"FLYING FLEA"—BUILDING THE WINGS

NEWNES

PRACTICAL MECHANICS

NOVEMBER

6D.

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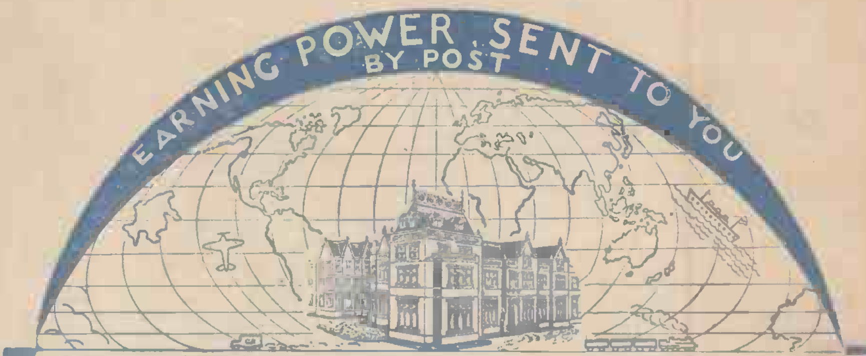

STUDY AT HOME IN YOUR SPARE TIME

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,

J. H. Bennett

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If you do not see your own requirements above, write to us on any subject.

HOW TO STUDY

In your spare time when it suits YOU. You fix your own time, you do not GO to your studies—the postman brings THEM TO YOU. There is nothing that a class-room teacher can show on a blackboard that we cannot show on a white paper. The lesson on a blackboard will be cleaned off, but our lessons are PERMANENT. A class-room teacher cannot give you a private word of encouragement, but a Correspondence Tutor can do so whenever your work deserves it. On the other hand he can, where necessary, point out your mistakes PRIVATELY.

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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Dept. 76, THE BENNETT COLLEGE, SHEFFIELD.

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Edited by F. J. CAMM

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Notes, News, and Views

French Radio Eye for Shipping

THE liner *Normandie* has been equipped with new electric apparatus devised by a young French scientist, M. Ponte. Its purpose is to detect at night all ships or other objects in the vicinity of the great liner, and thus ensure protection against collisions.

The Sun and Wireless Reception

FOR the past eleven years, Dr. Stetson, of America, has been experimenting with an automatic recorder which records the signal strength of broadcasting every night. By means of these records it has been found that sun spots influence the ionisation of the upper atmosphere which varies the reception of distant broadcast stations. The sun follows in an 11-year cycle, and according to Dr. Stetson the best wireless reception was obtained five years ago and it will be poorest in 1939 and 1940.

A New Type of Craft

A NEW type of boat has just been launched at Le Havre. It is called the ocean glider and has received the name of *Genial*. This original craft, furnished with two rafts each of 22 metres in length, provided with a motor of 100 h.p., and weighing 15 tons, will be used as a passenger boat between Le Havre and Trouville. It can carry 75 passengers and has a speed of 22 knots. During the winter, it will be used on the French Riviera.

A "Sunshine" Lamp

AN electric light bulb providing vitamin D, the "sunshine vitamin," has been developed by Dr. Sperti, of America. This new bulb, which is the result of more than ten years of research in selective irradiation, can be used in any electric-light socket, and provides both the ultra-violet rays necessary to build up vitamin D, and sufficient light-rays for reading and working. This development disproves the theory that sunburn is essential for the development of vitamin D in the skin.

A New Balloon Record

A NEW world distance record for balloons is claimed by the Soviet pilots, Romanov and Babykin, who have covered 1,437 miles in their balloon in fifty-six hours.

Modern House Construction

A HOUSE of copper, designed to resist the ravages of time and proofed against weather, fire, lightning, and termites, is the latest in modern house construction. The principle involved in this kind of construction is an all-metal exterior fastened to an all-steel framework. Outside walls are composed of heavy copper plates backed by composition board to give additional stability. The roof is covered with sheet copper over a wooden deck and insulation and sound-proofing are provided by a 4-in. thickness of spun glass between walls and roof, which is said to have the insulation value of 8 ft. of solid masonry.

The Shape of the Earth

DISCOVERIES about the shape of the earth and differences in gravity were recently disclosed by Prof. Meinsey, who made a 23,000-mile voyage in a Dutch submarine during his researches. He refutes the suggestion that the earth is "flattened" at the Equator as well as at the Poles. His experiments in the submarine, he declared, proved that the earth is flattened only at the Poles. The professor also discovered that there is a difference in gravity on the oceans and on the continents.

World's Longest Air-mail System

THE world's longest air-mail system was recently inaugurated when the first consignment left Croydon for China. Henceforth, two mail liners will fly the new route in each direction every week.

Plane Flies Like a Bird

WE learn that M. Dubois has produced a cycle-plane driven entirely by man-power. The wings of the plane are shaped like those of a bird, and flap up and down during flight.

A Substitute for Radium

WE learn that the production of an inexpensive but powerful substitute for radium is now possible on a commercial scale. The suggested substitutes for radium are chemicals made active by bombardment with atoms of heavy hydrogen. Before the atoms are bombarded, they are whirled about in a special mechanism, until they are given the energy of 5,000,000 volts. By this method, and using sodium, enough can be made radio-active to equal the potency of 50 milligrams of radium.

French Streamlined Train

THE first streamlined train in France recently started a regular service on the P.L.M. Railways, between Paris and Evian.

Mysteries of the Cosmic Ray

DR. R. MILLIKAN, world-famous physicist, is now conducting experiments at Fort Sam Houston, San Antonio, Texas, from balloons, in a series of cosmic-ray tests.

A Million-volt Generator

DR. W. BENNETT, of America, has designed a new type of million-volt generator, for use in the study of nuclear disintegration. Because it is much smaller and less costly than the models previously used for the same voltage, the new generator is expected greatly to increase the possibilities for the study of the atom and its nucleus. The generator will be used in operating a high-vacuum tube at extremely high voltages, to produce high-speed particles which disintegrate nuclei of atoms and change the chemical elements.

How to Build the "FLYING FLEA"

This Month we Deal with the Construction of the Wings of the "Flying Flea"

TO cut a metal fitting out of a mild steel sheet of 2 mm. thickness might frighten some amateurs.

Look at the illustration first of all, and cut a pattern in cardboard with the holes cut in it. Place this pattern on the steel sheet and mark it with a thick pencil or chalk. Fix the steel in a vice having jaws at least 4 in. long, and chisel it off with the edge of a cold chisel. Hold your chisel almost horizontally.

If you are obliged to hold the piece which has to be cut, beyond the jaws, give the chisel a slight slant in order not to tear the metal. You will soon acquire the knack of holding the chisel at the correct angle for free cutting.

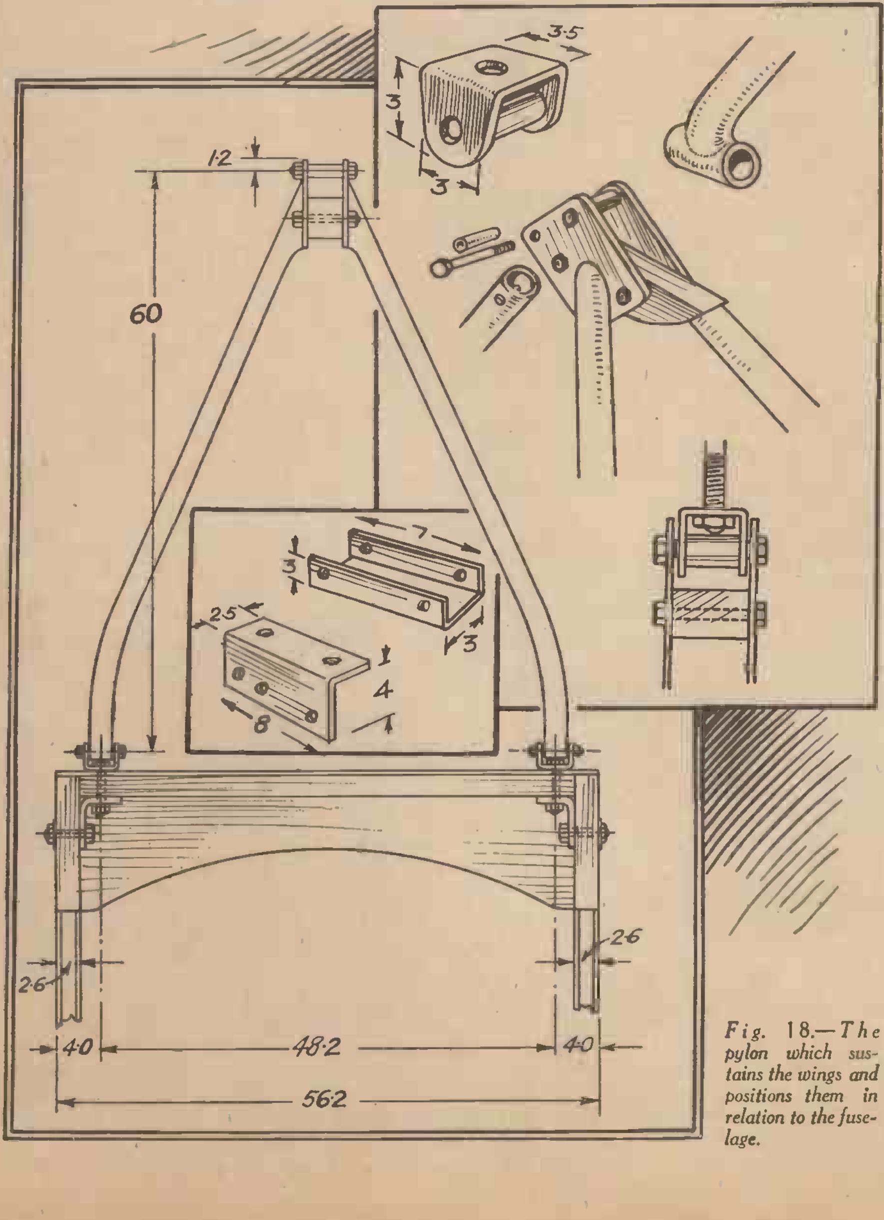


Fig. 18.—The pylon which sustains the wings and positions them in relation to the fuselage.

Bending

One ought never to bend a piece of steel at a right angle, even for the smallest fitting, owing to the hammering necessary which cracks the metal.

Always interpose between the piece you have to bend and the jaws of the vice a piece of steel of the same thickness which has already been correctly bent.

Pierce the holes some distance from the edges. Where the drawings do not show the exact dimensions always leave between the hole and the edge of the material a distance of 8 mm. to 10 mm. all round the hole.

All bolts on an aeroplane ought to be made so that they cannot become loose. When it is a case of a piece which will often have to be taken down, fix the nut with a split pin or a safety pin. In very careful assemblages, use castellated nuts, or lock-nuts.

When one does not foresee the necessity of frequently taking the pieces apart, it is quite easy simply to burr the end of the bolt with several blows of the hammer on the end of the bolt which extend 2 mm. beyond the nut. Before taking it apart, a few strokes with a file will replace the thread and remove the burr.

Every screw, axle, and wire bracing must be securely fastened, because if you neglect to fix, voluntarily, a dozen screws, it may be that none will come loose; but if you forget one only, and one which may be important, you can be quite certain that that one will come away.

As you construct, or file, or screw, always think that one day the piece upon which you are working will hold you suspended in space several thousand metres above the ground.

The Main Landing Gear

The axle is a tube 1·2 metres long in 36 mm. × 40 mm., reinforced internally with another tube 800 mm. long in 31 mm. × 35 mm. This makes a thickness of 4 mm., and weighs 4 kilos. It is very heavy, but it is solid and will not bend. You will not be afraid of damage when you are running over bumps. A single tube would not be sufficiently strong.

The play of 1 mm. between the two tubes allows one to be pushed inside the other. If they were both the same size, you would not be able to get the inner one in place. A filling of hard wood is not suitable, because, although it is lighter, it only stops bending, but will not prevent breaking. Its elasticity allows the metal to fracture, and one day the axle will break under a light shock.

A collar is fixed on to the tube by a 6-mm. bolt. It will prevent the tube from sliding in the rubber shock absorber, in the same way that the block holds the latter under the skid of the body.

Do not drill any hole in the axle at this spot.

A piece of 8-mm. rod goes through the axle at its middle point, and a tube made out of sheet metal of 1 mm. is rolled round. The rubber washers are then inserted between the two metal washers and the whole is held in place by a nut. This prevents the axle from turning, by supporting it on the front planking through the hole.

The axle bears down on the pad of rubber of a thickness of 12 mm. cut from the tread of an old motor-car tyre (Fig. 19). This pad is fixed on the ·6-mm. aluminium washer and held by two screws and a plate.

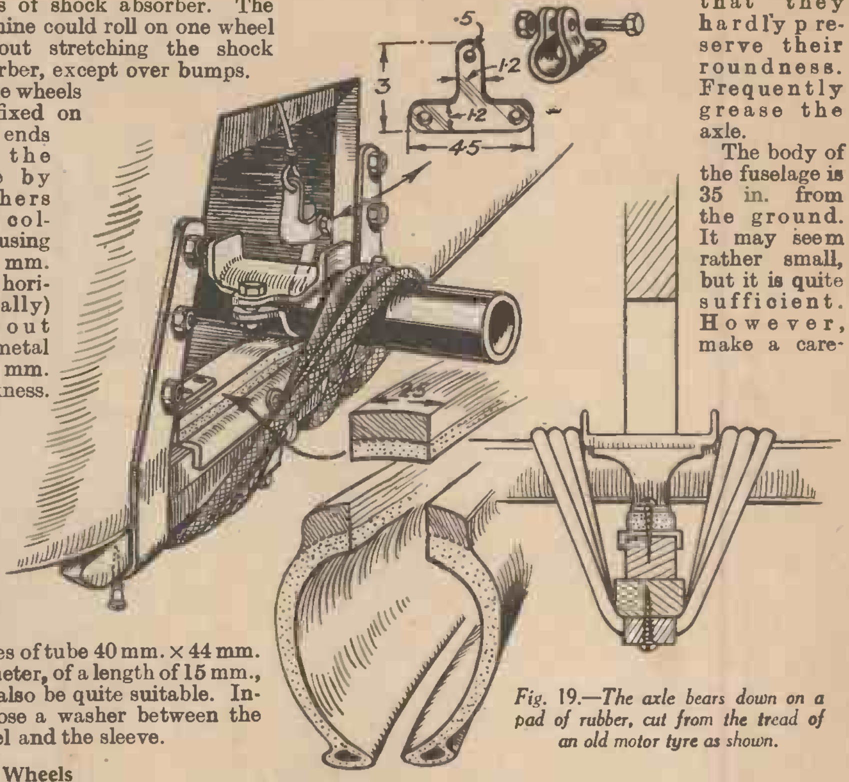
Elastic Suspension

The rubber shock absorber of 12 mm. diameter, which commences to stretch under a pull of 40 lbs., and which has a length of 1 metre 90 mm., is fixed at each end into a metal fastening in metal of 1 mm. with a bolt of 4 mm. One end of the shock absorber is fixed under the axle by a screw in 4 mm. × 20 mm. The shock absorber passes behind the stop, and afterwards six times round the axle, and under the skid, as shown in the drawing. One pulls on it until it is just slightly stretched. The other end receives a wire 2 mm. diameter, which will be securely attached to a screw placed conveniently under the seat planking. The screw prevents the last turn from slipping.

Before cutting the shock absorber, bind it with rubber tape (two turns), and cut in the middle of the binding with a knife.

In its longitudinal view the suspension appears as shown in Fig. 19, which shows the axle, its collar, its pad of rubber, the strip of aluminium, the longeron of the fuselage, the skid which reinforces it, and the lower stop with the three turns of the shock absorber on either side; which make altogether, on each side of the body, twelve turns of shock absorber. The machine could roll on one wheel without stretching the shock absorber, except over bumps.

The wheels are fixed on the ends of the axle by washers and collars (using a 5 mm. bolt horizontally) cut out in metal of 2 mm. thickness.



Pieces of tube 40 mm. × 44 mm. diameter, of a length of 15 mm., will also be quite suitable. Interpose a washer between the wheel and the sleeve.

Fig. 19.—The axle bears down on a pad of rubber, cut from the tread of an old motor tyre as shown.

The Wheels

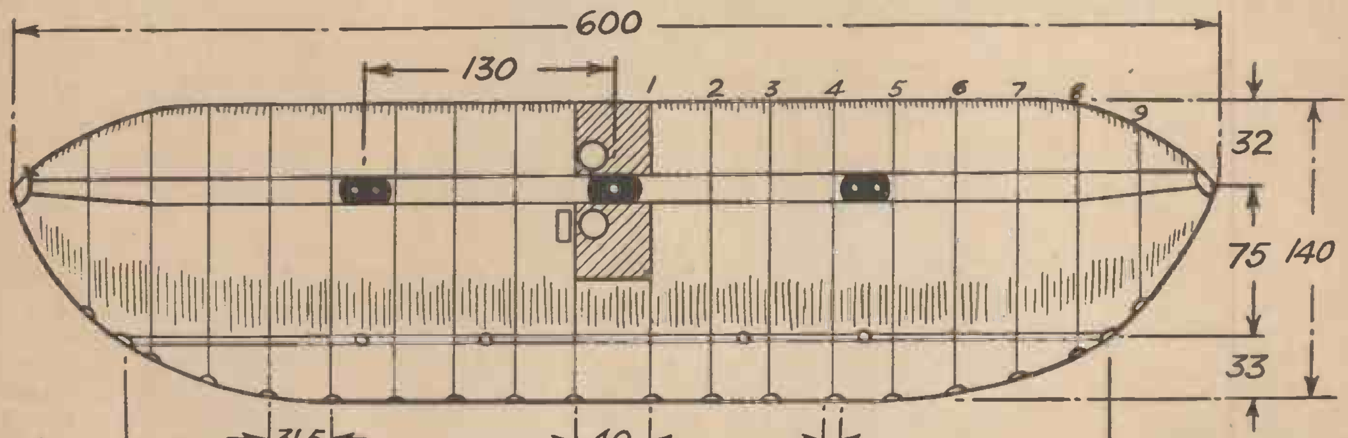
The dimensions of the tyres should be 450 mm. × 100 mm., which, when lightly inflated, absorb most of the roughnesses of the ground. Only the bigger shocks will have to be taken by the shock absorber. One blows up these pneumatic tyres so that they hardly preserve their roundness. Frequently grease the axle.

The body of the fuselage is 35 in. from the ground. It may seem rather small, but it is quite sufficient. However, make a careful inspection of the ground from which you are taking off, and flatten with blows from a spade any bumps which seem a bit too high.

