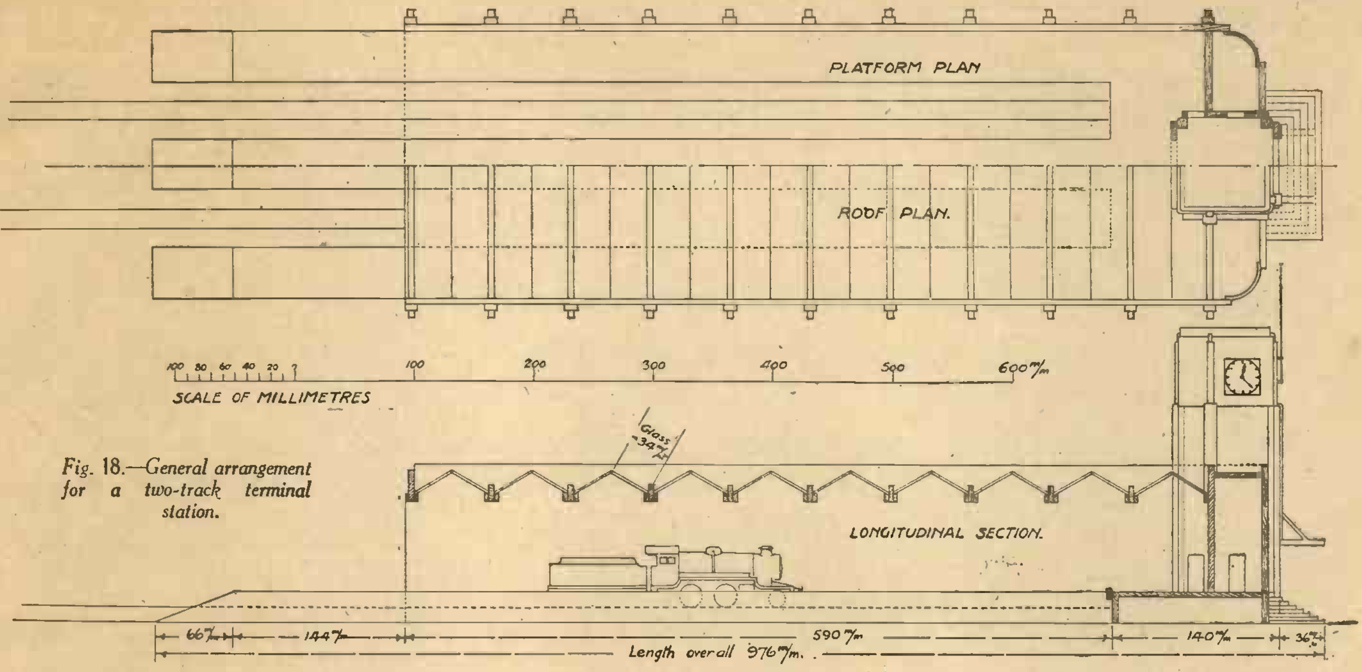


Fig. 18.—General arrangement for a two-track terminal station.

Adapting the Twin-Train Table Railway

By E. W. Twining

Continued from page 486 of the May Issue

IT has been suggested that for the railway I should give some designs for buildings and engineering works. Covered by the latter term will, of course, be tunnels, bridges, etc. Of buildings, particularly for a model railway, the terminal station is the most important and imposing, and I propose to deal with this first. The first consideration, perhaps, for the amateur who is laying a railway, in deciding the size of the terminus is the question of how much space can be allotted for it to occupy. Another point is the matter of cost. On the first depends not only the length but the width, and the width may be controlled from a point some little distance from the station itself—by the number of tracks which it is desired shall enter the station. At first sight it may appear that the cost of a terminal station may not be much affected by size; neither is it in modelling the building itself, but a large number of tracks and platforms necessitates a corresponding number of points and crossovers, for it is obvious that there must be means of transferring a train from any bay in the station between the platforms to any track, or to either track—the up or the down.

The 6 ft. Way

It will be found that where points are introduced, outside of a terminal station, the tracks cannot be laid closer together than 90 mm. centre to centre. This is an unvariable amount so that in the vicinity of points, the space between rails, known as "the 6 ft. way," will actually scale about 15 ft. In stations, therefore, where crossovers are adjacent, both terminal and wayside type tracks must be this distance apart. Fortunately the space between the rails need not be wasted. In the case of a wayside station, an island platform can be adopted. In a terminus, also, platforms can be placed between the tracks. Of course, in a normal full size station one would not find a platform between every single track, but there are isolated cases where such an arrangement occurs and in any case it will make a model station look busier to have the greatest number of platforms with the maximum number of tracks which can be afforded. Normally there would be two tracks between every platform: perhaps two arrival side by side on one side of the station and two departure arranged on the other side—that would constitute a small terminus.

Loading Gauge Clearance

However, most readers will wish to insta the minimum number of tracks and platforms practicable to give a good appearance, and I think that two lines of rails with two side platforms and one centre one meets this requirement. Such an arrangement is shown in cross section in Fig. 17. This is more or less a diagram constructed to show the clearances required by the trains. As a matter of fact, the greatest projections are to be found on the engine and these necessitate a space between the edges of platforms of 48 mm. With the centres of the tracks placed at the before-mentioned