The Control Stick

A tube traverses the fuselage from side to side underneath the rectangular hole.

The centre of the tube is held between two blocks and two cheek pieces by four bolts 5 mm. diameter. Between these strips, and the 6 mm. bolt and the washers of 1 mm., the control stick pivots. On the top of this stick is riveted a steel hook of 2 mm., which will prevent your hand from slipping off, and also will enable



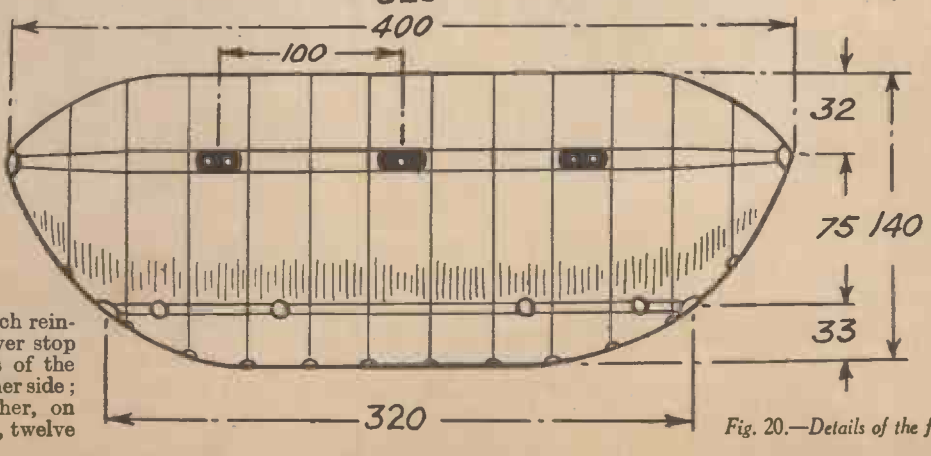
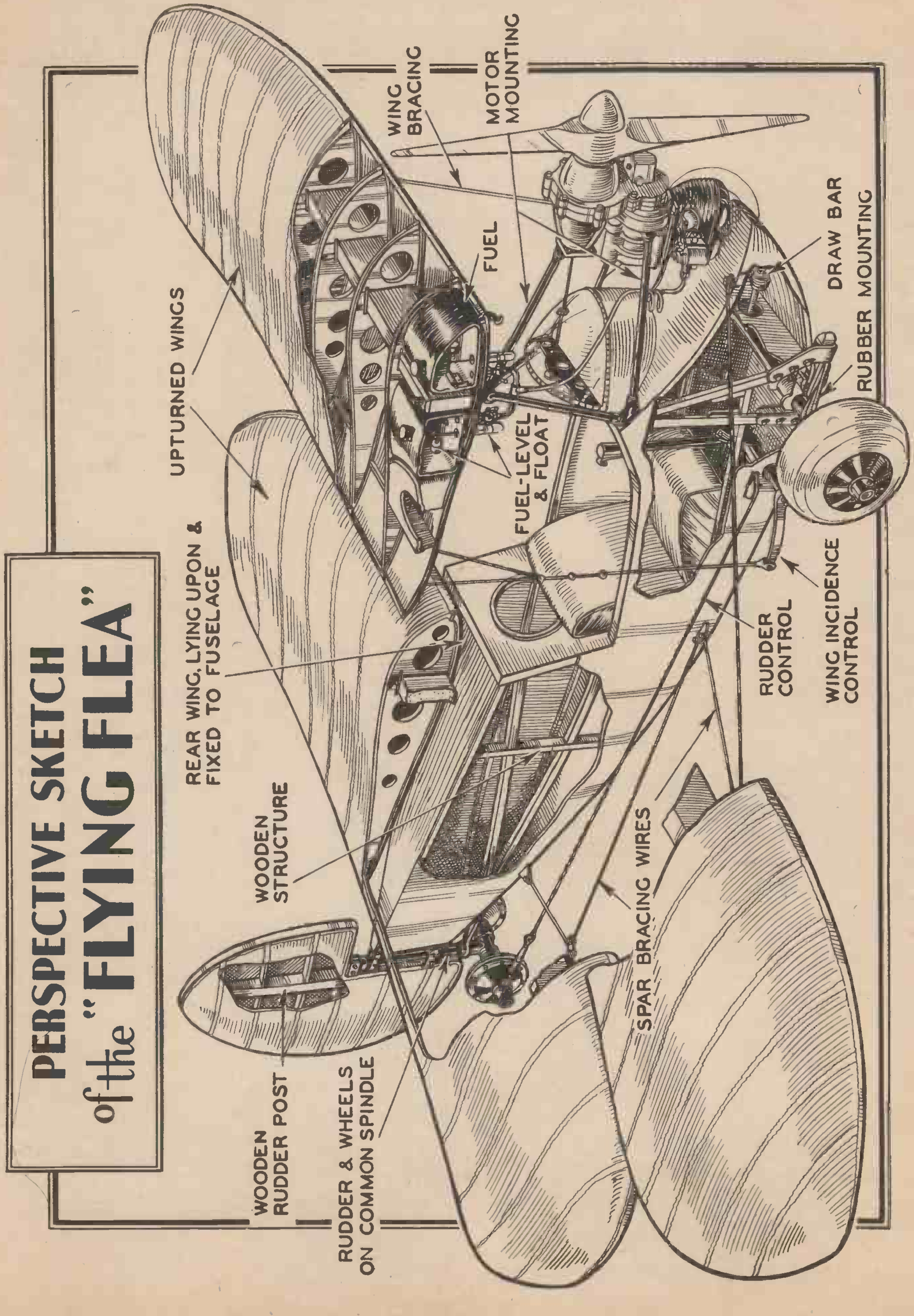


Fig. 20.—Details of the framework of the wings.



PERSPECTIVE SKETCH of the "FLYING FLEA"

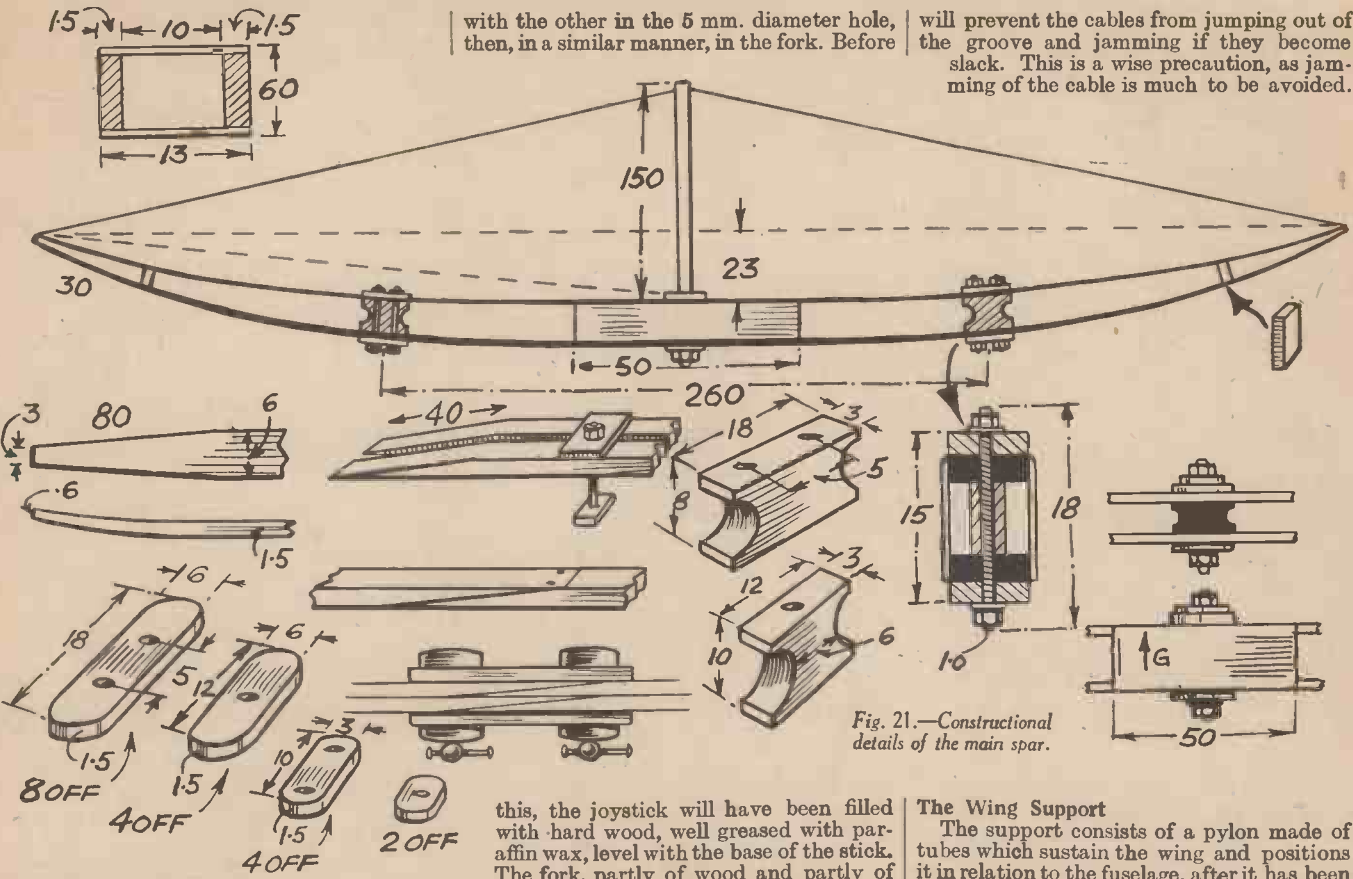


Fig. 21.—Constructional details of the main spar.

you to join the stick to the dashboard by rubber strips cut from an old pneumatic tyre. These strips will relieve the pilot of the continuous pull of the stick in a forward direction.

The tube extends beyond the sides of the fuselage for about 50 mm. Two flared sleeves prevent it from sliding laterally, and, if possible, without any play. Put washers between the fuselage and the sleeves.

These sleeves carry the levers made from 10-mm. bar heated to a red heat, flattened at one end and riveted at the other so that they will not come out of the sleeve. This sleeve is fixed to the tube by a bolt of 6 mm., taking care that the lever, when looking at it from the end of the tube, is at right angles to the joystick.

This latter disposition is for the control of the wing, to which the eyes of the levers, one on each side, will be fixed by a control cable.

Fitting the Rudder and Wing Control

The control of the rudder and wheels can be placed in position. Two cables 5 metres long of 2·4-mm. section steel and extra flexible, will be passed through the 6 mm. diameter hole in the joystick, and prevented from moving at the middle point by the 5 mm. diameter bolt. Each double turn will cross with the other in the 5 mm. diameter hole, then, in a similar manner, in the fork. Before this, the joystick will have been filled with hard wood, well greased with paraffin wax, level with the base of the stick.

The fork, partly of wood and partly of metal, should be filed round. The 4-mm. rivet prevents the cables from escaping from the fork. It is flush with the outside of the joystick. A drop of oil will prevent wear on the cables.

Each double cable, of a length of 2 metres 50 mm., passes over the pulley. (This is a cast pulley and has a very wide groove: the diameter at the bottom of the groove being 40 mm. at least, which revolves on the axis of a diameter appropriate to the hole through the centre of the pulley.) A nut on the interior of the fuselage at one end, a bearing at the other, and a screw 184 × 5 × 25 mm. fix this axis, which will be slightly inclined by means of a block under the bearing in order that it can be aligned with the bottom of the control stick.

Finally, the double leads join up with the turn-buckle where they are attached by the grip, adapted for cable of 4·5 mm. Bind each free end and join the ends to the cable. They will be about 50 mm. to 100 mm. beyond the grip.

The little piece of strip steel of 2 mm., fixed by two screws close up to the pulley, will prevent the cables from jumping out of the groove and jamming if they become slack. This is a wise precaution, as jamming of the cable is much to be avoided.

The Wing Support

The support consists of a pylon made of tubes which sustain the wing and positions it in relation to the fuselage, after it has been fitted with its bracing wires.

It is made of two tubes in 17 mm. × 20 mm., welded to two cheek pieces of 2 mm. separated by a block of hard wood and joined by two bolts of 6 mm. (see Fig. 18). Where welding is not possible it can be bolted together. This is the head of the pylon.

The feet of the pylon, lightly bent (at red heat), are blocked with hard wood, and are pivoted at the U-piece in 2 mm. material, furnished with a 6-mm. bolt. This is joined to another piece of metalwork by two 6-mm. bolts which go right through the crosspiece, to which they give great rigidity. On the other hand, the metal piece is fixed by three 4-mm. bolts to the three laths of the landing gear.

It would be better if the feet of the cabane were finished off by a transverse tube welded on to them.

The head of the pylon is kept in position by a tube about 300 mm. long—the exact length will be decided at the moment when the wing is adjusted—and which is pivoted at either end on the 30-mm. tubes made of a 1·5-mm. strip rolled.

The axis tube of the foot is fixed between two strips of metal, which will be bolted to the motor when that is in place.

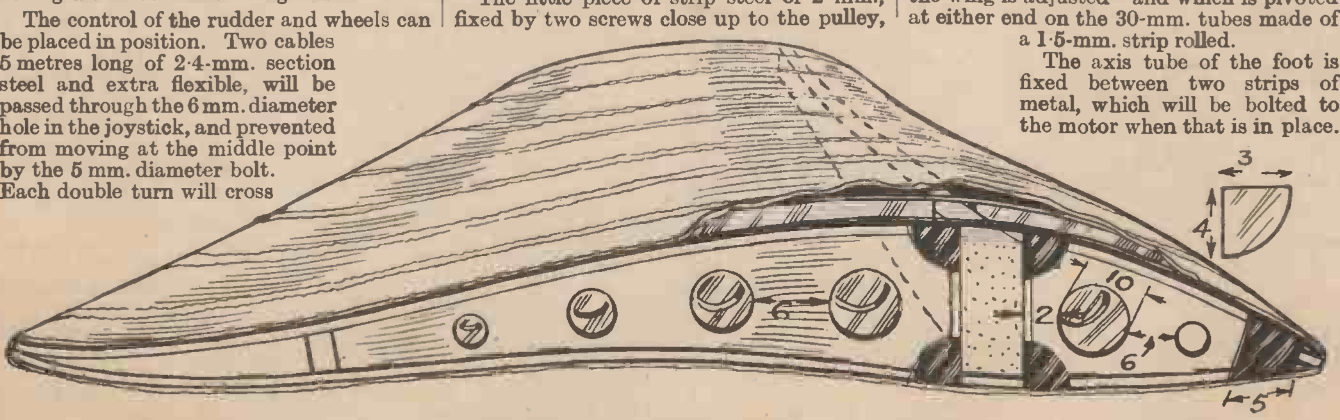


Fig. 22.—A sectional view of the wing, showing the rib construction.

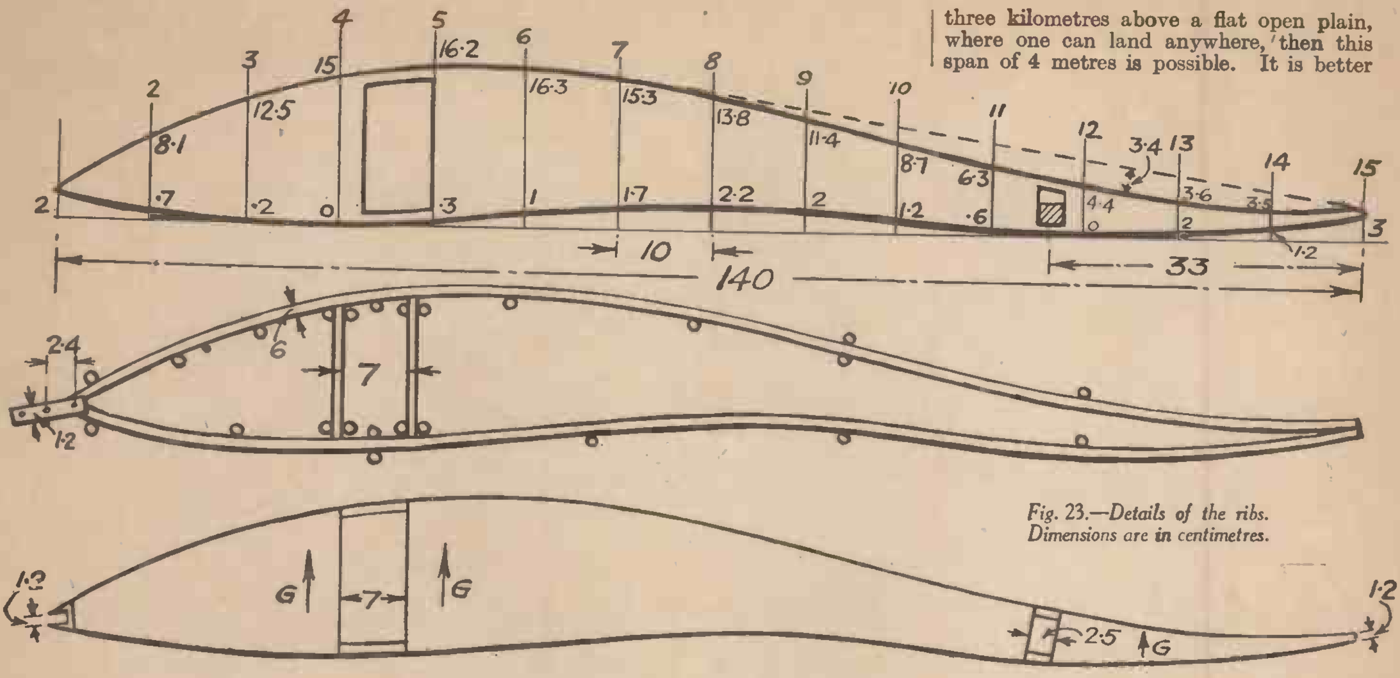


Fig. 23.—Details of the ribs. Dimensions are in centimetres.

The Wing Pivot

The tube of the head of the pylon is the axis on which the wing will pivot. For that, a bolt made of screwed rod of 10-mm. material, 200 mm. long, goes through the wing, and holds to it the metal piece which is bent into a U and welded on to a tube made of rolled strip of 2-mm. thickness. The pivoting is assured by these two tubes revolving one on the other, one being fixed on to the pylon, and the other fixed to the wing. In case it is impossible to weld, one can arrange a metal fitting without a tube, but doubled. The tube will be so arranged that the metal piece moves freely on it, but without lateral play. Perfect adjustment of these two tubes is useless; whether there is 1 mm. or 2 mm. of play is of little importance, provided that they are approximately round. A drop of oil is all that is necessary.

Choice of Span

The wing span should be adapted to the space in which it is to be constructed.