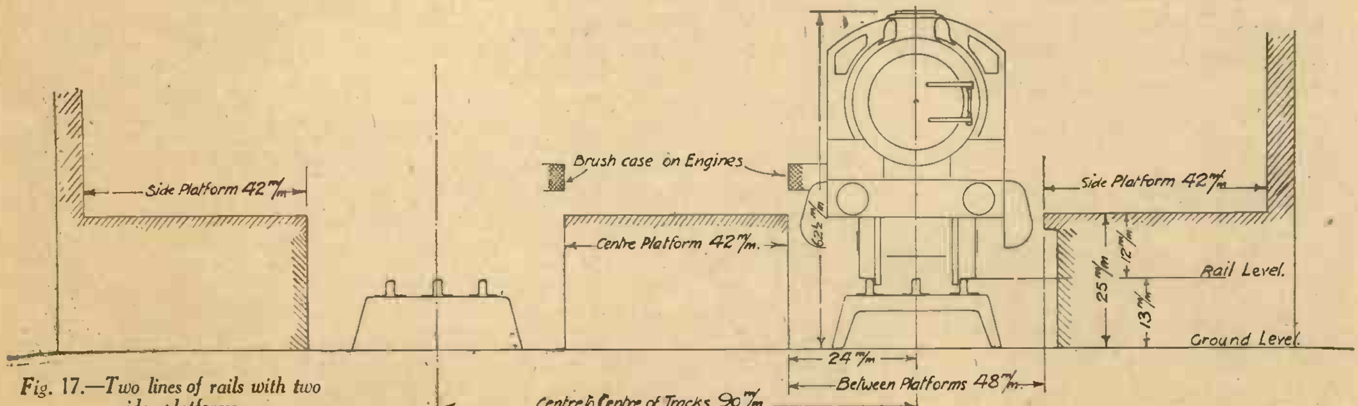


Fig. 17.—Two lines of rails with two side platforms.

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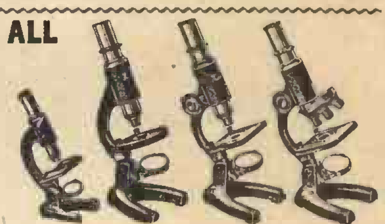

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90 mm. distance apart, this width between the platforms results in a width of 42 mm. for the platform surface. The sum of the width of three platforms and two track spaces gives a measurement of 222 mm. between the inside faces of the station walls: that is to say, about 8¾ in. If the reader thinks that this is cutting matters too fine from the point of view of appearance he can either increase the width of the outside platforms or make a larger station.

A More Imposing Terminus

Supposing that economy, both of space and cost, is not a consideration, a three-track station is ideal. It is much more imposing, more realistic and there is, of course, much more reason for making it a covered station. Obviously, of course, a little station having only two tracks would, in full size practice, not be entirely roofed in. Such a station with four platforms would have a width measurement of 312 mm. between the walls or, say, 12¾ in. inside of the walls. With regard to length, it would seem that this can be made the same whatever number of tracks and platforms are introduced. Obviously, it should not be shorter than the length required to accommodate the longest train. In large stations the platforms always extend beyond the roofed-in portion, and so we can quite well make our platforms have a total length of about 700 mm.

Form of Roof

In model work it must be remembered that the arched structure involves very much more complication and labour and necessitates a higher architectural front to close in the upper part of the arch. An arched roof cannot very well be filled with glass, and celluloid would have to be resorted to.

I strongly recommend the reader to follow the lines of such a modern station as, we will say, Waterloo where the roof is broken up into ridges and valleys and carried on open lattice girder work. By copying this type a roof becomes an extremely simple thing to construct and is equally effective. Indeed, it has a much better appearance because it is more realistic and less ostentatious. If the roof were required to cover seven or eight or more platforms the case would be different and there would then be more reason for a more imposing structure.

Design for Station

Fig. 18 will convey sufficient information to enable anyone to build a two-track three-platform terminus as indicated in Fig. 17. In this design I have kept the roof as low as practicable. This, together with the breaking up of the roof into a large number of bays or ridges and valleys, will have the effect of making the expanse of glass seem greater than it is. The width between the walls will be 222 mm. as already mentioned. This measurement will be the length of the strips of glass to be cut and the width of them will be 34 mm. The materials of which the walls, platforms, etc., are constructed must be decided by the reader himself. Plywood will suggest itself to most and will make a perfectly good job provided the cut edges can be planed dead smooth, which is not an easy thing to do. I should personally prefer straight grained plain wood such as satin walnut or American whitewood. The thickness is for the walls ¼ in., whilst 3/16 in. will be most suitable for the girders which will carry the glass of the roof. There are details which will obviously be of other sizes; the measurements can be taken from the drawing.

Position of Entrance

The main entrance to the station is placed at one end, but this is a point which must be modified if it is found unsuitable on the reader's arrangement of his railway. Actually, of course, an entrance of similar design can be placed in the middle of the length of the station, on one side or the other. A flight of steps is unavoidable for taking the imaginary public from the roadway up to the level of the platforms. In the model, track, station and everything will, I presume, be laid upon a shelf. Unless such roadway is built up to the platform level these steps cannot very well be omitted. Over them I have shown a plain canopy. A booking hall is indicated inside the entrance under the tower and refreshment rooms, left luggage office, etc., can be arranged on either side. For the clocks in the tower I suggest that a couple of cheap wrist watches be bought, the glass removed and possibly new paper dials painted and mounted on the existing ones. An arrangement must be made inside of the tower to hang or otherwise support the watches so as to make them readily removable for rewinding.