The ideal is a room or apartment of 3 metres × 4 metres. The machine itself is small, but this room should suffice for it. The wing is the largest part and has a span of 4 metres.

The plane was first tried with a 5½ metres span, but it was decided to try 4 metres as a test.

The first profile, with a flat lower side and the tail turned up, showed itself perfectly stable, but it did not lift well. The machine meandered across country, but it wanted the full power of the motor, and it scarcely climbed at all.

Lateral Stability

If one only wants to flutter, so to speak, to learn to fly on little journeys of two or three kilometres above a flat open plain, where one can land anywhere, then this span of 4 metres is possible. It is better than a machine which only rolls on the ground; better than a "penguin" because it really flies "in the air," and the principle incorporated in the "Flea" will permit faults of piloting which, in an ordinary aeroplane, would lead to catastrophe. Its lateral stability is immense.

Commence in that way if your room will not allow you to make a bigger wing. This wing of 4 metres for the standard model will be suitable for the rear wing of another "Flea," or perhaps will be the means of doing a kindness to a pal.

If you are light (10 stone) and are only thinking of short journeys, then a span of 5 metres will suit you very well, but on 6 metres you can weigh 12 stone, and you can carry with you enough petrol for three or four hours' flight.

Whether on 4-, 5-, or 6-metre span, the construction is identical. You only have to elongate, at your discretion, the ends of the wings (which means a few extra normal ribs to nail) and alter the attachment of the bracing wire. The central part remains unchanged.

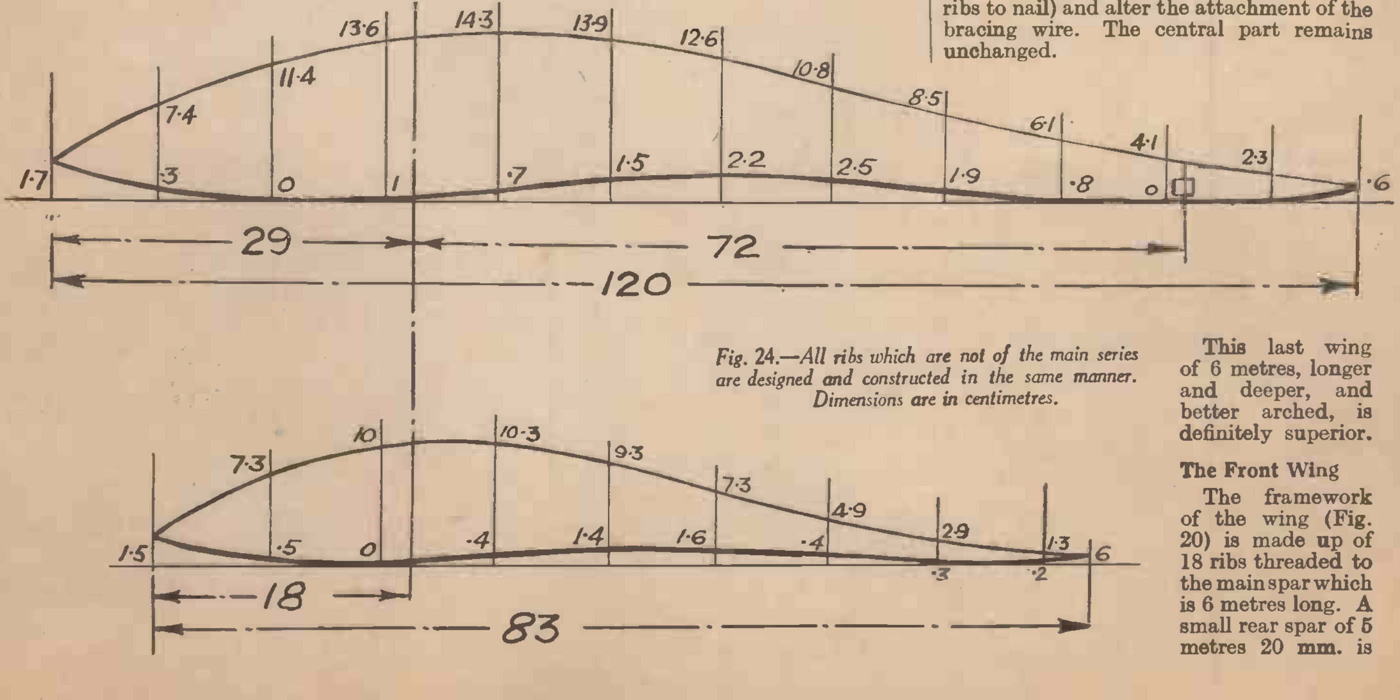


Fig. 24.—All ribs which are not of the main series are designed and constructed in the same manner. Dimensions are in centimetres.

This last wing of 6 metres, longer and deeper, and better arched, is definitely superior.

The Front Wing

The framework of the wing (Fig. 20) is made up of 18 ribs threaded to the main spar which is 6 metres long. A small rear spar of 5 metres 20 mm. is

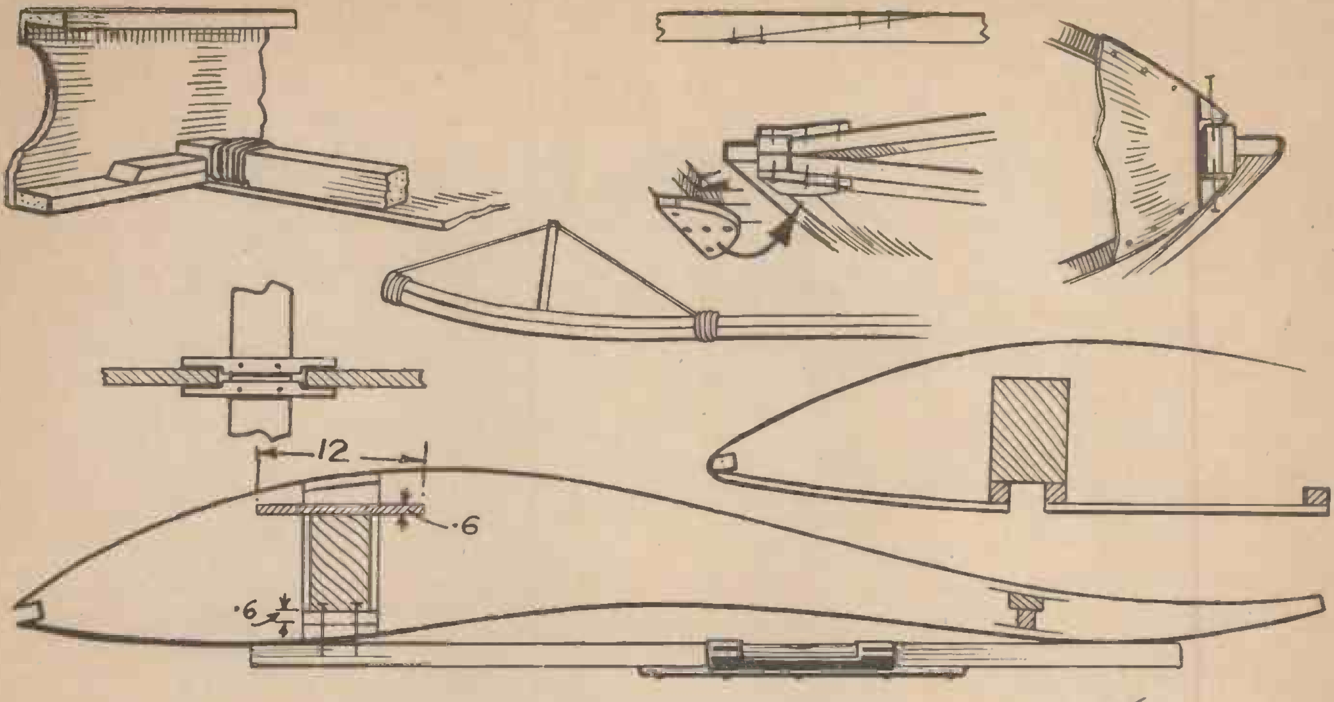
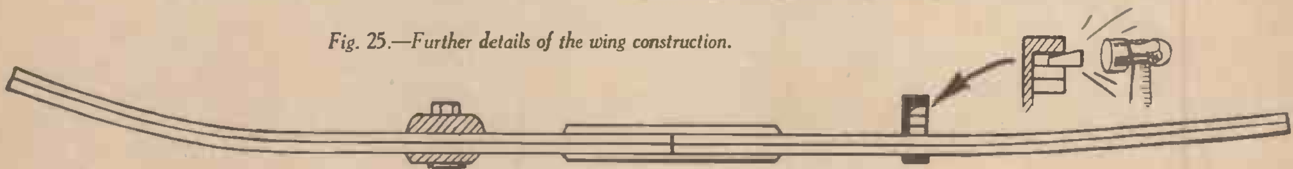


Fig. 25.—Further details of the wing construction.



inserted into the tails of the ribs, which are all of the same pattern.

The two ribs on the extreme ends are of a different pattern, because of the tapering of the wing in plan.

The leading edge and the trailing edge (in treble strips glued together), with the small spar, triangulate the framework, which does not need any other stiffener. And so, in the interior of the wing, except for the nailing of the plywood, there is not a single piece of metal. No fittings, no wires, no turn-buckles. The wing is supported on the pylon by its centre at a place where the block is shown, while the system of bracing cables, joined to the wing, keeps it steady but allows it to pivot about the axis.

The pivoting is controlled by the cable which joins the lever of the control column to the small spar, to which this cable is fixed at the spots marked by the four blocks. A spring, attached as shown, pulls down the wing in front.

The Main Spar

The spar is made of two flanges in 15-mm. × 60-mm. material, planed up to points and curved and maintained in correct form by two webs of 1·5-mm. plywood, of which the grain is vertical to the depth of the spar. The depth of the spar is 130 mm. (see Fig. 21).

It is perhaps difficult to find ordinary pine as long as 6 metres free from knots. This great length, on the other hand, is rather inconvenient for delivery. Let us start, then, with lengths of 3 metres 20 mm., which can be glued solidly together in the middle on the bevel.

Plane up at the same time the ends of the two 15-mm. × 60-mm. planks to a length of 400 mm., and they are then placed side by side and fixed together by a bolt. Take care that the surface is quite flat and regular. After planing it pass a file or rasp over it in order to take off the polish.

Join the bevels together with glue and align carefully the two planks, which will be temporarily fixed by two small nails. Glue all over this and press it carefully between two blocks in two vices or two strong screw presses. Leave it for about 24 hours in which to dry.

Next, prepare for the two wings two blocks which can be of good pine or of beech. All the holes are of 11 mm. diameter. Get ready also five screwed 10-mm. rods 180 mm. long.

Assembling the Spar

After removing the two flanges out of their presses and smoothing their four faces correctly, drill a 11-mm. hole in the middle and two holes 500 mm. apart at 1 metre 300 mm. on both sides of the centre. Stated more exactly, these double holes will be 3 mm. closer to the centre in the upper flange.

Place the two planks on two trestles and glue them together. Make certain that

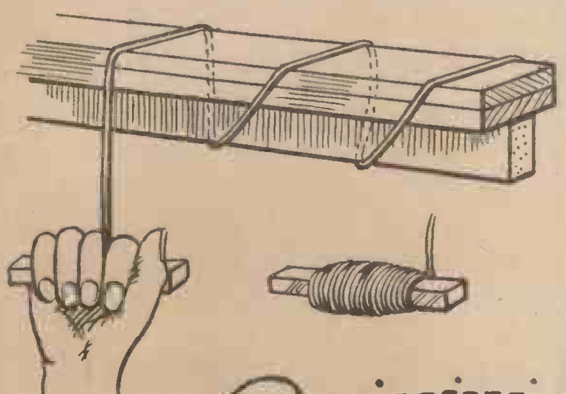


Fig. 26.—The method of covering the ribs.

these two planks are quite parallel end to end.

Now glue on each side two plates of plywood 1·5 mm., 130 mm. broad and 500 mm. in length.

With the aid of a cord or a wire 2 mm. diameter and the king-post made of a tube 1·5 metres long, pull up the points of the flanges in such a way that the thread, stretched between the points, passes at a height of 230 mm. above the central boxed portion.

A temporary block, 40 mm. in height, will separate the flanges at 300 mm. from the ends.

Take care to see that the arch of the flanges, as checked by the thread, is approximately equal to the right and to the left hand. Next, provide both faces of the spar from end to end with strips of 1·5-mm. plywood (nailing it with fine nails 8 mm. long in a zigzag at every 15 mm.). Place the plywood strips side by side without overlap.

Altogether this 6-metre-long spar requires 1 square metre of plywood. It weighs 15 lbs.

Construct in the same way the spar of the rear wing, but on a span of 4 metres, and with a curve of 180 mm. under the thread. This spar weighs 11 lbs.

To facilitate the folding of the wings for transportation along the road, place some blocks at the same distance apart as on the front wing.

Let everything dry for 12 hours before taking out the screw rods and the blocks.

You will be surprised at the stiffness of these beams. They give the impression—and a perfectly correct impression—of really solid bits of stuff, to which one could trust one's life. You can make these two spars in one day.

The Ribs

Cover a board measuring 300 mm. × 1,500 mm. with white paper, and mark out on it the profile of the rib as follows :

Draw a straight line (Fig. 23) at 50 mm. from the lower edge. On this line draw 15 perpendiculars spaced 100 mm. apart, and mark them in accordance with the drawing given. For example, 2—0 marks the point of the leading edge, ·7 and 8·1 are the respective distances to the line of the lower side of the upper side of the wing, and so on right up to the tail of the rib, of which the trailing edge is 3 cm. above the line. This line is the chord of the wing.

Join all the points together, and this will give you the form of the profile of the wing.

Two laths in 6-mm. × 12-mm. material are held between nails 2 mm. long, of which you will have cut off the heads, and which mark out the lines required.

At 320 mm. from the leading edge mark off the line for the axis of the bolts of the spar. Place the 6-mm. × 12-mm. laths on either side of this line, leaving a free space of 70 mm. This is where you will thread the spar on to the ribs.

Join the two flanges by a web of plywood 1·5 mm. thickness. Keep the grain in the position shown by the arrows. Nail it every 25 mm. with nails of 8-mm. length. Dismount it and the rib is now retained in form.

Now nail the leading edge and the four gussets.

In this way construct 22 ribs.

With a cutting compass lighten the ribs. This should prove a simple matter, and should remove about 20 grammes from each web ; it is very little, but it will lighten the set of ribs by half a kilo, and that is certainly proper aviation practice.

The rib weighs 160 grammes. It requires ten minutes to nail it up.

The ribs which are not of the main series —the ribs 8 and 9—each one repeated four times over, will be designed and constructed in the same manner in accordance with the drawing (Fig. 24).

One can prepare the webs and laths in five hours. All 31 ribs can be nailed up in one afternoon, although you should allow several hours for rubbing up with sand-paper.

The batch of 18 ribs weighs 3 kilos.

One square metre of plywood of 1·5 mm. makes webs for eight ribs.

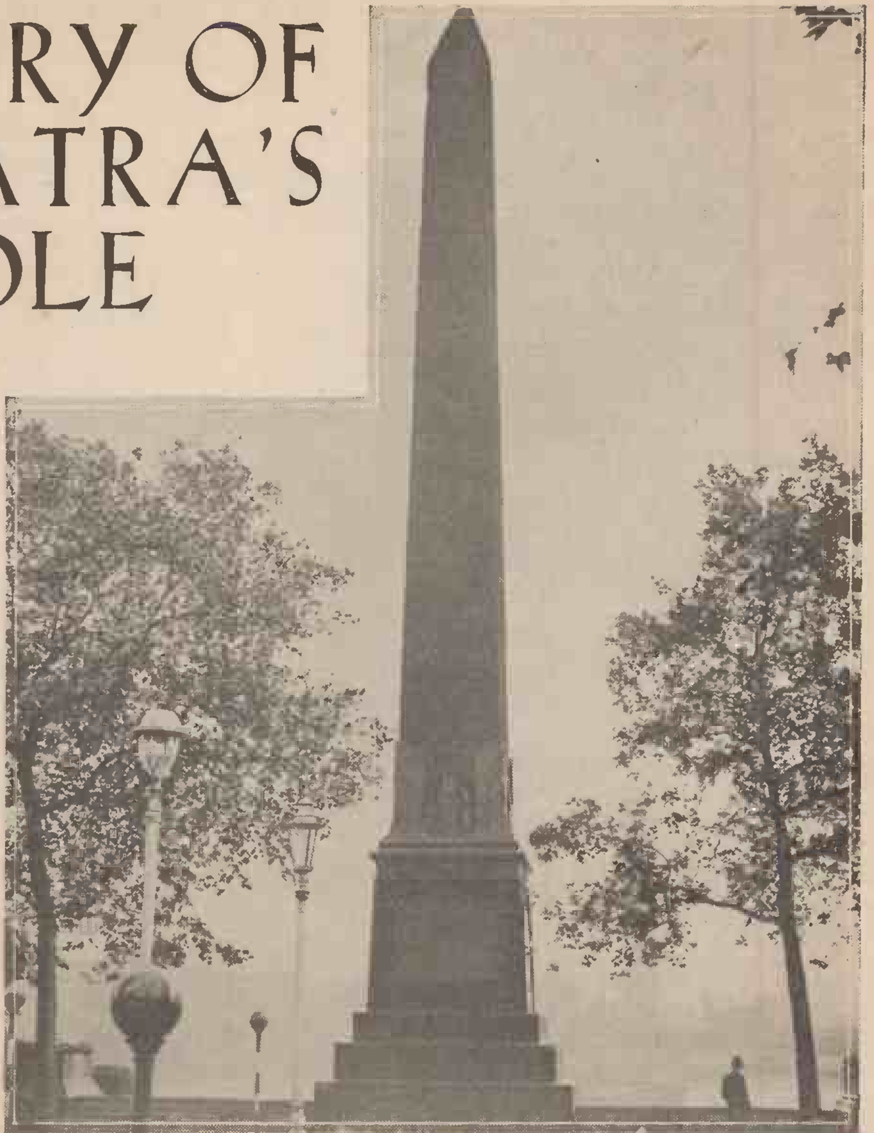
You will find it very easy to nail two nails in three seconds, but if you utilise a box of nails put on a slant. This slope will have the effect of making the nails roll until their heads are all pointing downhill. With a pair of pinchers you can then easily pick up each nail, and bring it under the hammer with the point about 1 mm. from the wood ; at your first blow the nail is stuck into the wood. Take away your pincers, and with one more blow the nail is driven home.

You will get along quite fast, and will avoid damaging your thumb and fingers.

Take the pot of glue well away from the box of nails.

THE STORY OF CLEOPATRA'S NEEDLE

This Interesting Relic is the Largest Hewn Stone in this Country. It Weighs 186 tons and Rises to a Height of 70 ft.