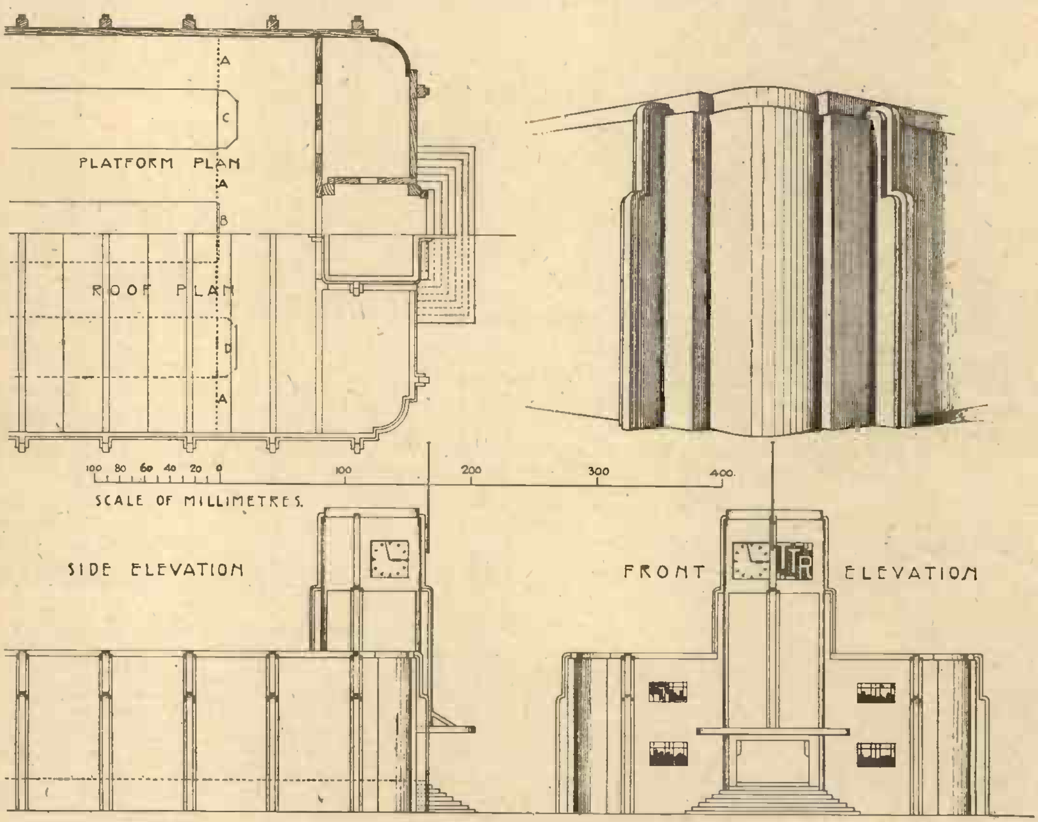


Fig. 19.—A design for a 3 track, 4 platform terminal station.

Modern Architecture

I have worked on a distinctly modern line in designing the architectural features of our terminal station. Fortunately for the model maker the modern styles makes for simplicity of construction. One could not very well have anything easier to reproduce than the plain, bold features of such a building as shown. The buttresses, which are repeated along the whole of each side of the main walls, are the only features which may be worth giving special treatment. They are by no means complicated, but it would relieve the tedium of making so many items all exactly alike if they could be reproduced almost automatically. I suggest, therefore, that one only be carefully made in wood, coated with shellac, then with a film of grease, and a plaster cast taken from it. This cast, when thoroughly dried, can be used as a mould and the number of buttresses required cast in lead, or some such metal with a low melting point. It will be noticed that the corners of the main front are rounded off. Perhaps the easiest way to reproduce these will be to use pieces of an ordinary brown cardboard tube 2 in. in diam. cut up to the required measurement.

A 3 Track, 4 Platform Station

Fig. 19, although following exactly the same lines and the same design, shows a station of more imposing appearance. The extra width brought about by the addition of another railway track and another platform, making an extra 90 mm., gives a much finer effect to the main front elevation. In this drawing I have prepared a separate enlarged sketch showing the details of the corners, including the offsets, to the walls and the buttresses. From the roof and platform plans it will be seen that I have shown greater space between the booking offices and the ends of the platforms. The side offices, refreshment rooms, etc., are also made larger. There are some accessories which ought to be included in such a terminal station as this. For instance, gates ought to be made at the ends of the platforms at *A*: a destination and departure and arrival indicator might very well be placed at *B*, whilst bookstalls and a cigarette shop can go at *C* and *D* immediately behind the buffer stops, which should, of course, terminate each line of rail.

It will be noticed that I have avoided showing any windows in the subject of Fig. 18, whilst in Fig. 19 I have shown them only at the front end. Personally, I should prefer to omit windows entirely, although strictly speaking they are needed for lighting the interiors of the offices and refreshment rooms. I leave it to the reader to decide whether he will put them in. If they are introduced either glass or celluloid can be used ruled up for the iron frames with whatever colour is adopted for the relief. Actually there is not much relief anywhere, flag mast, window frames and numerals on clock dials being the only points where little bits of colour can be brought in—blue, vermilion, orange or green. The main walls on the inside should, I think, be painted stone grey, as also platform surfaces and outside steps. The outside walls should be either white or pale cream, the finish known as "snowcrete" is that almost invariably adopted on this style of modern architecture.

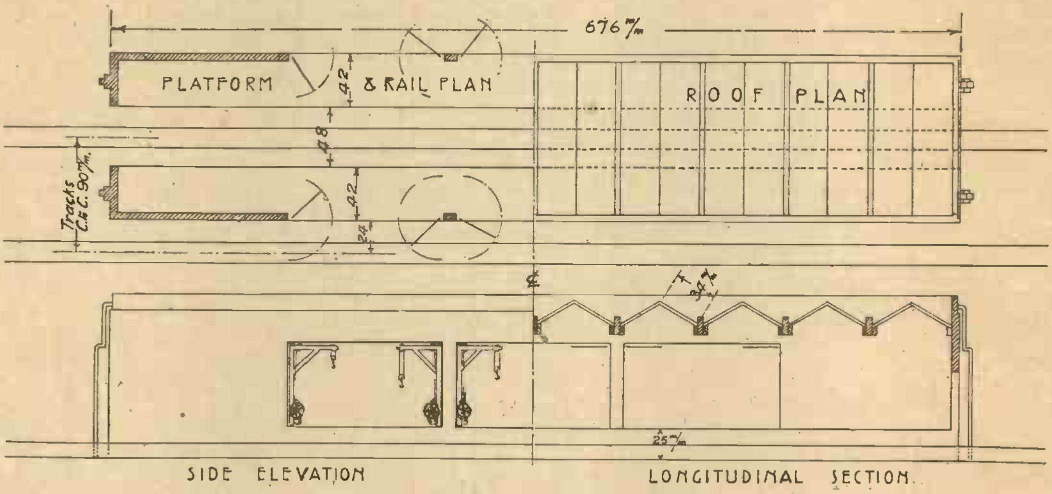


Fig. 20.—A design for a model goods depot.

A Goods Depot

Next in importance I suppose to the passenger station will be the goods depot. I do not suppose many readers will want to devote much space to this department, so I am just giving him a comparatively simple design for a goods shed which yet will be sufficiently large to be efficient. It does not call for description beyond saying that the same lines are followed in construction and architectural style as in the station. One railway track runs through the centre of the shed whilst another passes alongside of it. On the opposite side to the railway track it is intended there shall be a road on which lorries will be loaded up. Cranes are indicated on either side of each of the six openings for loading and unloading wagons. As will be seen I have made the length of the shed, measured over the main walls, 676 mm. If this is thought unnecessarily big I suggest that the number of openings in each of the side walls be reduced from three to two, which will have the effect of shortening the building by 124 mm.

(To be continued)

WIRELESS ON THE AIRWAYS

A WIRELESS installation claimed to be the most modern and efficient ever constructed for use in commercial aircraft has now been completed and is to be fitted into "Canopus," the first of the great Imperial Airways Empire flying-boats.

The wireless equipment for this fleet of 28 great new Empire flying-boats is being constructed in the Experimental Aircraft Establishment of the Marconi Company at Hackbridge, close to the London air-port, and embodies all experience gained in the use of wireless telephony and telegraphy in fifteen years of airway operation.

Apart from the actual wireless problems which arose in designing the sets for the new aircraft, the problem of fitting the various wireless devices without in any way detracting from the high speed of these giant flying-boats has also had to be solved. Attaining, as they will, a speed of close on 200 miles an hour, the question of eliminating wind-resistance in the fitting of aerials and accessories has become extremely important.

Providing the Current

A special study of this matter has, in the new sets, produced some excitingly interesting results. For example, instead of there being an external windmill generator producing current for the wireless, an entirely new system is being employed in which dynamos and generators inside the hull, coupled to the main engines of the flying-boat, provide the necessary current. Another ingenious way of eliminating external resistance is to be found in connection with the loop aerial for direction-finding. This, when not in use, is lowered through a trap-door, vanishing inside the hull.

In the new Empire flying-boats the wireless operator will have a compartment, installed with every form of modern equipment, situated on the upper deck immediately behind the control-cabin of the Captain and First-Officer. Here will be placed the new type of set which has been designed specially for these big flying-boats. It will be known as the Marconi A.D. 57a/58a type. For transmitting purposes it will operate on wave-lengths of from 16–75 metres and from 600–1,100 metres, while for reception it will operate on wave-lengths of from 16–75 metres to 600–2,000 metres.

Direction-finding Apparatus

A feature of this new installation is that a direction-finding apparatus is embodied in the main set, and is not a separate piece of equipment, as has been the case hitherto. By the use of this direction-finding equipment the wireless operator will be able to tune in to any ground stations that may be operating within range, and plot out the air-liner's position at any time during a flight.

Wireless developments not only play their part in the navigation of modern air-liners, but they are also at the service of passengers when any important or emergency message needs to be transmitted. By facilities now in existence on the Empire routes, an urgent cable for any passenger who is in flight can, after it has been sent to the nearest convenient land-station, be transmitted from that station to the air-liner, being taken down and handed to the passenger by the wireless operator of the aircraft. By a similar system, should a passenger in flight find that he or she needs to send an urgent message, this can be transmitted by the air-liner operator to the nearest ground station, and then sent on to its destination by the land service.

NEW INVENTIONS

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

How to Draw a Cork

ALTHOUGH the drawing of a cork does not require as much skill as the extraction of a tooth, some aptitude is required in order to perform the operation successfully. Readers of *Treasure Island* will remember the buccaneer whose method of getting at the contents of a bottle quickly was to knock the neck off, which he did with a dexterity suggesting much practice in the beheading of bottles. It would not be easy to state who first invented that spiral contraption known as a corkscrew, but we are all familar with its lineal descendant which acts by means of a screw driven into and through the cork. This appliance is open to the objection that, in the case of weak corks, the screw sometimes fails to grip the cork, and when driven through, particles of the cork may drop into the liquor. With the aim of obviating these disadvantages, an inventor has thought out an improved cork-drawer. This comprises a casing adapted to fit over the crown of the cork. On the inside of the casing is a coiled resilient metal band to embrace the top of the cork. One end of the band is free and has teeth for engagement with the cork. The other end is fastened to the casing, so that the cork will be gripped by the band upon the casing being turned in one direction, and released when it is rotated the opposite way. If this device really does what is claimed, it will enable one to drink to the health of the inventor.

Elastic Socks

ELASTIC used to play a prominent role in the footwear of our ancestors. In the Victorian era, elastic-sided boots were very general and getting them on and off involved a considerable amount of effort, not to mention expletives. For doffing boots, our forefathers employed what was called a bootjack.

The latest idea for utilising elastic in connection with the feet is to use it in the manufacture of socks and stockings. An elastic section extends across the upper part of the foot near the toe. This may be supplemented by elastic sections across the sole and round the back of the heel. It is contended for this invention that it will increase both the comfort and the wearing qualities of the hosiery. The ground for this claim is that, since elastic gives, it does not produce the resistance which the less stretchable wool supplies. The consequent resilience makes for the longevity of the hosiery, while the pliability adds to its comfort. However, to vary an old adage, the proof of the stocking is in the heating. It remains to be seen whether, as elastic is rubber which is non-porous, the use of this material in socks and stockings may be objected to from a hygienic point of view. One should add that, since it is not proposed to make the foot entirely of elastic, the woollen part will allow for ventilation.

Speaking of elastic reminds me that it has recently been proposed to incorporate this material with spats, which makes for a closer and better fit upon the boot.

Elastic boot and shoe laces have also been devised, and these, being capable of expansion, may contribute to the comfort of footwear.