Cleopatra's Needle, which stands on the Embankment in London and round which is woven a fascinating story.

CLEOPATRA'S NEEDLE is the largest and most interesting hewn stone in this country, and its story is a fascinating blend of romantic history and mechanical ingenuity. The mere quarrying of this mighty block of granite was a remarkable mechanical achievement, for it is 70 ft. long and weighs 186 tons, or somewhere about ten times the weight of the largest stone at Stonehenge. It was split off a red granite cliff at Syene (or Assouan) about fifteen centuries before Christ. The workmen cut a long groove in the solid rock, and drilled it with a series of holes. Wooden pegs were hammered into the holes, the groove was then filled with water, causing the pegs to swell, and the tremendous pressure split off the block in a clean line. It was then rolled by means of levers, or perhaps dragged on wooden runners, to a spot near the river Nile, and placed upon an enormous raft made of palm trunks lashed together, and partly supported by inflated bladders or skins. Here it remained till the winter floods reached the raft, and it was then floated seven hundred miles down the river to Heliopolis, and the pillar—with others—was set up in front of the great Temple of the Sun, where it remained for 1,400 years.

Years of Labour

If this venerable relic could only speak, what amazing stories it would tell! It would speak of the toiling slaves who devoted long years to quarrying, shaping and polishing the pillar—the lettering was cut some centuries later. Probably half a man's lifetime was taken in the mere preparation of the pillar, and placing it on the raft. We know that a similar pillar, which is now in front of the Church of St. John Lateran, at Rome, was thirty-six years in preparation; and it is obvious that moving such tremendous masses by slave labour without modern machinery must have been a matter of inches or less in a single day. It is likely that the patriarch Abraham may have stood and watched the slaves working on this mighty task, and Joseph and Moses must often have walked under its shadow when it was finally placed before the temple. We know that both these historic persons were closely connected with the city, for Joseph married the daughter of a priest in this temple, and Moses was educated in all the learning of Egypt in the College there. This old pillar must also have witnessed the panics caused by the Plagues of Egypt, the mourning for the "First-born," and the exodus of the Israelites. Centuries passed and it still stood erect when Anthony wooed Cleopatra, but seven years after her death it was removed to Alexandria and set up before Cæsar's palace, and it is quite possible that Joseph and Mary may have seen it when they passed by with the Holy Child, some twenty-three years later. Fifteen more centuries elapsed, the glory of Egypt had departed, and the proud palace of the Cæsars crumbled to ruin, but this mighty pillar still rose proudly erect, defying the hand of time. Then, about three hundred and fifty years ago, the sea encroached upon the land, and by washing away the sands undermined the needle, which fell but remained intact. It was still lying there in 1798 when Napoleon conquered Egypt. Later Nelson destroyed the French fleet at Aboukir Bay, and in 1801 a fierce battle was fought within sight of the Needle, and Sir Ralph Abercrombie defeated the French and added Egypt to the Empire. The victorious troops conceived the idea of bringing the pillar home as a trophy of victory, and our brave soldiers cheerfully gave a part of their scanty pay for the purpose. The War Office, however, vetoed the idea (being almost as purblind then as later) and all that resulted was that the Obelisk was moved a few yards, and a brass tablet was placed upon it recording the victory.

Offered to England as a Gift

In 1820 Mehmet Ali, the then ruler of Egypt, offered the Needle as a gift to Britain on the accession of King George IV, but it was refused. When King William IV came to the throne in 1831 the offer was repeated, together with a promise of free transport, but was again foolishly declined. In 1867 the Khedive sold the land on which the Needle lay, to a Greek, who was about to break this precious relic up for building stone, and it was only saved by the intervention of General Alexander, who had for some years been pleading with the government for its safe removal to England. Seeing that the matter was now critically urgent, he approached Professor Wilson, who guaranteed the money for its removal here. The work was entrusted to Mr. Dixon, C.E., and a sum of £10,000 was agreed for the cost. Mr. Dixon went to Egypt, and unearthed the monolith, which was now buried in sand. An iron watertight cylinder was constructed, about a hundred feet in length and of much greater diameter than the Needle. The precious obelisk was encased in the cylinder, which was pointed at each end, and quite water-tight.

The *Olga* steam tug was hired to tow it to England, and left Alexandria on September 21st, 1877, with its precious burden. For twenty days all went well, but when crossing the dreaded Bay of Biscay on October 14th, a violent storm blew up, and the cylinder was flung about in every direction, and finally sank at the after end, leaving the fore part almost vertical. At midnight the crew of the *Olga* believed that it was foundering, and thought that it would carry their small craft down with it, so the tow rope was cast off and the tug went on to England with the sorrowful news of the disaster. But Cleopatra's Needle was not so easily lost, and the pontoon floated about for sixty hours till the storm abated, and was then picked up by the steamer *Fitzmaurice* and towed into Vigo Harbour. After a few weeks' delay it was brought to England, and set up on the Thames Embankment.

Partially Destroyed by a Bomb

Even then its adventures were not over. The venerable monolith which had glowed dusky red in the mystic flame of the Pillar of Fire, which to Pythagoras and Solon, as also to Cæsar and Cleopatra, had been an ancestral monument, and which had heard the thunder of Napoleon's guns, was all but destroyed by a Zeppelin bomb during the Great War. The base of the pillar, and that of the flanking lions, is deeply pitted and scarred by an aerial torpedo which wrought frightful destruction, but which happily caused no injury to the ancient inscriptions which cover each of the four faces. For nearly two thousand years these hieroglyphics were an unsolved riddle, but the discovery of the celebrated Rosetta Stone more than a century ago provided a key to the riddle, and they have now been translated. It has been discovered that the inscriptions on the Needle were cut by two different kings, the first by Thothmes III, and the second, two centuries later, by Rameses II. These were the two greatest kings of ancient Egypt, but the translation is devoid of special interest, being mere boastful references to the importance of the kings.

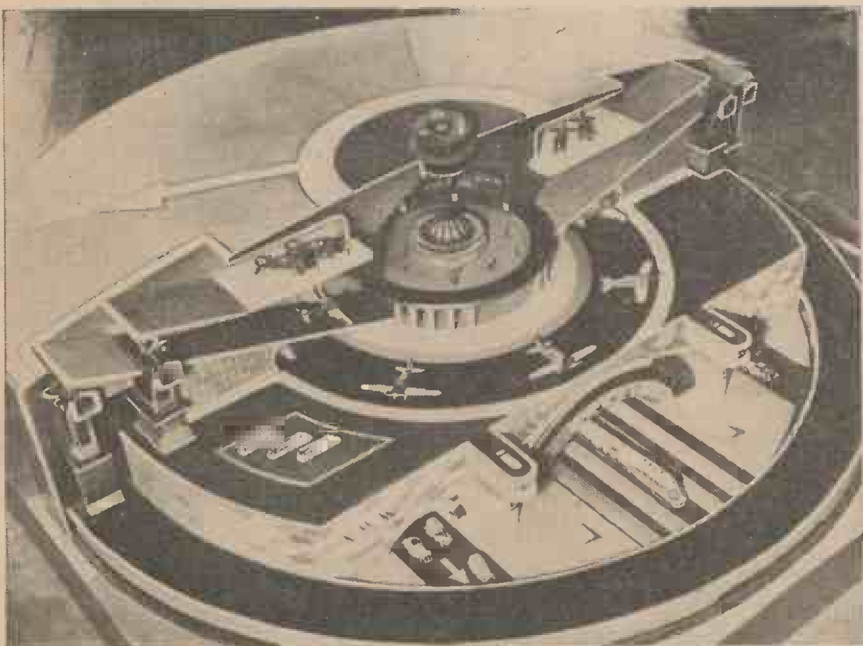
The *letters*, however, are most fascinating, as they represent the world's first form of writing. It is said there were twenty-five letters in the Egyptian alphabet, and also many signs—as in Chinese—which represent complete words. Although the finger of time has somewhat defaced the signs, it is still possible to recognise some of them, and for the benefit of those interested I will mention a few of the letters.

An Eagle is *A*, a leg *Bu*, a Bowl *ka*, a sitting lion *Lu*, an owl *Mu*, a human hand *Ti*, a chicken *ui*, and a zig-zag *na*.

So next time you walk down the Embankment have a good look at Cleopatra's Needle, for no other stone in all Britain has so fascinating a story.

Underground Aerodromes

An Aerodrome of the Future which has many Outstanding Features



UNDERGROUND aerodromes costing from about £1,000 to £6,000,000 are now under serious contemplation in America. Such airports are not only designed to serve the regular commercial airlines, but are proposed as impregnable outposts in the scheme of national defence.

An underground aerodrome to serve the needs of nation and community in war and peace, has been laid out in plans and models by Harvey Wiley Corbett, co-architect in the construction of Radio City, and Francis Keally, well-known for his advanced ideas in modern architecture, in association with aeronautical engineering experts.

The underground aerodrome is designed not only to serve incoming and outgoing airway lines, but it also brings air and ground transports together in a way that greatly expedites the transfer of passengers, mail and express, thereby reducing the expense of such operations. With aeroplanes speeding mail to all points of the compass, the above experts propose to extend the underground pneumatic mail-carrying system which handles 10,000,000 letters and small packages under the streets of New York every 24 hours.

The underground aerodrome dispenses with vans, which are generally held up in city traffic. The underground pneumatic tube carries mail at a speed of 1 mile per minute, between post-offices and airports. In time of war, the experts say, the underground airport would be a formidable unit in the national defence system. It affords the utmost security for an air force, and it provides for the swift reception and dispatch of personnel and equipment. The pneumatic tubes would provide certain transit for documents and military dispatches. The surface of the underground airport is bowed, to facilitate the take-off of departing 'planes and to slow up the incoming ones. Concealed ramps, flush with the airport surface, provide a means of admitting on arrival, 'planes with passengers and mail, to the levels below.

Two interesting photographs of the underground aerodrome showing the internal construction.

The Second Article of a Short Series

Installing DOMESTIC ELECTRIC APPLIANCES

An Instructive Series on Installing Electric Bells, Improving Existing Bell Installations by Fitting Indicators, and Obtaining the Greatest Service from Electrical Apparatus which Constitute One of the Main Items in a Modern Home

WHEN a bell is operated by two pushes, complications arise as to which push has caused the bell to ring, and so an indicator board should be fitted as, with three or more pushes, a board becomes essential. The indicators consist of a small electro-magnet in series with each push, and in front of each magnet a freely-moving pendulum armature is mounted, so that when the circuit is closed, it commences to oscillate and thus indicates from which point the summons came. This arrangement is quite suitable for most ordinary work, but when installing, buy a box with at least two more holes or windows than are at present required; thus if an extra push is added, it is only necessary to add a new indicator to the board, and connect it in series as before (see Fig. 1). The above type of indicator is only suitable when the person called is within hearing distance of the bell, and will arrive at the board in time to see one indicator moving, but in those cases where the person may be some distance away, a mechanical reset movement is needed. This consists of a similar electromagnet which comes into series with the push when it is pressed. The circuit is closed and the indicator drops in front of the window, and is reset by pressing a small lever.

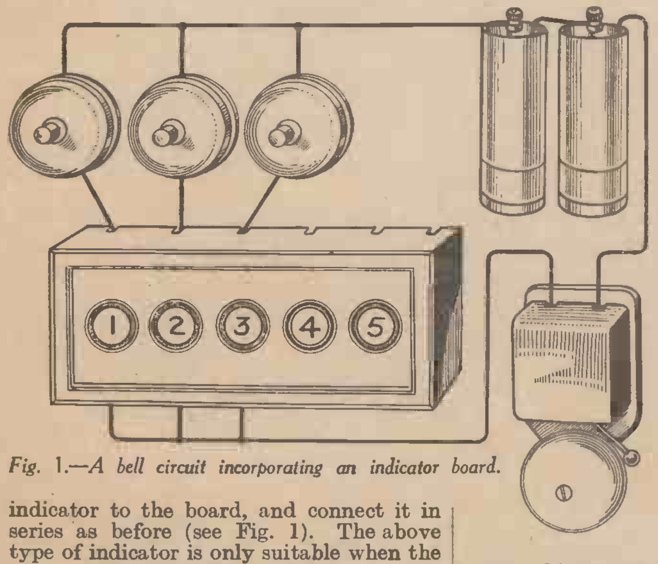
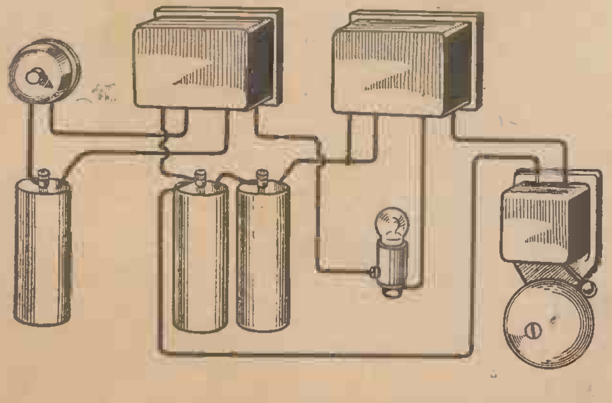


Fig. 1.—A bell circuit incorporating an indicator board.

Electrical Indicators

Electrically-reset indicators can be obtained. It is not worth while making up one's own indicators, but it is cheaper to buy ready-made ones and mount them on home-made boards, than to buy complete indicators. Various indicators and circuits are shown in these pages, and from these any normal connections can be worked out. It is sometimes necessary to have two bells in circuit, one with a high note and the other low, or one bell may be replaced by a buzzer. Such circuits are useful when wired up, as it is possible to locate the person ringing by the tone of the bell. In such cases the indicator boards can be mounted together or on separate floors. With long runs and indicators in circuit, it will be found necessary to have a larger voltage battery, and cells should be added until satisfactory working conditions result. It is in this connection that the transformer proves very useful. In exceptionally long runs, a relay can be incorporated to operate the bell. Run double-wire from the push to the relay and battery (a single cell would be sufficient to operate it) and the local circuit consists of a bell and battery. Relays can also be used in the bell circuits to switch on lights and open and close other switches. Connect them in series with the bell operating relay, and not in the bell circuit, otherwise, if a relay is connected in series with a bell, the intermittent current passing through it will not hold the contacts closed, so that apparatus in the local circuit does not function properly. If a bell is desired to be used in conjunction with a visible signal, this may be connected in series with it. It must, however, be of a small capacity, as a large filament will not heat up, and this saves the cost of an extra relay and battery (see Fig. 2).



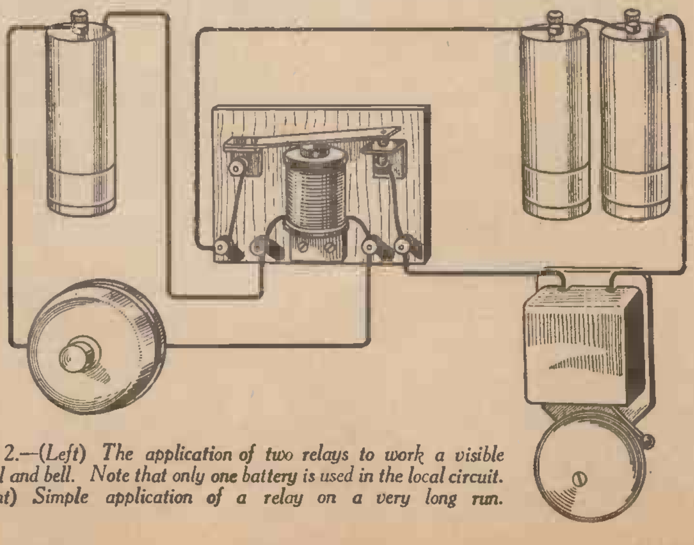


Fig. 2.—(Left) The application of two relays to work a visible signal and bell. Note that only one battery is used in the local circuit. (Right) Simple application of a relay on a very long run.

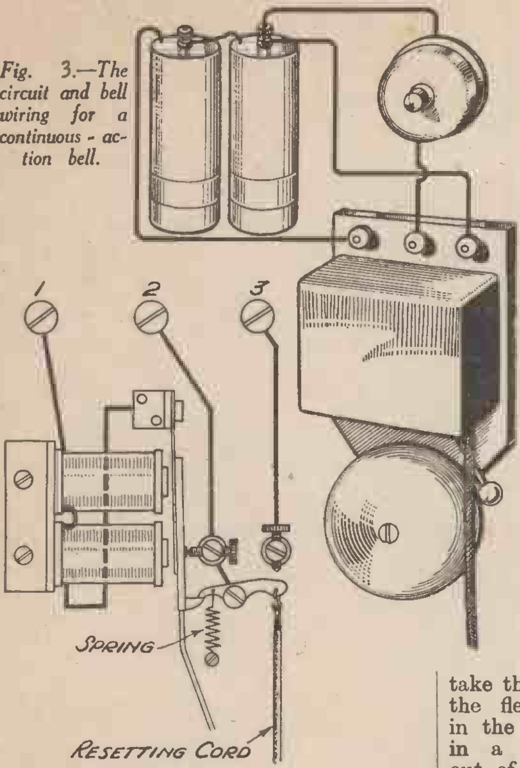


Fig. 3.—The circuit and bell wiring for a continuous - action bell.

Burglar Alarms

For burglar alarms, a continuous-action bell is essential, since a cunning man might open a window slowly, hear the alarm start, and of course immediately close the window before the alarm has had time to awaken anyone. With the knowledge that alarms are fixed, he can beat a safe retreat, or if determined to enter the house, dismantle the alarm. This is possible unless it is so fixed that the circuit is closed even when the glass is removed. With an ordinary bell circuit, it is possible to close the circuit and open it again so quickly that the bell gives only one or two feeble strokes, not sufficient to awaken even a light sleeper. A continuous-action bell prevents this, since once the circuit is closed the bell will ring until reset (Fig. 3).

A letter-box alarm is very simple to construct and install, and is wired in parallel with the front-door bell, so that if an indicator circuit is used, the summons will come from the front door. The components are cut from $\frac{1}{16}$-in. sheet brass, and may be fixed directly on to the door, or mounted on a small panel (see Fig. 5). The contacts are so arranged that they only close the circuit while the letter is actually being pushed in, thus the bell will only ring for a few seconds. This has the advantage that if a newspaper is pushed in and left in, the bell will not ring continuously, which would prove most annoying if the paper was brought some time before the household's awakening. Wires are connected to the moving arm and the side bracket, and this is bent so that when the arm is pushed out through 40° it makes contact, but on pushing it farther the contact is opened, and the bell stops ringing.