Convenient Combinations

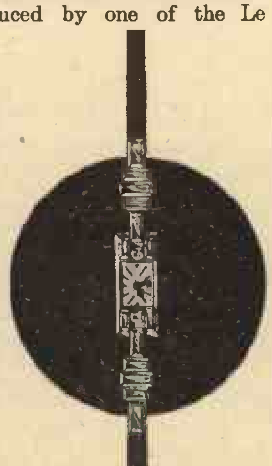
THE possibility of tropical heat in the near future (if our fickle climate permit) makes appropriate a device which has been patented in the United States. This is a combined washstand and shower bath. The basin, which is normally in the customary position of that article, has guide means by which it can be lowered to the floor and the douche can then be operated.

Another invention of this type recently patented in this country is a convertible chair. The aim of the inventor has been to design a simply constructed chair which, as though touched by a magician's wand, can be immediately turned into a small ladder. When the seat—hinged at the rear of the chair frame—is lifted, steps on the underside come into operation. To guard against the danger of this piece of convertible furniture playing one of its parts at the wrong time, the inventor has provided an automatic catch which holds the steps in position. And it is maintained that there is no likelihood of the chair or steps being upset or collapsed.

BY DYNAMO.

World's Smallest Watch

THE watch shown on this page is considered to be one of the most remarkable achievements of the watch manufacturers. Produced by one of the Le Coultre factories, it is claimed to be the smallest watch in the world. It is built on the "Duoplan" system, which makes it possible to accommodate a much larger barrel and balance than would otherwise be possible. The movement has 16 jewels, and the bi-metallic balance is cut and provided with screws for accurate adjustment. The watch, complete with dial, weighs 1.21 grammes, or 23 of these watches weigh about 1oz.



A remarkable achievement of the watch manufacturer.

To fully appreciate the construction it is necessary to examine the movement under a powerful glass, and the performance is such that it is guaranteed to keep time within a ¼ minute per week.

BUILDING A SYNCHRONOUS ELECTRIC CLOCK

(*Continued from page* 563)

D. The perforated plate is again employed to position holes *C* and *D*, which are in both gear plates. A ½-in. pinion on the spindle in hole *D* drives an idle ½-in. pinion, which meshes with a 1½-in. gear wheel on which is secured the hour hand. These last mentioned two pinions and gear wheel are accommodated on the front face of the gear plate and it is necessary to saw off the bosses on the pinions and file them smooth. This is done so that the dial of the clock may be brought sufficiently close to the gear plate to allow the boss of the 1½-in. gear to project slightly through the dial.

The ½-in. pinion on the spindle *D* is secured to the spindle, by soldering. If the hole in the pinion is countersunk fairly deeply, sufficient of the spindle will be exposed to ensure a sound soldered union without projection of the spindle end beyond the face of the pinion.

The Idler Pinion

The pin on which the idler pinion revolves, consists of a short length of axle rod on which a head is formed with the aid of a thin, tight fitting washer soldered on. The position of this short spindle, which only penetrates the front plate, is found by trial, using crimped paper strips to give clearance, as explained earlier. The spindle is secured by means of a collar sweated on to the back of the gear plate.

To allow for adjustment of the hands, to the correct time, the 50-tooth wheel on the minute hand spindle is secured to the spindle with a friction device, consisting of a six arm star piece. (See Fig. 6.) It is sawn and filed out of a small piece of springy brass, soldered to a collar and the arms bent to bear on the face of the wheel. The wheel has its grub screw removed. The wheel is prevented from moving away from the star piece by having its boss in contact with the boss of the ¾-in. pinion which drives the 12 to 1 reduction train.

At this stage, the polishing and, if desired, lacquering, of the brass parts may be undertaken. Clean up all the brass work with fine emery cloth. When the polishing is satisfactory, apply a lacquer composed of a small quantity of scrap, colourless, celluloid dissolved in amyl acetate. Sixpenceworth of this solvent will be sufficient for the job. The same lacquer is also suitable for applying to the face of the clock, after it has been marked out, to prevent it fingermarking.

The various parts may now be assembled. Screwed rods cut into lengths of 3½-in. provide the means of securing the stator poles and gear plates in their correct positions. Nuts and washers are used in preference to distance pieces to position the various parts, as they provide means of adjusting the spacing.

At this stage the front supports, which are similar to the rear legs, except that they are as high as the dial, can be made. To ensure that all the holes are in line, a long piece of axle rod should be inserted through the holes in the back bearing strip, front and rear gear plates, during assembly.

When the clock is completed and running it is, or it should be, quite silent. To show that it is running and therefore indicating the correct time, an indicator is provided. It consists of an 1½-in. sprocket wheel to which is attached a disc of white paper, or thin card, on which are painted two black segments. The wheel is attached to the spindle in hole *A*, the spindle being made long enough to take it. The wheel rotates at approximately 40 revs. per minute, and a semicircular window in the dial allows it to be seen.

Winding Operations

It consists of 8 ounces of No. 36 S.W.G. double silk covered instrument wire wound on a bobbin which is a neat fit on the stator yoke. The bobbin is built up by wrapping stiff paper, or very thin card, around the yoke until it is three layers thick. The end cheeks of the bobbin are cut from $\frac{3}{16}$-in. thick ebonite. They are 2 in. square. The central rectangular openings are cut with the aid of a fretsaw, taking care to make them a neat fit over the paper wrapping on the yoke. Secure the end cheeks in position with a little celluloid cement or shellac. When the bobbin is dry slide it off the yoke and fit it onto a piece of wood, previously cut to the same dimensions as the yoke. Commence, and finish off the winding by soldering the 36 guage wire to a short length of flex pushed through a hole in the end cheek, taking care to insulate the joint with waxed paper or radio sleeving.

Wind on the entire 8 oz. of wire as evenly as possible, inserting a layer of thin paper between every few layers of wire. The paper will assist in keeping the layers even. The exact quantity of wire is not critical and there is no need to count the turns. This winding enables the clock to run for approximately nine days for a consumption of one unit of electricity. When the winding is complete it should be covered with a wrapping of dark coloured paper and doped with celluloid lacquer.

The winding is again fitted on to the yoke and placed in position between the stator poles. See that the transformer iron strips bed neatly up to the ends of the pole pieces so that there are no small gaps in the magnetic circuit.

Testing Out

Now connect the winding to the mains, with a temporary piece of flex, and the clock is ready for testing. Spin the rotor, with the aid of the ¾-in. sprocket wheel secured to its spindle as a finger grip, gently round. If everything is in order and the right starting speed has been attained the rotor will continue to revolve. A few trials may be required to get the knack of spinning it at just the right speed for starting.

The Hands and Dial

The hands are sawn and filed from thin sheet brass, and when completed they are given a coat of black lacquer. The minute hand has a collar soldered to it to secure it to its spindle. The hour hand has a piece of tube, whose bore is a push fit on the boss of the front 57-tooth wheel, soldered to it for mounting. This tube should be about ¼ in. long and, if a piece of drawn tube is not available, it may be fashioned from a strip of brass bent round the wheel boss.

The case, also gives room for personal expression. The one illustrated is built from ordinary window glass, bound at the joints with "Passe Partout." The construction of it was aided, greatly, by making a rough cardboard box, the size of the inside of the glass case, on which to secure the pieces of glass whilst the joints were drying.

Money Making IDEAS

Advice by our Patents Expert

AN ENLARGING EASEL

"I HAVE made, and have been using for several months now, an easel for use when enlarging photographs, and shall be glad to know if you consider it to be an article worth patenting. I have found it most effective and simple to use." (A. S., Warrington.)

THE improved device for use in enlarging photographs is fit subject matter for protection by patent and, we think, from personal knowledge it is novel. In view of its apparent utility, it should certainly have a commercial value if properly marketed. We would advise you to apply for a patent with a provisional specification, which will give you protection for about 12 months at the lowest cost. During this time, it should be possible to ascertain if the invention is likely to be a commercial success or to get likely firms interested in the invention before having to incur any great expense in obtaining a patent.

A ROTARY COMBUSTION ENGINE

"I ENCLOSE a sketch of a rotary combustion engine, which I would like you to criticise, giving me information as to the practical value and novelty of the idea." (G. L., Nr. Burton-on-Trent.)

THE improved internal combustion rotary engine is not thought to be broadly novel. The use of an eccentrically disposed drum, provided with hinged abutments and rotating within a cylindrical casing, has been many times proposed in rotary engines. We would advise you to make a search amongst prior patent specifications dealing with the subject matter of the invention before proceeding further in protecting the invention. The difficulty likely to be experienced in making a workable engine resides in the making of a gas tight joint between the vanes and the casing without impairing the free hinging of the vanes.

AN IMPROVED WATERING-CAN ROSE

"WOULD you please help me out of the following difficulty. I have taken a provisional patent for an improvement to watering-can roses. This consists of a detachable perforated cap, so that the perforations may easily be freed after having become clogged. I have approached a firm who seem interested, and they have requested a copy of the specification and a drawing. I have made a sample, which they would also like to see.

"Since taking out the patent, however, I have found it necessary to make a small modification.

"I enclose wording of my specification as it stands, and a sketch of the improvement necessary. Could you please tell me: Must I take out a patent of additions for the provisional specification, or am I allowed this much latitude? (Between the provisional and complete specification). Will it be safe for me to allow the manufacturer to see this alteration before registering it, should this be necessary?" (M. B., Hants.)

YOUR present difficulty is one that often arises from not employing professional assistance. The provisional specification should describe the nature of the invention. It is also advisable to describe, in more or less detail, an example of the way of carrying the invention into practice. The latitude allowable in covering modifications or alterations in the complete specification depends largely on the way the provisional specification has been drafted. If the basic idea is novel, the various methods of carrying the idea into practice may be allowed in the complete specification. If, however, the invention is a specific improvement on known practice, then any material alteration in the described improvement will not be allowed in the complete specification.

In the present case, provided there is any novelty in the invention, then the slight alteration proposed can be included in the complete specification and would be allowed.

We think you will be safe in submitting the improvement to the manufacturers interested in the invention.

It is possible for an applicant to file two or more applications for patents, each with a provisional specification, for inventions which are cognate or modifications one of the other during concurrent provisional protection, and to file a single complete specification in respect of all the applications. The term "provisional patent" is not correct, there is no such thing as a "provisional patent."

AN AUTOMATIC VALVE

"I SHOULD be grateful if you would advise me on the commercial practicability of the invention I have worked out, particulars of which I enclose herewith." (F. M., Kennington.)

WE do not think the automatic valve for controlling liquids broadly novel. It would appear to be a modified form of float valve commonly used in carburettors of internal combustion engines. Advised to make a search amongst prior patent specifications dealing with the subject before incurring the cost of applying for a patent with a provisional specification.

The specification as drafted would possibly be accepted by the Patent Office, but it is not drafted in the best or usual way. If the invention is novel, then the specification as drafted is too specific and it would be difficult to introduce any modifications of the invention which might occur during experimenting into the complete specification. It is not usual, nor is it generally desirable, to file a drawing with a provisional specification. In any case a sketch in the body of the specification would not be accepted by the Patent Office; a properly executed drawing on a separate sheet would be required.

SELF-IGNITING METALS

(*Continued from page* 564)

bulb-tube, although, really, in the above experiments, there is no need to ignite the hydrogen stream at all.

Pyrophoric nickel powder can also be made by gently heating nickel oxalate, the latter substance being prepared by adding a solution of oxalic acid or an oxalate to a solution of a nickel salt. Usually, however, pyrophoric nickel is best prepared by means of hydrogen treatment of nickel oxide.