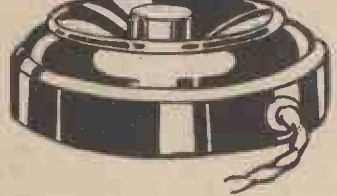


Fig. 4.—A push with side leads for operation on a desk, etc.

Clean Contacts

The improvements that can be made to quite an ordinary circuit without affecting the main wiring are many and varied, and it is to these little extra points that attention is drawn. The user sees nothing of the wiring or battery; it is only the pushes and their arrangement that concern him. For bedrooms, all pushes should be fitted with an extension socket, so that in times of illness it is only necessary to plug in a pear push and length of flex to reach to the patient's pillow (Fig. 6). Where pear pushes are fitted in an invalid's room, these also should be provided with sockets so that extension wires may be fitted. This will be found very useful when a person moves from a bed to a window seat; the extra push is removed at night time so as not to be in the way. In studies and offices, extensions are often needed, but these should take the form of flat-backed pushes with the flex leaving through a bushed hole in the side. They are also very useful in a dining-room and do not look out of place on the table, if they are of the china type (see Fig. 4). Sometimes an extension bell is required, and this should be connected in parallel with the usual bell. In such cases, a small two-pin socket is connected in parallel with the bell, and the extension bell has a two-pin plug attached through a long length of flex. Extension-bell sets are often very useful, and consist of a small bell and a single dry cell mounted in a small and portable case, which is connected through a length of flex to a pear push.

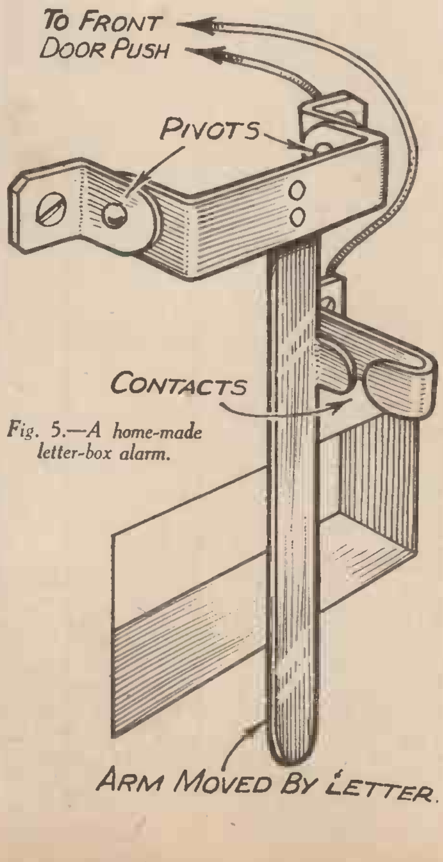


Fig. 5.—A home-made letter-box alarm.

Locating Faults in Wiring

Faults in bell circuits are comparatively easy to locate, due to the shortness and low resistance of the runs. If the bell starts ringing and continues to do so even when the push is disconnected, it indicates that there is a short on the push circuit, most probably caused by a staple. When a bell will not ring, test the battery with a voltmeter, preferably one of low resistance, examine all contacts, and if these seem the least doubtful, clean and smear with vaseline. Repeat the procedure for the push and bell, as it is important to clean all contacts, since it may be the cumulative effect which is causing the trouble.

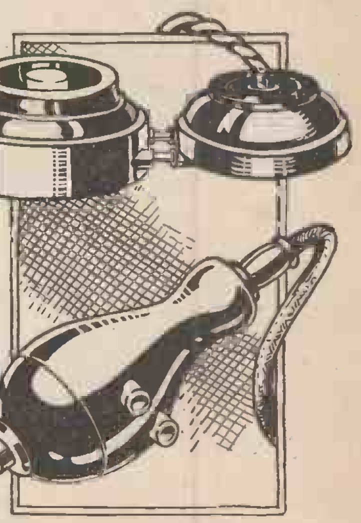
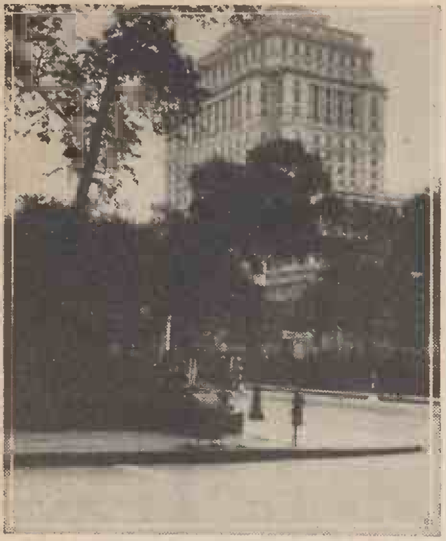


Fig. 6.—(Above) A push with extension socket and plug, and (below) a pear push with a socket for extension leads.

The Lighting Circuit

Before attempting any alterations to a lighting or power circuit, one must be quite familiar with the wiring rules and regulations, and in cases of hire-purchase installations one must make application in writing before any alterations are undertaken. We cannot deal with the wiring rules, as readers are expected to have a working knowledge of them. The two-point circuit is perhaps the most useful that can be applied to domestic work, and every room that has two doors or entrances should have a switch by each door. In theory this seems obvious, but in how many cases is it installed? Bedrooms should also have two-point control, a two-way switch being fitted by the door and a two-way pear push on a length of flex over the bed. In the case of corridors with stairs and several doors opening on to them, three- and four-point control can be fitted, in fact there is no limit to the number of points that can be installed. When modifying a circuit to two-point control, first examine the present one and determine the feeding wires, also obtain the necessary cable of the correct size, and two two-way switches or a two-way pear push. With a pear push it is necessary to have a three-plate ceiling rose, from which the switch is suspended on a length of triple flex.



The Sun Life Office building, Montreal—one of the largest commercial structures in the British Empire—is a typical example of ferro-concrete construction.

Modern Miracles in Ferro-Concrete

Ferro-Concrete Construction Consists of a Concrete Building Having an Interior Skeleton of Steel-work. Such Buildings are Chiefly Built in Earthquake Zones as they are Enormously Strong.

THE coming of ferro-concrete represents a very remarkable development in building and engineering practice during the last few decades. Concrete itself is of course no new discovery. Many of the great buildings of the Roman era were chiefly constructed of this material. The walls were made of concrete, leaving the corners, doorways, and window spaces to the masons, and domes were also made from concrete, which had the great advantage that the thrust ceased immediately the material had set. The great Dome of the Pantheon at Rome is made of concrete, as is also the larger and later Dome of Santa Sophia at Istanbul, which vies with that of our own St. Paul's, although built more than a thousand years earlier.

For the benefit of the uninitiated, it might be mentioned that concrete consists of broken stones or gravel, thoroughly mixed with Portland cement and plenty of cold water. The proportion of cement to stone varies somewhat according to circumstances, and most failures of concrete are due to bad mixing, or skimping the cement. The grain of the concrete is determined by the size of the broken stones used, and when finely sifted small chippings of granite, or even sand, are used, the resulting block takes a very smooth surface, and cannot be easily distinguished from a solid mass of stone.

This property enables the architect to produce ornamental designs, mouldings, etc., very cheaply by setting the concrete in specially prepared frames, and such ornamental work costs no more than plain blocks. A further and very interesting development, which is seen both in Spain and California, is *concrete sculpture.*

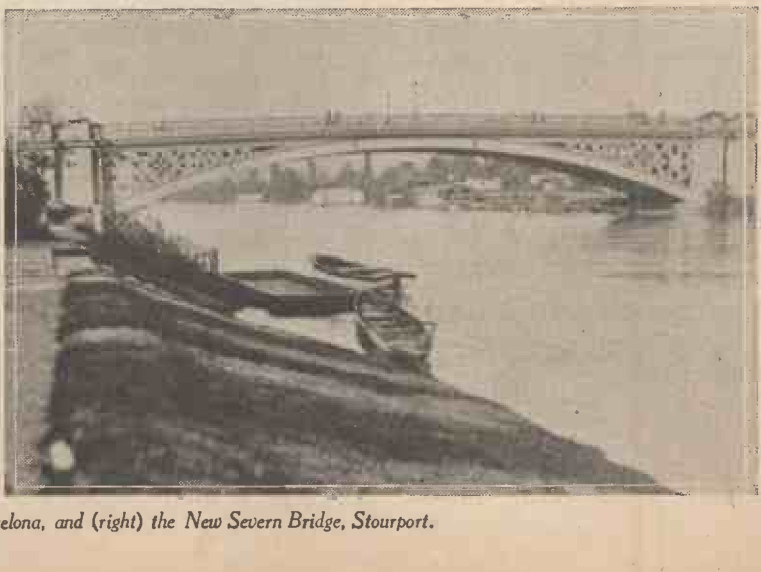
Concrete Sculpture

The artist works upon the mass of concrete while still soft and wet, and so can produce figures, foliage, and other designs at a fraction of the cost and labour involved by chiselling in stone. The enormous new cathedral at Barcelona, and several new churches in Hollywood (California) and Los Angeles, exhibit this remarkable new art, which *at a distance* resembles the most elaborate work of the mediæval sculptors, but when close up is found to be definitely rougher and lacking in intricate detail.

As its name implies, *ferro-concrete* consists of a concrete building having an interior skeleton of steel-work. Such buildings are enormously strong, and have been largely used in earthquake zones.

A complete frame-work of steel girders is constructed and jointed together; then concrete is placed over the steel-work, and forms a solid wall which is both quake-proof and fireproof. Buildings like this will rock violently without suffering any structural damage, and they cannot burn.

Ferro-concrete is used extensively for diving towers. This fine example at Coate Water (Wilts) is 33 ft. above the surface of the water, which is 10 ft. deep. It cost about £700.



(Left) The Rocky House, Barcelona, and (right) the New Severn Bridge, Stourport.

Ferro-concrete plays a large part in the construction of skyscrapers in New York.

There has therefore been a great development of ferro-concrete building in all earthquake areas, and especially along the Californian coast from 'Frisco to Los Angeles; in Japan, Jamaica, Sicily, and many other places. Perhaps the most remarkable of the cities is Los Angeles, with its marvellous Hollywood Terminal Building, the church of St. Vincent, and in the Wilshire Boulevard, and Grauman's Theatre, all of which display daring and elaborate designs in concrete.

The Terminal Building

The Terminal Building is of course a skyscraper of some thirty stories or so, with both a tower and spire rising above the main mass of the building, which is relieved from heaviness by parallel vertical strips or pilasters running right up the walls. This is a fine example of modern commercial Gothic, and the main doorway shows very elaborate concrete sculptures. St. Vincent's Church also boasts very flamboyant decorations, which at a slight distance closely resemble the work of the mediæval sculptors.

We have shown that ferro-concrete construction gives a high degree of safety from fire and 'quake perils, but it has further advantages, viz.:

Economy of cost, since a large amount of unskilled labour can be used, and the concrete can be cheaply and thoroughly mixed by machinery.

Reduction of the period of construction, because this method is speedy and eliminates the slow hand labour of bricklayers and masons.

Large window space, because the strength of the structure is in the steel frame, and so large areas of window glass can safely be used.

Larger rooms and less restricted floor space, because the steel lining of floors permits vastly greater spans without interior walls or pillar supports.

Decoration is cheaper, because wet-concrete sculpture can be used, or pre-cast mouldings formed at a very low cost.

Ferro-concrete bridges have some further advantages over both steel and stonework structures. They are not liable to the corrosion which involves such heavy expense in painting metal; and they have greater rigidity than steel, and can be built in much longer spans than any stone or brick-arched bridge.

Modern Buildings

These advantages are so important, that nearly all large modern buildings are built mainly of steel and concrete, and even when the outer walls are of masonry or brickwork, the strength and solidity of the structure depend on ferro-concrete. It is interesting to examine one of these buildings in course of construction, because the building methods are quite different from those employed on old-fashioned structures.

In commercial structures or residential blocks the steel frame is always erected first, the walls being put in long after.

The new cathedral at Barcelona well illustrates the altered technique and many advantages of ferro-concrete building. This, by the way, is said to be the greatest church of its kind in the world, and so ambitious a plan would certainly not have been attempted but for the manifold advantages of ferro-concrete. The building was commenced during the period of prosperity (for Spain) caused by the Great War. Barcelona is the greatest city in Spain, and its citizens were anxious to excel all other cities in the Peninsula. Their own ancient cathedral, built in the eleventh century, is small and hemmed in by buildings, and the faithful longed to construct a vast building which would tower above the houses and excel even the glories of such historic cathedrals as Seville and Burgos. But these splendid fanes were built during an age of intense faith and abundant resources, and only modern technique made it possible to attempt to surpass them. The dominating idea of the cathedral is height, its slender pinnacles (each almost as high as our own Salisbury Spire) and central and western towers soar above the close-packed houses of the city. On the hill of Tibidabo, just outside the city, there is another concrete church (the Sacred Heart) also of almost modern construction—started about 1914, and finished in about a couple of years. Here the architect has imitated the outline of a mediæval fortress. The famous "Rocky House" in the city is a large modern block of flats, built in ferro-concrete and having a most striking effect.

The great new Cathedral at Barcelona—snapped ten years ago when half-finished—showing vertical method of construction.

Buildings of Great Size

The British Empire has many ferro-concrete buildings of great size. The graceful Sun Life Building, which dominates the City of Montreal, is claimed to be one of the largest commercial structures in the Empire, and the gigantic Royal York Hotel in the rival city of Toronto is said to be the Empire's greatest hotel building.

The style has developed still further in the U.S.A. New York's amazing skyline consists of an incredible number of gigantic buildings, all of which are wholly, or mainly, of ferro-concrete. They rise before the observer in every shape—spires, pyramids, or rectangular blocks. They are so lofty that some of them are *literally cloud-capped*—like mountains—when the lower air is cloudless. The spectacle is repeated to a lesser degree in all the great American cities, and notably Chicago, 'Frisco, and Los Angeles, but the whole subject of the skyscraper is too big for this article, and demands a story to itself.

Buildings in Northern Europe

Ferro-concrete building has developed greatly in Northern Europe, and especially in Germany, where modern architects have evolved some daring new styles to suit their new medium of expression.

The Centennial Hall at Breslau is a gigantic circular building, with a lofty domed centre. The interior shows vast concrete ribs supporting the roof in a very bold and daring fashion. Very original, too, is the "mushroom" restaurant built on the tower of the old fort at Cologne, and projecting beyond it like the cap of a mushroom. The Exhibition at Leipzig has many fine ferro-concrete buildings; one of the finest is the gigantic Hall of the Tool Manufacturers, with a vast "classical" façade with concrete pillars.

The Einstein Tower

But one of the most original designs known in modern concrete construction is the work of Herr Erich Mendelsohn, who designed the amazing Einstein Tower at Potsdam. In shape it resembles an enormous jack-boot, and the architect has obtained a monolithic effect, *i.e.*, the building appears as if carved from one huge block of stone. Concrete lends itself to this, because it can be constructed almost without joins, and the few that exist can be "rendered" over with fine cement and so disappear. It is presumed that the strange

(*Continued on page* 80)

The Royal York Hotel, Toronto, is said to be the largest hotel in the Empire.

Masters of Mechanics

Thomas Newcomen, who was the First to Construct an Engine, the Motive Power for which was Derived from Steam

INVENTORS, during the early days of mechanics, were invariably looked upon as plausible schemers, if not as actual scoundrels. Their inventions, it was considered, were put forward purely and simply as money-making schemes, devoid usually of all practicability, and, quite often, of all possibility. Inventors, indeed, during that transitional period of the seventeenth and eighteenth centuries which saw the rise of modern mechanics, were the most distrusted of men.

It is probably owing to these facts that we know even less about the life history of one of the most original minds in the history of the steam engine than we do about that of Shakespeare. The title, "Father of the Steam Engine," has often been applied to James Watt. More properly, however, it should be given to a much earlier inventor, one Thomas Newcomen. [*Watt was merely a scoundrel with little, if any, knowledge of mechanics, and who filched the ideas of others.—Ed.*]

The Newcomen Engine

All that we know about Thomas Newcomen is that he came of an old Devonshire family and that he lived in Dartmouth. Whether he died rich or poor is not known. Being of a retiring disposition (so it is said), he did not concern himself with the current affairs of his day. It is thought, therefore, that after he had perfected his engine and had supervised its erection in various parts of the country he retired to Dartmouth, in which town he died towards the middle of the eighteenth century. No monument marks his burial place, however, nor is any record of his death to be found.

Newcomen probably combined the trades of blacksmith and ironmonger in Dartmouth. How he first became acquainted with the problem of obtaining motive power by means of steam is not, and perhaps never will be, known. It is thought, however, that Newcomen was fully conversant with the work of Dr. Denis Papin on the steam engine (outlined in the last article of this series), because, in his "atmospheric" engine, Newcomen utilised Papin's basic idea of causing the pressure of the atmosphere to drive a piston downwards into a cylinder after a partial vacuum had been created underneath it by the condensation of steam. Thomas Savery, too, lived at Modbury, some fifteen miles away from Dartmouth, and since Savery's engine obtained considerable renown at the time, it is quite impossible to think that Newcomen was not fully acquainted with its operating principles. It has been asserted that Savery, on hearing of Newcomen's engine, threatened the latter inventor with proceedings on account of a supposed infringement of his patent and that Newcomen, rather weakly, agreed to grant Savery an interest in his "atmospheric" engine for a term of years. Whether this story is true or otherwise, there is no doubt of the fact that Newcomen's "atmospheric" engine did not infringe Savery's patents, for the Newcomen engine operated upon an entirely different principle.

"Atmospheric" Engines

Newcomen invented and built a number of his "atmospheric" engines, each model being a substantial improvement upon its predecessor. His first engine was made about the year 1705, and a Dartmouth glazier, John Cawley (or Calley), assisted in its construction and had a part interest therein. The engine was not immediately successful. Gradually, however, Newcomen introduced improvements, with the result that before many years elapsed there were few large mines of any importance which did not employ a Newcomen engine for pumping purposes.

The principle of Newcomen's engine will be apparent from a short study of the diagram given on the next page. A rocking or oscillating beam, pivoted at its centre, was attached by means of a chain to a pump at one end and to a piston at the opposite end. The piston, which was about a foot or even more in diameter, was leather bound and it was free to move up and down within a large cylinder composed of cast brass (cylinder boring was unknown in those days). The cylinder was usually placed directly above a hemispherical boiler, from which steam was admitted to it directly by turning on a cock. The simple form of safety-valve devised by Dr. Denis Papin was fitted to the steam boiler.

Probably the last-remaining Newcomen engine in this country. For many years it stood in a field near Ashton-under-Lyne, Lancs, before being purchased as a relic by Mr. Henry Ford and being shipped to America.

Cooling Systems

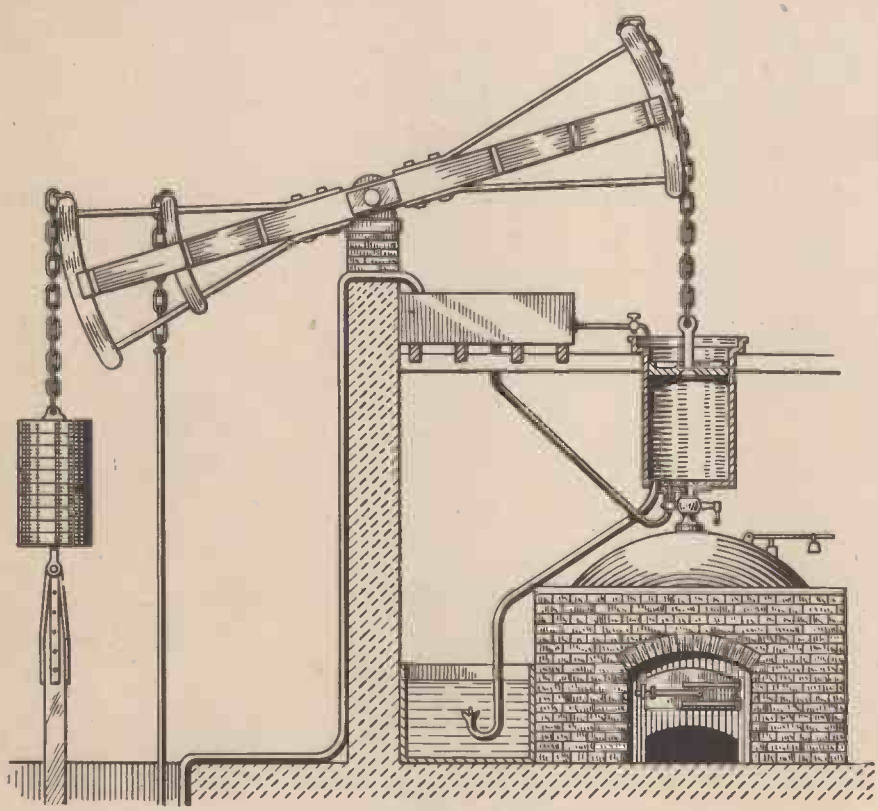
When the piston reached the top of its stroke, steam was admitted into the cylinder. In Newcomen's earliest engines, the cylinder was then immediately cooled by having a stream of cold water directed against its exterior walls. Afterwards, Newcomen surrounded his cylinder with cold water, but, finally, he caused a jet of water to be injected into the cylinder by the turning on of a tap. These methods of cooling the cylinder caused the steam to condense. A partial vacuum was created below the piston, whereupon the latter was immediately driven downwards by the external pressure of the atmosphere. In Newcomen's early engines, the operation of the piston was exceedingly slow. His improved engines, however, gave an operating efficiency of 16 or 20 piston strokes per minute, a speed which, in those days, was considered eminently satisfactory.

Piston rings were quite unthought of in Newcomen's day, and in order to prevent the escape of steam past the piston, the latter was bound at its edges with leather or even cloth. Still further, a layer of water, derived from a supply tank, was kept continually on the upper surface of the piston in order to provide an effective seal.

The World's First Successful Steam Prime-mover

It will be seen, of course, that in Newcomen's "atmospheric" engine the work is not actually performed by steam power, but rather that the steam is merely utilised to produce a vacuum at definite intervals on the underside of the piston. The actual power of the engine is derived from the downward pressure of the atmosphere in forcing the piston downwards in the cylinder. At the same time, it was entirely through the vacuum-producing powers of steam that the Newcomen engine derived its motive power. Hence the Newcomen "atmospheric" engine was the world's first successful steam prime-mover.

For the successful working of the Newcomen engine, an attendant had to be employed continually in order to open and close the water-injecting and the steam cocks. This task was usually assigned to boys, the work being easy although monotonous in the extreme. About the year 1713 a lad named Humphrey Potter—"the lazy genius" he has subsequently been called—devised a very simple method whereby the continual opening and closing of the steam and water cocks by hand could be done away with. The lad, Potter, merely tied lengths of string to the cocks and attached the other ends of the strings to the rocking beam of the engine. By this means, the engine was made to operate its own valves. Humphrey Potter's plan worked well, although it is said that Newcomen himself instantly dismissed the youthful genius for his inattention to the engine, dubbing him a "lazy little beggar." Suffice it to say, however, that in 1720 Potter went over to the Continent. He seems to have been last heard of in Hungary, in which country he erected a large Newcomen engine to pump water out of a mine. Potter's original idea of causing the valves of the Newcomen engine to be worked automatically was afterwards greatly improved upon and it became a standard fitting on all later engines of the Newcomen type.


The working principle of the Newcomen engine.

Newcomen's first commercially working engine was erected at a colliery near Wolverhampton. It was reasonably successful. Soon afterwards, another engine of a similar type was built for a colliery at Newcastle-on-Tyne. A third Newcomen engine was erected at Leeds, whilst a fourth was erected in 1714 at Austhorpe, in Yorkshire. The Austhorpe engine possessed a piston of no less than 23 in. diameter. Its rate of working was 15 piston strokes per minute and it drew water from a mine shaft 111 ft. deep. Newcomen and Cawley obtained the sum of £250 per annum for its erection and its maintenance in working order. Cawley, the Dartmouth glazier and partner of Newcomen, erected the engine, but he died three years afterwards —in 1717—whilst engaged in superintending the engine's working.

Cornish Tin Mines

Newcomen, now alone, next proceeded to erect his improved engines at the Cornish tin mines, where a great demand for pumping engines had arisen. The first Newcomen engine erected in Cornwall was built at "Wheal Fortune" tin mine, near Penzance. This engine had a piston diameter of 47 in. It pumped water from a depth of 30 fathoms. Afterwards, Newcomen erected another of his engines at "Wheal Rose" tin mine, near Redruth, in Cornwall. H re the engineer employed was Joseph Hornblower, a Staffordshire man and a member of a family which subsequently became justly celebra ed in the perfection of the steam engine.

Newcomen's engines were extremely wasteful of fuel. They were slow in operation and, often enough, unreliable in the extreme. Despite all this, however, Newcomen's original engines continued to function for many a year after they had first been erected. As late as the year 1852, a Newcomen engine could be seen in active operation at a colliery near Glasgow, whilst only two years ago the remains of a Newcomen engine, which for decades had stood in a field near Ashton-under-Lyne, Lancs, were purchased by Mr. Henry Ford, the famous motor-car manufacturer, and removed bodily across the Atlantic for renovation and reassembly in the Ford Museum at Detroit. To this day may be seen at Elsecar, in Yorkshire, a colliery pumping engine which was originally a Newcomen "atmospheric" engine, but which has, at some period in its history, been converted to steam working.

MODERN MIRACLES IN FERRO-CONCRETE

(Continued from page 78)

outline of the tower has some reference to the theory of Relativity.

In our own country we have numerous factories, bridges, and other structures in ferro-concrete. Among public buildings so built is the huge Ministry of Pensions building at Acton, the England Pavilion, and the Stadium at Wembley. Nearly all modern factories are built this way. There are some private houses; several streets of these can be seen at Welwyn Garden City. Most of our new arterial roads are also of ferro-concrete, and many fine new bridges, among which the splendid single-arch example over the Severn at Stourport deserves special mention.

It will be interesting to observe how the idea progresses, and what new designs can be produced by means of this highly practical material.

Films in Relief

A DEMONSTRATION was recently given in the Grand Hall of the Brussels International Exhibition of a new type of cinematograph, invented by an Italian, M. Gedini Giovanni. The invention is a new stereoscopic apparatus. The audience watches the screen through specially tinted glasses which makes the scenes appear quite realistic.

Inventors of the Aeroplane

The Names of Cayley, Henson, and Stringfellow Will no Doubt be Unfamiliar to Most Readers, but Indirectly These Three Men were Responsible for Considerable Pioneer Work in the Development of the Aeroplane

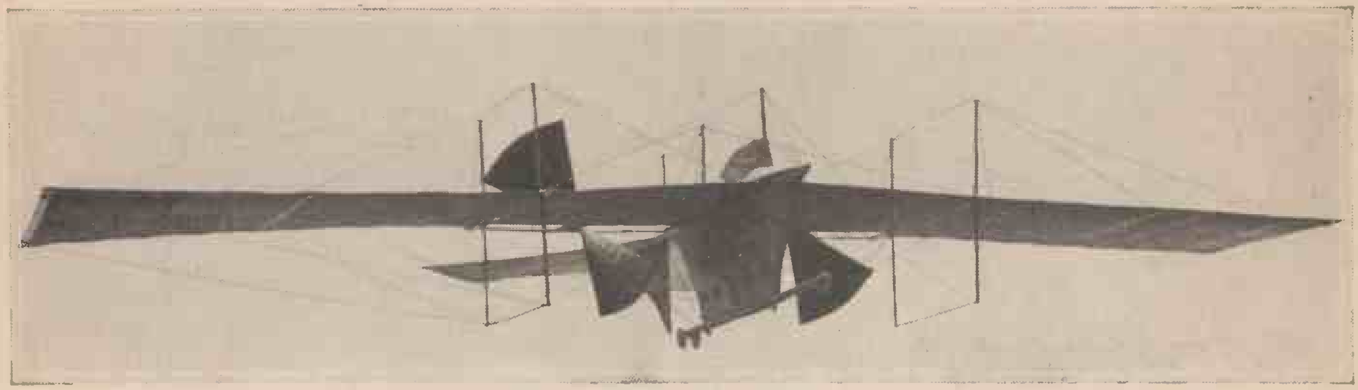


Fig. 1.—A view of the Henson-Stringfellow model of 1844–7. The wing span is 20 ft.

By G. R. Garratt, M.A.

WHO invented the aeroplane? In spite of the almost universal appeal of aeronautics to-day, I suppose that not one person in a thousand could give a satisfactory answer to the question. Perhaps the names of Wilbur and Orville Wright are the most familiar amongst the pioneers, but one must in fairness admit that the aeroplane of to-day was invented more than sixty years before the Wright Brothers achieved the first successful man-carried flight. This memorable event occurred in 1903, and in the race for development during the last thirty years the names of the real pioneers have been almost forgotten. In fact, it is only in recent times that the work of Cayley, Henson, and Stringfellow has become appreciated at its proper value. The modern aeroplane was not created, constructed, and flown by any one man; it was gradually evolved over a period of about one hundred years by a few scientists and engineers, each of whom contributed to the final achievement, and amongst the very few who made substantial contributions, these three must take the premier place. Indeed, if it had not been for the work of these men, the aeroplane of to-day might not exist.

Sir George Cayley

Sir George Cayley was born in 1774. As a scientist he soon acquired an international reputation, and although speculation on the practicability of human flight had occupied the minds of such men as Roger Bacon and Leonardo da Vinci throughout the ages, Cayley was the first to apply his mind scientifically to the problem, and to explain the principles on a mathematical basis. He was not a practical engineer himself, and though he undertook various experiments to gather data in support of his theories, he left the next generation to develop them into practical form.

His one practical effort was made late in life and never got beyond the stage of rough sketches. It was an interesting proposal however and, some years ago, a small model was made at the Science Museum to show the form which it would have taken (see Fig. 2). The "wings" are really large circular lifting screws and are set on two spindles at an obtuse angle to each other, thus giving a dihedral angle. The wings were to be revolved to provide the necessary lift by means of a power unit in the body of the machine, which was also to be used to rotate the two propellers in the rear.

Cayley's proposed machine was not so important a contribution as his paper on "Aerial Navigation," which was published in 1810, and which not only laid the foundations of the modern science of aeronautics, but also formed the inspiration for Henson's invention and patent of 1842. Cayley declared his belief that the transportation of passengers and goods at speeds of 100 miles per hour was a possibility, and his statements were based upon his research and calculations and not upon idle prophecy. He advocated the use of a curved wing section, he stated the principles underlying stability, and he suggested the dihedral angle; he showed how directional control could be attained by the use of rudders, and he outlined all the fundamental features of a flying machine, including an estimate of the amount of power required. In fact, Cayley's work at the beginning of the last century provided almost all the knowledge necessary for the accomplishment of mechanical flight. It remained for others, however, to apply the knowledge in practical development.

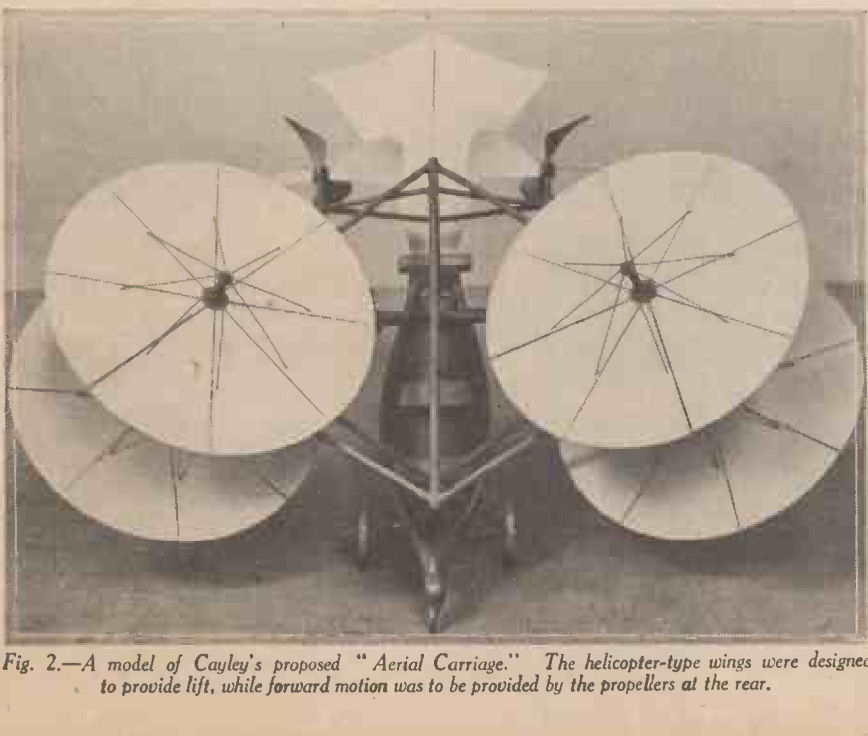


Fig. 2.—A model of Cayley's proposed "Aerial Carriage." The helicopter-type wings were designed to provide lift, while forward motion was to be provided by the propellers at the rear.

William Henson's "First Aerial Project"

It was in 1842 that William Henson, then 37 years of age, filed his famous patent for "The First Aerial Project," and, in doing so, attracted to himself almost world-wide interest. To what extent he obtained his ideas from Cayley's writings is not known with certainty, but there is no doubt that, directly or indirectly, Cayley was his inspiration. It was one thing, however, to discuss scientific principles; it was quite another matter to produce a cut-and-dried plan for the construction of an aeroplane comparable in size with a modern air-liner—which is virtually what Henson did—and we cannot be surprised that his plans were received with ridicule.

Henson proposed to construct a large monoplane with a wing span of 150 ft. His patent specification and drawings describe the construction in great detail and, with the exception of the lack of ailerons, he described every essential feature of the modern aeroplane, even down to the use of streamlined wires for bracing the wings. He proposed to use a steam engine of 30 h.p. for driving the twin air-screws, and he proposed to launch his machine, the weight of which he estimated at 3,000 lb., by allowing it to run down a steep incline.

Henson had undoubtedly made a few experiments with gliders to gather data for his design, but he was of too ambitious a nature and too lacking in patience and perseverance to wade through all the stages of development. Instead, he jumped straight to what he conceived as the final form his machine would take and without any practical results to back up his claims, and in face of popular ridicule he attempted to form a company to exploit his invention.

Perhaps capitalists were wiser in those days than they are to-day; at any rate there was no response to Henson's appeal for funds, and, having failed to raise the capital necessary, he resolved to construct a model instead. In this he was assisted by his friend John Stringfellow, a lace manufacturer, and an amateur mechanic of considerable skill.

Stringfellow possessed just those qualities which Henson lacked. He was enthusiastic, but he was level-headed. He had patience and ingenuity, and it is not difficult to understand why he eventually succeeded where Henson had failed.

Stringfellow's main interest undoubtedly lay in the engine rather than in the aeroplane, and to him fell the task of designing and building a steam engine for the model which they constructed between 1844 and 1847.

This historic model, which is now preserved in the Science Museum, has a wing span of 20 ft., while the wings have a chord of 3·5 ft. The wings are rigged with flat steel wire from six streamlined masts, while the engine and boiler were carried in the "car." The two airscrews are 3 ft. in diameter and were originally made with four blades each, but as four blades were found no more efficient than two, the number was reduced. The airscrews were driven in opposite directions at a speed of about 300 revolutions per minute by means of multiple cord belts from the large pulley on the crankshaft, and it was stated that the thrust at this speed was over 5 lb., with the boiler pressure at 100 lb. per square inch.

Fig. 3.—The engine of the Henson-Stringfellow model, constructed by John Stringfellow.

A view of the model is shown in Fig. 1, while the engine is shown in Fig. 3. The boiler and furnace are, unfortunately, now missing

It will be seen that the undercarriage of Henson's model consists of two long members which are attached to the bottom of the car and which carry three wheels, apparently for use on an inclined plane down which the model was to glide for launching. Such a method of launching has serious disadvantages for a pilotless machine—as Henson would have realised had he been a mathematician—because the change of attitude necessary at the end of the launch is very difficult to adjust beforehand without introducing instability.

During the construction of the model, Henson and Stringfellow lived at Chard, in Somerset, and in 1847 the model was taken by night on to the Bala Downs, two miles away. For seven weeks they continued their experiments and trials, but the machine would not support itself for any distance, always gradually losing height. Perhaps the engine was not sufficiently powerful, or perhaps the thrust developed on the ground was not maintained in the air. One thing is certain, however, and that is that the model was far too large for initial experiments and its lack of stability exposed it to the mercy of ground currents and may have prevented a successful flight.

In spite of every effort, success was not attained, and, discouraged by repeated failures and by the financial loss, Henson gave up. He abandoned the work, married, and in 1848 he emigrated to America. By this "retirement" Henson lost much of the credit due to him for his invention and for his work in laying the foundations of the design of the modern aeroplane. In retrospect, however, we can appreciate his work in proper perspective and we can but admit that the aeroplane as known to-day was invented by Henson in 1842.

Stringfellow's Achievement

Henson's departure for America marked the beginning of a new stage in the history of power-driven flight—the stage when Stringfellow, undeterred by failure, continued the work alone with the fixed intention of demonstrating, at least to his own satisfaction, the possibility of power-driven, heavier-than-air flight.