Platinum

Finally, although not strictly speaking a "pyrophoric metal" in the sense commonly used, there is one metal which may be obtained in a remarkable powder form. This is the metal, platinum. Unfortunately, however, it is a very expensive metal. If, however, a tiny scrap of platinum is dissolved in a mixture of two parts strong hydrochloric acid to one part of strong nitric acid (this acid mixture constituting the well-known *aqua regia*), the solution very gently evaporated to dryness, and the residue then dissolved in a small quantity of clean water, the addition of a few drops of formalin will bring about a jet-black precipitate in the liquid. This precipitate is metallic platinum, technically known as "platinum black." Now if a small quantity of platinum black is taken up on the end of a matchstalk and held in a slow stream of coal gas coming from a gas jet, the platinum black will, within a few seconds, become red hot and ignite the gas. This principle was at one time used in the production of automatic gas-lighters, but, platinum becoming too expensive for general use, the making of such gadgets was ultimately discontinued.

The remarkable effect in the above case is not one of oxidation as it is with the above pyrophoric metal powders. The platinum becomes red hot owing to some quite unknown action to which, for want of a better understanding, chemists have applied the term *catalysis*, meaning a process which is mysteriously stimulated by the presence of some special agent, the stimulating agent in this instance being the platinum black.

A TOWNSHIP IN MINIATURE

(*Continued from page* 568)

boats sometimes glide over the surface of the water and a small pleasure steamer is invariably anchored alongside the town pier. A glass-domed concert pavilion is built on the end of this pier, and it sends melody floating across the enchanting little scene. It is most entertaining.

The trains travel among woodlands of dwarf conifers or high up on ledges. They flash under tunnels and draw long lines of freight beside the water, over bridges, through stations and on again until held up by signals or slowed down by the gradient.

Nearing the town, one comes across a wayside inn called "The Spider's Web," where miniature figures of farmers, quenching their thirst, are indeed tantalising! Other hostelries and interesting buildings abound in this model township, but a unique specimen is that of a bathing pool, set into a grassy slope. It is rectangular and tiled throughout, so that it holds water, on which, numerous little figures may be seen floating and swimming. Others recline upon sun-bathing lawns while some are perched up on the various lofty diving boards. Changing cubicles surround the bath, and every one of these little fragments is built to withstand the weather all through every season.

EQUIPMENT FOR TESTING THE THRUST OF AIRSCREWS

(*Continued from page* 579)

fairly long flight is desired. Curve "B" is an arrangement of ten strands (as against seven in the case of curve "A"), and is used on a fairly heavy biplane. The initial thrust is usefully higher and gives the machine some five or six seconds to take off, but, of course, the power falls off more rapidly, and the flight is of shorter duration. But in each instance, by the aid of the preliminary "bunch-test," the most suitable type of motor unit has been ascertained.

A Power-Driven Propeller

Turning now to the power-driven propeller, the question of suitable testing equipment resolves itself into the provision of a means of driving the propeller at a number of different speeds, each of which, when set, can be relied upon to remain constant. A variable-speed electric motor is ideal for this.

Owing to its weight, however, and that of the necessary similar counter balance weight at the other end of the carriage, it will probably be found that the "tractive resistance" of the carriage is of some consequence. In the case of the apparatus used, it amounted to about 1½ oz., and thus all thrust readings obtained had to be increased by this amount. In testing, a speed of say so many revolutions per minute is obtained and the thrust measured on the scale. The speed is then increased and a further thrust reading taken, and so on, until the speed range of the driving motor has been covered.

Fig. 5 shows results obtained when testing two propellers of the same diameter and weight, but of different pitch, and the results, when closely examined, clearly show the advantages to be derived from research work of this kind. With the driving motor developing in each case approximately $\frac{1}{16}$ h.p., the 12-inch pitch propeller develops 9 oz. thrust at 1,200 revolutions per minute, compared with the 10-in. pitch propeller which requires to run at 1,400 revolutions to produce the same thrust. Whilst, if the 12-in. pitch propeller is brought up to this latter speed, it develops just on 11 oz. thrust.

Differently Designed Propellers

It is interesting to note these considerable differences, which are entirely due to the variation of the pitch angle of the propeller blades. Broadly speaking, the thrust developed is approximately 20 per cent. greater for the 12-in. pitch propeller as compared with the 10-in. pitch propeller, when tested at any given speed. The knowledge of such differences in characteristics between propellers of different designs is invaluable to the aeromodellist, and the trouble taken in obtaining such knowledge is well repaid in the added confidence one has in setting a machine off on its maiden flight, secure in the knowledge that, in so far as the propeller and motor are concerned, proper attention based on ascertained facts, has been given to their design.

PRACTICAL MECHANICS Replies to Queries and Enquiries

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

HIGH-TEMPERATURE LIQUIDS

"WILL you state the boiling point of brine solution, naphtha, nitrobenzene, aniline, dimethylaniline, glycerine, and mercury?" (G. S., Middlewich.)

IT is quite impossible to give you a really satisfactory reply to your query since you do not state the exact purpose for which you wish to use a high boiling-point liquid. The choice of a suitable liquid will depend upon the design and size of the pipe circuit through which you wish it to flow, the materials of its construction, whether the flow circuit is a closed or open one, and on other similar considerations.

However, the following are high-boiling liquids, the ones starred (*) being relatively expensive, but, none the less, suitable for a very small apparatus:

Liquid	*Boiling Point* (Degrees Centigrade)
Brine solution	Up to 120°
Naphtha	150° approx.
Nitrobenzene	205°
Aniline	184°
*Dimethylaniline	192°
Glycerine	290°
*Mercury	357°

CASTING ALUMINIUM

"(1) HOW can I obtain aluminium for casting purposes?

"(2) If a petrol engine was adapted to use a different fuel, what changes in compression would have to be made in order to obtain the same amount of power as that developed by the use of petrol?

Example

Petrol	**Compression Ratio**		**5·1 : 1**
Methane	**,,**	**,,**	**: 1**
Methyl Alcohol	**,,**	**,,**	**: 1**
Hydrogen	**,,**	**,,**	**: 1**
Ethane	**,,**	**,,**	**: 1**
Ethyl Alcohol	**,,**	**,,**	**: 1**

"(3) What is the best formula for an electrolyte for chromium plating?" (A.S., Essex.)