Stringfellow modified the original design in several important directions. He adopted a smaller and more convenient scale for his model, he devised an ingenious system of launching whereby the performance of the model could be largely ascertained prior to release into free flight, and, finally, he con-

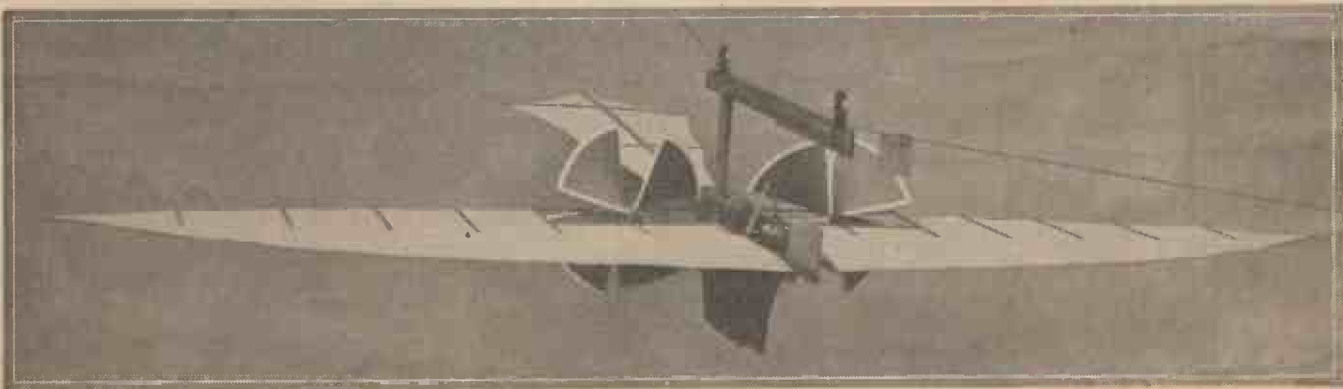


Fig. 4.—A replica of Stringfellow's model showing the launching device.

ducted his experiments in the calm air inside a long room. These modifications in the plan culminated in success in 1848 and the model flights which were made at Chard and later in London demonstrated that a heavier-than-air machine could support itself while travelling through the air, an event of outstanding importance in the history of flight. It seems extraordinary to-day to realise that this event occurred nearly ninety years ago and it seems even more remarkable to recall that more than fifty years were destined to elapse before a successful man-carried flight was achieved.

Stringfellow's model of 1848 had a wing span of 10 ft., the wings tapering to points at the ends. Right- and left-hand airscrews were fitted, 16 in. in diameter, and the total weight of the model, including fuel and water, was under 9 lb. The construction of the boiler is unusual and it is interesting to note that it conforms in principle to that described in Henson's specification although it was almost certainly designed by Stringfellow. It is made of thin copper sheet, silver soldered at the joints. The cones, which are for the purpose of giving additional heating surface, are connected with the steam drum above and with water chambers below. The boiler was fired by means of a lamp burning naphtha or methylated spirit, but the lamp is now unfortunately missing.

It is interesting to note that some years after the experiments of 1848, the engine and boiler were acquired by a firm of lace manufacturers of Tiverton, and for about fifty years it was used to drive a small lace machine in the factory. The engine is now preserved in the Science Museum together with the remains of the model aeroplane.

When the model was acquired by the Museum, its condition was much deteriorated. Many parts were missing altogether and those which still remained were in too delicate a condition to permit reconstruction in its original form. Fortunately however, many notes and sketches existed which enabled an almost perfect replica to be constructed to show the original form. The photograph of the replica (Fig. 4) also shows the method of launching devised by Stringfellow, without which he might never have achieved success.

The launching device consisted of a horizontal member which was supported on a stretched wire by means of two deeply grooved wheels. A smaller horizontal strip was attached beneath the main member in such a way that it was free to slide upon it, its movement being limited by stops which worked in long slots. When in position for launching, the model was suspended by a loop of string attached to the front of the car, the top of the loop passing over a pin on the launching device. The rear part of the model was supported by a vertical member which engaged with hooks on the model.

When ready for launching, steam was raised and the model restrained until the airscrews attained full speed. It was then released and permitted to run along the wire until the lower member of the launching device encountered a stop on the wire. This caused the loop of string to be released, thereby freeing the model in front, and its inertia served to draw it off the rear support and to launch it into unrestrained flight.

The great advantage of this method of launching was that trials could be made without actually releasing the model, and thereby risking serious damage, until the performance of the restrained model appeared to indicate that a successful flight could be expected. The stop on the wire could then be set to the point where the model became self-supporting, and it was found that the usual run required was about 22 ft.

The First Successful Model Flight

The first successful flights were made in the packing room of a disused lace factory at Chard. The room was nearly 70 ft. long, but only about 12 ft. high, so that the launching wire had to be placed fairly low in order to leave the model room to climb during flight. There seem to be no contemporary accounts of the experiments, but they were described a few years later by Stringfellow's son in a small pamphlet, in which he writes: "The inclined wire for starting the machine from, occupied less than half the length of the room and left space at the end for the model to clear the floor. In the first experiment, the tail was was set at too high an angle, and the machine rose too rapidly on leaving the wire. After going a few yards, it slid back, as if coming down an inclined plane, at such an angle that the point of the tail struck the ground and was broken. The tail was repaired and set at a less angle. The steam was again got up and the machine started down the wire, and, upon reaching the point of self-detachment, it gradually rose until it reached the farther end of the room, striking a hole in the canvas placed to stop it. In experiments the machine flew well when rising as much as one in seven."

The experiments were witnessed by numerous other observers, but, in spite of this, the momentous achievement attracted singularly little attention at the time. Perhaps the reason for this was that Stringfellow was not interested in self-advertisement or commercial development, and his sole motive was to satisfy himself as to the possibility of mechanical flight.

Further experiments took place in London during the same year and a flight of 40 yd. was finally achieved.

Stringfellow's Later Work

Stringfellow's "rest" was a long one—in fact it was more than fifteen years before his enthusiasm was again aroused—by the formation in 1866 of the Aeronautical Society of Great Britain, which later became the Royal Aeronautical Society. The immediate cause of Stringfellow's revival of interest was the holding in 1868 of the first Aeronautical Exhibition, at the Crystal Palace. He had been asked to contribute to the exhibition, and actually supplied three entries, a light steam engine of about 1 h.p., a high-pressure boiler, and a fine working model of a triplane.

The triplane is naturally the most interesting of the three exhibits, and although no records exist to show that it ever made an unrestrained flight, it is of historic interest, since it is the first machine to have been constructed with superposed planes. It had been shown mathematically that an efficient wing, or aerofoil, as we should term it to-day, must be long in proportion to its breadth. If much weight was to be supported, this necessarily implied a very long wing, which presents obvious mechanical difficulties—or else the use of superposed planes as adopted by Stringfellow.

These three pioneers, Cayley, Henson, and Stringfellow, can together claim to have laid the foundations of the aeroplane of to-day, and although at the time their work attracted scant attention, we can to-day appreciate the full value of their experiments. To Cayley we owe the theory of flight, to Henson and Stringfellow we owe the practical application. The work of these three covered a period of over seventy years and the fact that the practical work was confined to models does not in any way reduce its importance.

Fig. 5.—The engine and boiler of John Stringfellow's model. The very light construction is an important feature and the complete model, including fuel and water, weighed less than 9 lb.

Building a Balsa Model Aeroplane

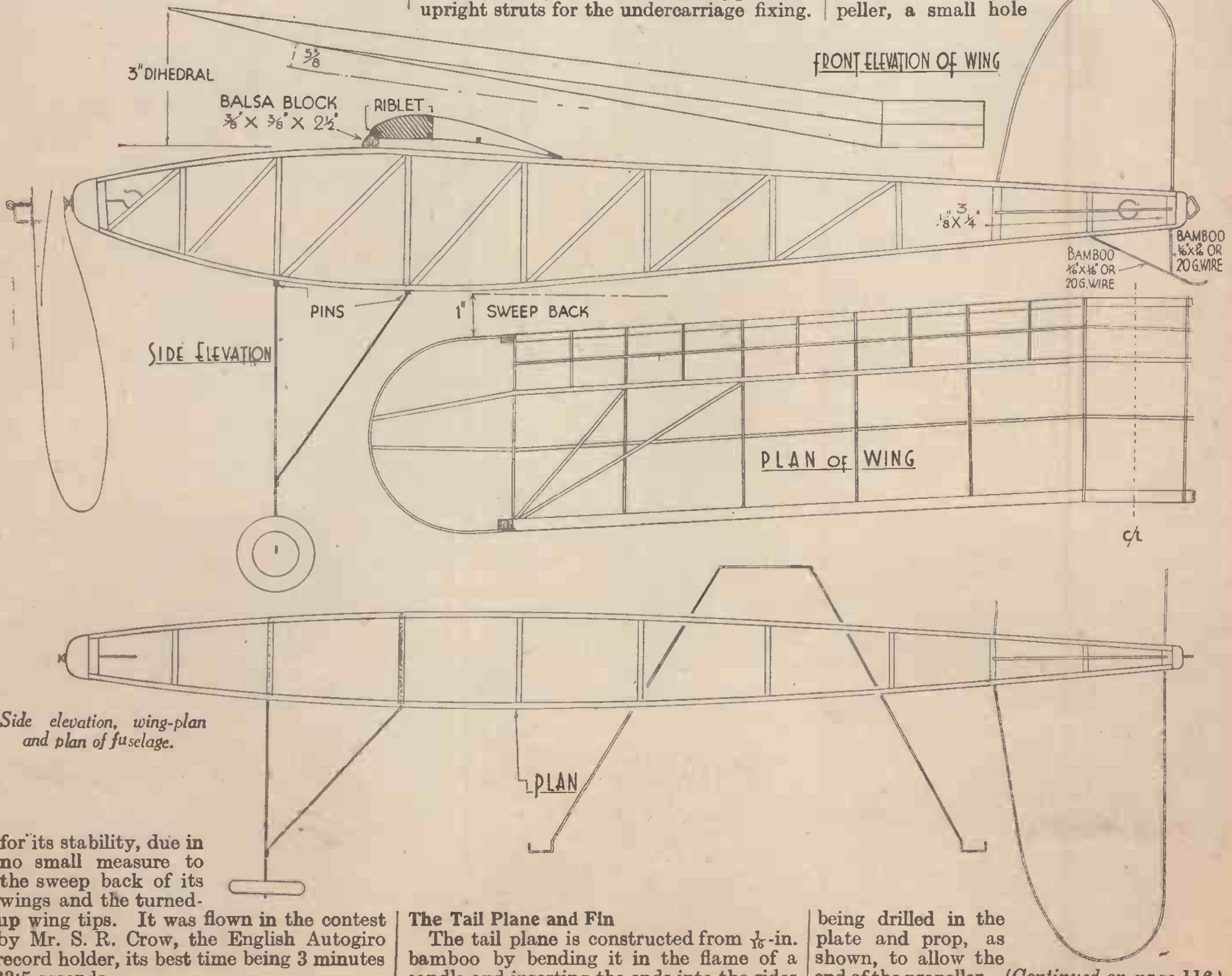
Below are given Constructional Details of the Australian Wakefield Cup Entry—the "Milton Special"—a Feature of which is its Remarkable Stability.

Showing the finished model in the hands of a model aeroplane enthusiast.

THE Milton Special, the construction of which is described in this article, is the machine that came fifth in this year's Wakefield Contest. It is remarkable for its stability, due in no small measure to the sweep back of its wings and the turned-up wing tips. It was flown in the contest by Mr. S. R. Crow, the English Autogiro record holder, its best time being 3 minutes 33·5 seconds.

The construction of the model is quite simple, as it is built "on the flat."

Prepare a full-size drawing of the model, and pin this down to a flat board. Taking the side elevation first, pin down the two main longerons of ⅛-in. square balsa (medium hard) and cut and glue into position the upright struts, also of the same section balsa. Next finish one side of the fuselage by gluing into position the diagonal struts. Repeat this procedure, thus making two identical sides. Stand the two sides vertically on the plan view, and put in the cross struts, holding the stern and forward ends of the longerons in position with rubber bands whilst the glue is drying. When thoroughly dry, insert small sewing pins into upright struts for the undercarriage fixing.



Side elevation, wing-plan and plan of fuselage.

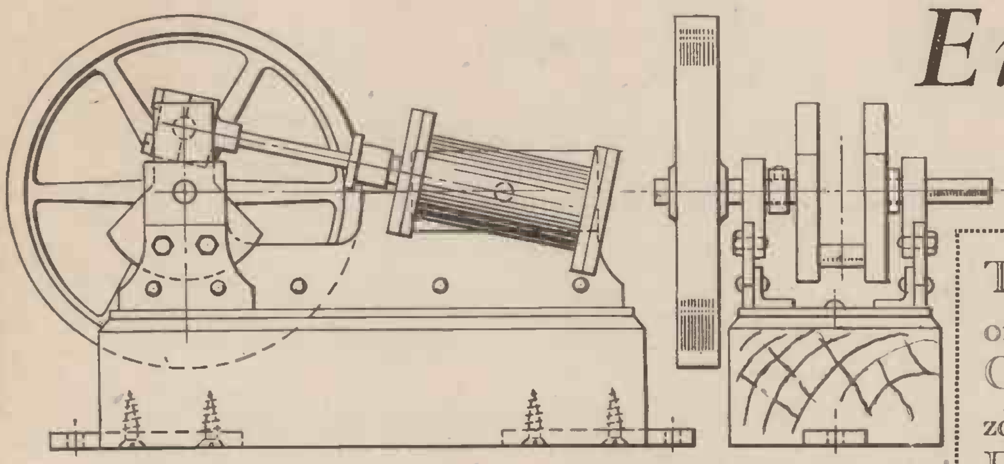
The Tail Plane and Fin

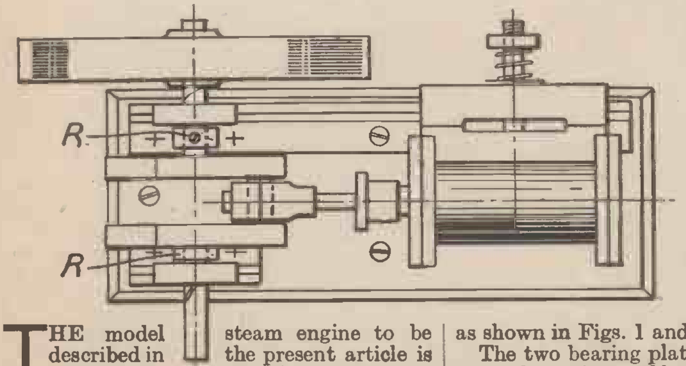
The tail plane is constructed from 1/16-in. bamboo by bending it in the flame of a candle and inserting the ends into the sides of the fuselage. The fin is made in the same way, and inserted into the top, making sure that all joints are well glued. The nose block is cut from a piece of hard balsa and an 18-gauge brass bush is inserted. The propeller shaft is made from 18-gauge wire passed through the bush from the rear. The rear hook is of 18-gauge wire cemented into the balsa sternpost.

The propeller is carved from a block of medium hard balsa, measuring 16 in. × 2½ in. × 1¾ in. as shown in the side elevation. The propeller is bushed to take the 18 S.W.G. shaft, and a small metal plate is glued to the front. This plate is of brass and is shaped to fit the front of the propeller, a small hole being drilled in the plate and prop, as shown, to allow the end of the propeller (Continued on page 116)

Working Model Steam Engines

The Construction of a Double-acting Oscillating Horizontal Engine is Dealt with in This Fourth Article of the Series





Figs. 1 to 3.—(Left) A side elevation and plan of the finished engine, and (above) a view of the engine with the cylinder omitted for clearness.

THE model steam engine to be described in the present article is of the horizontal type, and is provided with a double-acting oscillating cylinder which allows of a very compact layout. Figs. 1, 2, and 3 give the general views of the engine, from which it will be seen that the cylinder and crankshaft are mounted on side frames fixed to a baseplate, which in turn is mounted on a plinth. The cylinder, which has a bore of 1/2 in. and stroke of 1 in., is directly coupled to the crankshaft, to the end of which is fixed a spoked flywheel.

Engine Side Frames

The main side frame, *A*, which supports the cylinder steam block and one of the bearing plates, can be marked out on a piece of 3/32-in. sheet brass to the dimensions given in Fig. 5. Cut the frame to shape with the aid of a small cold chisel and hacksaw and carefully file down to the scribed lines. The dimensions for the other side frame are given at *B*, Fig. 5. On the inside of each side frame, lightly solder a length of 1/16-in. angle brass so that the bottom faces of the angles are flush with the edges of the frames. Drill 1/16-in. holes through the angles and frames and rivet them together with brass rivets, as shown in Figs. 1 and 3.

The two bearing plates, *C*, can be filed to shape from pieces of brass 3/16 in. thick, after drilling a 3/16-in. hole in each for the crankshaft, and 3/32-in. holes for the fixing screws. After filing the lower parts down to 3/32 in. in thickness, hold one plate in position on the main side frame and carefully mark on the latter the position of the two holes for the fixing screws. These holes are drilled and tapped to receive 3/32-in. bolts. Locate the holes for the fixing screws in the side frame, *B*, in the same way, and drill and tap them for 3/32-in. bolts.

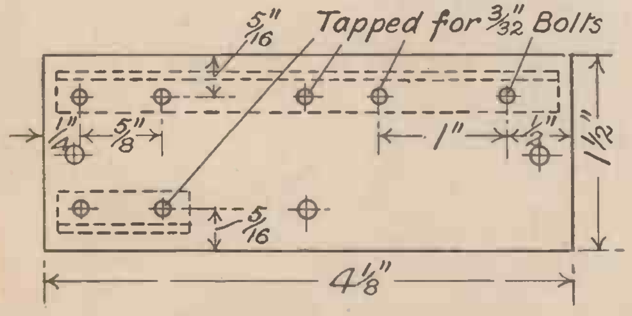
Baseplate and Plinth

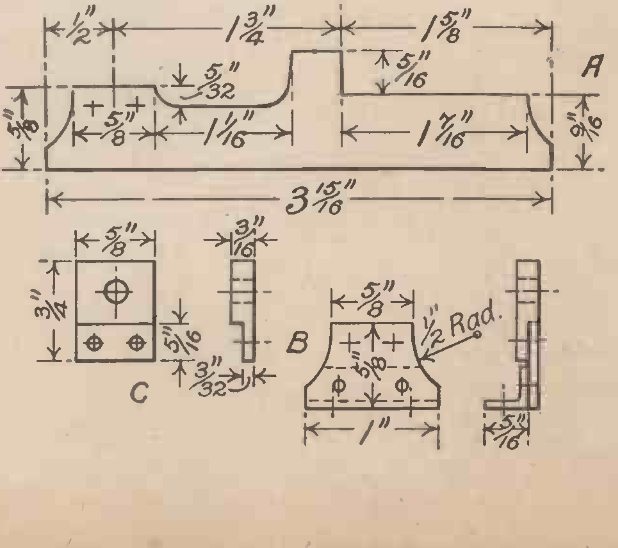
Cut the baseplate out of a piece of 1/16-in. sheet brass to the dimensions given in Fig. 4, and drill and tap the six holes to take 3/32-in. bolts for fixing the side frame angle pieces, the positions for which are indicated by dotted lines. The other four holes can be drilled 3/32 in. diameter to take wood screws for fixing the baseplate to the plinth.