(1) THE aluminium you require may be obtained from either The Aluminium Corporation, Ltd., Wellington House, Buckingham Gate, London, S.W.1, or The British Aluminium Co., Ltd., Adelaide House, King William Street, London, E.C.4.

(2) It is not possible to let you know in detail the most effective compressions for the internal-combustion engine fuels which you mention because so much depends upon the conditions under which the fuels are ignited. For ordinary engines using petrol spirits, compression ratios vary from 4 : 1 to 6 : 1, engines employing pure methyl or ethyl alcohols would require a compression nearly double the above, together with a longer working stroke. Gases would require a lower compression, since they are usually quicker-burning.

(3) A typical chromium-plating bath contains 250 grammes chromic acid and 2·6 grammes sulphuric acid per 1,000 c.c. of water. The articles to be plated form the cathode of the cell, the anode consisting of a strip of clean lead. A heavy current is required for successful plating.

CINEMATOGRAPH TERMS

"(1) I HAVE noticed that on cine films the speed of some is indicated by '1,500 H. and D.' or '26 Sch.' I am very curious to know what these mean and how they are found.

"(2) Could you please tell me of a suitable weekly or monthly paper for the amateur chemist?

"(3) Is it possible to make luminous paint of different colours (e.g. yellow, blue, green, etc.) from yellow phosphorous?

"(4) Is it possible for me to obtain a cylinder of oxygen and a siphon of SO_2 (sulphur dioxide). How much will they cost?" (M. G. A., Leeds.)

(1) "H AND D." and "Sch." denote, respectively, Hürter and Driffield and Scheiner, the names of individuals who invented methods of testing the sensitivity or speed of photographic emulsions. Thus, the expression, "500 H. and D." used in reference to a photographic film or plate, signifies that the film or plate has a relative speed or sensitivity of 500 when tested in the photographic sensitometer devised by Hürter and Driffield. Similarly, "26 Sch." denotes that a photographic emulsion has a speed number of 26 when tested by means of the Scheiner system.

Owing to their complexity, it would be impossible here to give a description of the Hürter and Driffield and Scheiner systems of speed testing, but you will find references to them in any good textbook of photography. The Scheiner system of speed testing is not used in this country, the "H. and D." system being employed exclusively. The speed numbers of these two systems are, of course, not comparable.

(2) There is no publication catering exclusively for the needs of the amateur chemist. *Practical Mechanics* is the only paper in this country which devotes a considerable amount of its space to articles of a practical chemical nature.

(3) It is not possible to make luminous paint of different colours from yellow phosphorous. Indeed, it is impossible to make satisfactory luminous paint of any description from yellow phosphorous. Yellow phosphorous is an exceedingly dangerous substance with which to experiment. Luminescent zinc, calcium, and barium sulphides may be obtained in a number of colours.

(4) You can obtain glass siphons containing liquefied sulphur dioxide gas at a cost of about 32*s.* 6*d.* each. Any chemical wholesaler or laboratory supplier will be able to procure these.

Oxygen cylinders, even the smallest, are more expensive, but sometimes the cylinders themselves are let out on hire. Enquire at the head branch of Boots the Chemists in Leeds, or, alternatively, at The British Oxygen Company, Ltd., Upper Edmonton, London, N.18.

GASES

"(1) IS it correct that when fluorine or hydrogen fluoride is dry, it does not attack glass? Can you tell me other substances which act in a similar manner. How can I dry fluorine gas or hydrogen fluoride?

"(2) Can you tell me from where I can purchase carbon (or graphite) rods and plates for electric arcs, batteries, electrolysis, etc., or can you give me the address of a manufacturer?

"(3) What is meant by the critical temperature and the critical pressure of a gas?

"(4) How can I prepare potassium oxide or hydroxide from the chloride?

"(5) Can you tell me the names of some solids, liquids, or gases which are spontaneously inflammable in air?" (R. K., Tottenham.)

(1) YES, fluorine and hydrogen fluoride, when *perfectly* dry will not attack glass and metals. Note, however, the stress which we place on the word "perfectly." To dry such gases to this extreme degree, they have to be passed slowly and repeatedly over powerful drying agents, such as phosphorous pentoxide, for periods of six months or more. It is quite hopeless for any chemical amateur to obtain gases in such a state of dryness.

(2) You can obtain carbon rods and plates from either Messrs. Chas. H. Champion & Co., Ltd., National House, Wardour Street, London, W.1, or India-Rubber, Gutta Percha and Telegraph Works Co., Ltd., 106 Cannon Street, London, E.C.4.

(3) For each known gas there is a particular temperature above which no degree of pressure will suffice to liquefy the gas. This temperature is called the *critical temperature* of that gas. The critical temperature of hydrogen is $-241°$ C., that of carbon dioxide, 31° C. Water (steam) has a critical temperature of 358° C.

The *critical pressure* of a gas is the degree of pressure which is required to liquefy a gas at its critical temperature. The critical pressure of oxygen, for instance, is 58 atmospheres of pressure, that of chlorine 84 atmospheres, that of carbon dioxide and hydrogen 72 and 15 atmospheres pressure respectively.

(4) Potassium hydroxide may be prepared by electrolysing a strong solution of potassium chloride.

(5) The best-known spontaneously-inflammable gas is the *phosphide of hydrogen*, P_2H_4, obtained in small quantities (along with large quantities of phosphine, PH_3) when yellow phosphorous is boiled in caustic soda solution. It is also formed when water is dropped on to calcium phosphide. When passed through a tube immersed in ice, the spontaneously inflammable phosphide of hydrogen condenses to a liquid. *Yellow phosphorous*, itself, is often spontaneously inflammable when exposed to warm dry air. A well-known spontaneously inflammable liquid is *zinc ethyl*, obtained by heating zinc powder with ethyl iodide in an atmosphere of carbon dioxide.

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