It is usual in a model steam engine of the type described for the plinth to be a light iron casting, but in the present model a plinth of hardwood such as oak, will answer the purpose quite well. The plinth is 1/8 in. longer and wider than the baseplate, and it will be seen that the top edge is bevelled all round to meet the edge of the baseplate. A fixing lug is provided at each end of the plinth, and these consist of pieces of 1/8-in. sheet brass 1/2 in. wide recessed into the wood leaving 3/8 in. projecting. Each lug plate is fixed to the plinth with two wood screws from underneath, a 1/8-in. hole being drilled in each projecting end.

The Crankshaft

For the crankshaft a piece of bright steel rod 3/16 in. diameter and 2 3/8 in. long will be required, and another piece the same diameter and 3/8 in. long for the crank-pin. The crank webs can be marked out





Figs. 4 and 5.—Plan of baseplate, showing setting out of holes for fixing bolts and screws, and details of side frames and bearing plates.

on a piece of sheet brass $\frac{3}{16}$ in. thick, and the two holes drilled through for the shaft and crank pin. Cut the webs roughly to shape with a hacksaw, and file down to the scribed lines leaving the edges as square as possible.

Slip the webs on the shaft in the position indicated in Fig. 6, leaving a space of $\frac{3}{8}$ in. between them. Next, press the crank pin in place so that an equal amount projects on the outside face of each crank web, and sweat the whole together, allowing the solder to run well into the four joints. File the projecting ends of the crank pin down flush, and then cut away that part of the shaft between the webs. File the rough ends flush with the inside faces of the crank. The flywheel, which is a six-spoked one, $2\frac{3}{4}$ in. diameter, should have a plain $\frac{3}{16}$-in. hole through the boss, and can be fixed to the shaft with a grub screw.

out and filed to shape from a piece of sheet brass $\frac{3}{32}$ in. thick. The cylinder covers are also $\frac{3}{32}$ in. thick, and each cover is fixed in place with four $\frac{1}{16}$-in. bolts, holes for which are drilled and tapped in the cylinder flanges. As the piston rod passes through the front cylinder cover a stuffing box has to be provided. This is made with short pieces of brass tubing, and a brass disc with a hole in the centre, a good sliding fit on the piston rod. The gland, *K*, must be a good push fit on the piece of tube which is soldered in the central

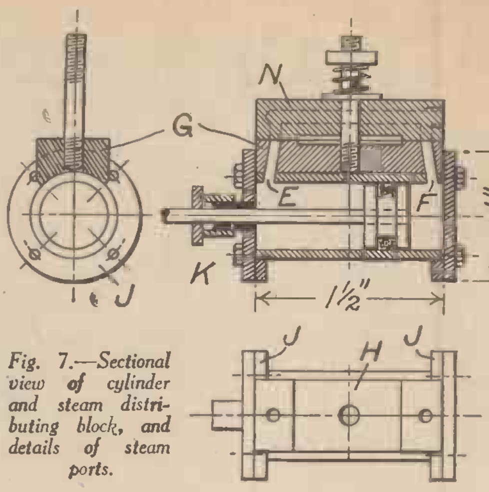
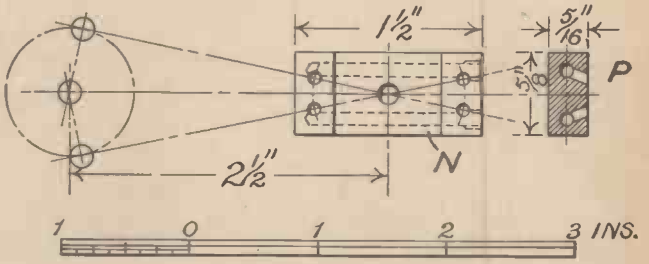


Fig. 7.—Sectional view of cylinder and steam distributing block, and details of steam ports.



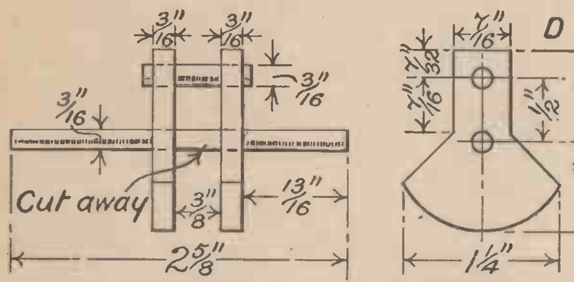


Fig. 6.—Details of shaft and balanced crank.

Cylinder Details

As the cylinder in the present model is a double-acting one, it will be a little more difficult to construct than the single-acting cylinders previously described, but with patience, and careful soldering, a serviceable cylinder should result. The finished cylinder will be equal in power to two single-acting cylinders of the same bore and stroke.

The cylinder has a bore of $\frac{1}{2}$ in. and a

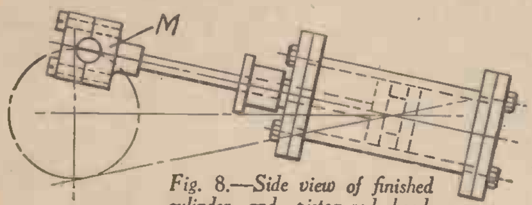


Fig. 8.—Side view of finished cylinder and piston-rod head.

stroke of 1 in., and for the cylinder barrel select a piece of solid drawn brass tubing $\frac{1}{2}$ in. inside diameter and $1\frac{5}{8}$ in. long. The tubing should be at least $\frac{1}{16}$ in. thick, and if it is sufficiently true it will only require cleaning out with a piece of very fine emery cloth wrapped round a piece of dowel rod of suitable diameter, using a little machine oil as a lubricant. File the ends of the tube square till it is exactly $1\frac{1}{2}$ in. long, and drill the two holes, *E*, *F*, near the ends of the tube, on a common centre line.

The port block, *G*, which is sweated to the cylinder barrel, can be fashioned out of a piece of $\frac{5}{8}$-in. by $\frac{3}{8}$-in. stick brass, one side being filed concave to fit the cylinder barrel after the holes for the steam ports and pivot pin have been drilled. For the latter cut off a piece of $\frac{1}{8}$-in. mild steel rod $1\frac{1}{16}$ in. long, and cut a thread on each end, as indicated. File the recess in the face of the block, as shown at *H*.

The two flanges, *J*, which are soldered to the cylinder barrel, flush with the ends, are 1 in. diameter, and are cut away to fit the port block, *G*. These flanges can be cut

hole in the front cylinder cover, and the stuffing box space can be lightly packed with a piece of oily cotton waste after the piston rod is in place.

The piston rod is a piece of $\frac{1}{8}$-in. steel rod $2\frac{3}{8}$ in. long, screwed at one end for the piston rod head, and at the other for the piston, which is formed with three brass discs, two of which must be a good fit in the cylinder barrel, and the third one, of smaller diameter, fitted between the other two so as to provide a packing space, as shown in Figs. 7 and 8.

The piston-rod head, *M*, shown in Figs. 1, 2, and 8, can be fashioned out of a piece of brass $\frac{5}{16}$ in. thick. It is split across the centre, and the end cap is fixed with two $\frac{1}{16}$-in. steel screws.

Steam Distributing Block

This is shown at *N*, and can be made from a piece of $\frac{5}{8}$-in. by $\frac{5}{16}$-in. stick brass. Two long $\frac{3}{32}$ in. diameter holes are drilled nearly through the block, as indicated, and the steam and exhaust ports are drilled to meet these holes at an angle, as shown at *P*. The relative positions of these ports are determined by the throw of the crank, and the distance of the centre of the pivot pin from the centre of the crankshaft, as shown in the bottom diagram in Fig. 7. The scale at the foot of Fig. 7 will enable the size and position of steam and exhaust ports to be checked. The lower pair of ports are the steam ports, and the upper ones the exhaust ports. The outer ends of the two long communicating ports can be enlarged to $\frac{3}{32}$ in. to take the ends of the steam and exhaust pipes.

The hole through the centre of the block must be drilled a good fit for the pivot pin, after which the recess can be filed across the centre of the block, as shown. The working faces of both blocks should be carefully prepared by rubbing them in turn on a piece of plate glass, using pumice powder and machine oil as an abrasive medium.

Assembling the Parts

Having got the piston to work smoothly, take the steam distributing block and neatly solder it to the main side frame in the position shown in Figs. 1 and 2, with the open ends of the long ports pointing away from the crankshaft. Now take the crankshaft and slip on two collars, *R* (Fig. 2), the one on the flywheel side having a small grub screw for fixing it to the shaft. Slip the other bearing plate with the small side-frame on the other end of the shaft, and after adjusting so that the shaft turns easily, screw down the angle bracket to the base-plate. After passing the cylinder pivot pin through the central hole in the steam block, slip on a thin steel washer and a short piece of brass wire spring, and screw on the nut for adjusting the tension.

Finally, connect up the piston-rod head to the crank pin and apply a little fine machine oil to all the working parts.

A SCALE MODEL OF THE "QUEEN MARY"

This Interesting Ship Model, which is Built to the Scale of ¼ in. to the foot, is the Largest of its Kind Ever Built in England

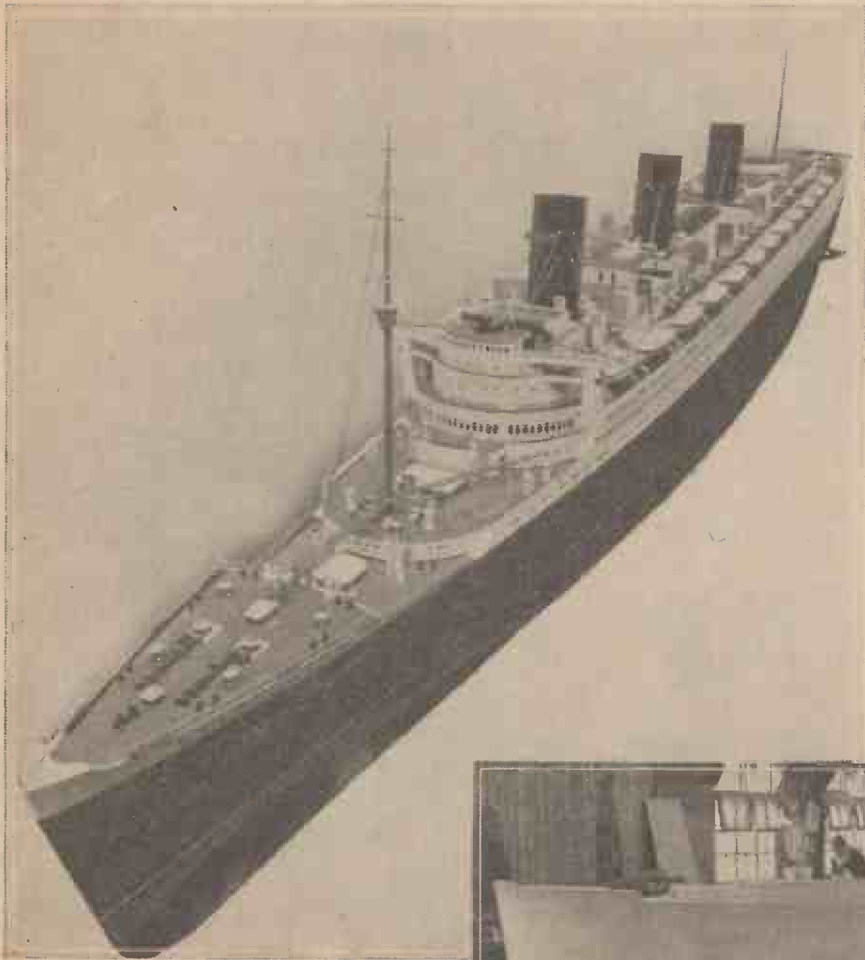


Fig. 1.—The completed model, which is 21 ft. 2½ in. long, 2 ft. 6 in. wide, and 5 ft. 9 in. high.

"I AM happy to name this ship the *Queen Mary*, and wish success to all who sail in her." The crack of the christening bottle, the clank of guide chains, and the deepening sound of a great ship entering her native element—thus a year ago, with cheering and hope, was launched Britain's challenger for that elusive and coveted Blue Riband of the Atlantic, and soon—next spring—she will set forth to prove her worth.

Throughout her notable career the *Queen Mary* has been featured and commented on by writers and critics until all the world manifests an interest in her.

In October the Cunard-White Star liner *Britannic* carried across the Western Ocean a huge model *Queen Mary* to give an early glimpse to Americans of the beauty of traditional yet progressive nautical design.

How the Model was Made

In connection with this model there are two interesting facts. It is the largest ship model ever constructed in England, and it was constructed in the record time of three months, whereas normally a work of this type takes at least six months.

For nearly thirteen strenuous weeks the craftsmen of a well-known model shipyard have been worked day and night to complete the model to time, and have deservedly achieved a world's record.

In the first place, directly the order was placed, the model-makers received all the external working drawings, giving all visible detail as far as was then known.

The scale was ¼ in. to the foot, making the approximate length 21 ft. 2½ in., breadth 2 ft. 6 in., and height 5 ft. 9 in. In the case of a model of a finished ship, hundreds of photographs are specially taken of the ship to assist the accuracy of the details, but this method, of course, could not be used for the unfinished *Queen Mary*.

Timber yards all over the country were searched for wood for the hull, which was eventually carved from long planks of seasoned African mahogany, and when hollowed out was large enough to hold nine of the workers. The planks, each about 2 in. thick, were roughly sawn to shape and then bolted and glued together to form a rough outline, which was finished off to templates made to the various sections of the hull. The inside of the hull was carved out before bolting the planks for two reasons—to lighten the weight of the model, and because there is less risk of the wood

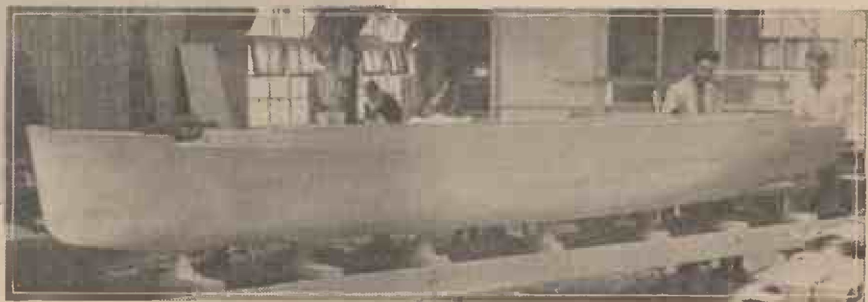


Fig. 2.—The finished hull ready for painting.

Fig. 3.—A stern view of the boat showing skilled craftsmen adding the final fittings.

Fig. 4.—The model nearing completion.

moving when done by this method. Then came one of the most skilled operations in the woodwork, to shape the hull by means of hand tools and templates to the exact form of its huge prototype, as a false cut would ruin the model. It was then smoothed down with glass-paper and received a number of priming coats and fillings, one after the other, with long intervals in between for drying.

The scores of decks and deck-house parts were of New Zealand kauri pine and close grained hard wood, accurately constructed from scale drawings, and these parts were then painted and all the decks were carefully lined out by hand to represent planking. Actually over two miles of this lining had to be done for the *Queen Mary's* deck expanses.

In the Metal-working Shop

The correct drawings to scale were supplied for each small part—winches, ventilation cowls, funnels, davits, bollards, anchors, propellers, etc. In the case of the more solid fittings such as winches, castings were made in the foundry in gun-metal, brass, or some non-ferrous metal, and were then finished by hand, and small details added to them by skilled model-makers. Others that were hollow, like the funnels, or flat, like window frames and sidelights, were wrought from sheet and strip metal, or, like stanchions, were turned from fine rod.

The funnels, which in the case of the *Queen Mary* were of considerable size, were rolled in sheet brass, and the banding and edging were riveted on and soldered. Before painting, all the small ladders, syrens, staging, etc., were tried in position, and removed for plating in bronze, silver, or gold. Some fittings are painted in correct colours, while others are plated. Then there is the glazing of port-holes and windows, and opinions vary as to the most attractive finish, because when the ship is at sea the colour of these depends on what is reflected in their plate glass—grey, green, or blue, according to the weather. The Dutch modellers nearly always use mirror glass or nickelled metal, but with this model a new experiment was tried by using bexoid in a mottled green, which gave a very successful result.

Completing the Model

When each part, large and small, was finished, a careful check-over was made to see that nothing had been omitted, otherwise the completion of the model would be delayed, if only for one small winch or bollard.

The great hull was taken from the paint shop and set up in a specially prepared dust-proof room, and a staff of six skilled craftsmen began the assembling.

They drilled the hull and fixed each little sidelight, and then the building up of the decks was commenced. Stanchions were fitted and handrails threaded, companion ways secured from deck to deck, masts and funnels erected, deckhouses, huge ventilators, davits, lifeboats, and all the numberless deck fittings placed into position.

Fig. 5.—Loading up the model for transport to London.

The last hand-rail was made fast, and the *Queen Mary* was ready for the inspection and approval of the owning company's naval architect, a worthy deputy of Britain's future " Queen of the Seas."

THE WORLD OF SCIENCE

Refrigerator Rail-Road Cars

IN an age when refrigeration is rapidly becoming recognised as an essential in food preservation, rail-road companies are not backward in using it to keep foodstuffs, flowers, and vegetables fresh in transit from producer to market. The London Midland and Scottish Railway has just put into service a fleet of large insulated refrigerator cars. These are of double-walled wooden construction. The cavity between the outside planks and the interior plywood lining is packed with crinkled aluminium foil. The refrigerating units are two tanks in the roof containing solid carbon dioxide, known commercially as dry-ice. The gas given off by the evaporating " ice " is led away outside the cars. The cooling circulation is provided simply by contact of the air in the car with the cold undersurface of the tanks. Cold air sinks down amongst the cargo and displaces warmer air from the floor.

The use of crinkled aluminium foil as a packing in place of asbestos, cork, or slag wool is an interesting modern development. Aluminium as a metal is a good conductor of heat. The real insulator is the little air-cells between the layers of the metal, and a shiny metallic surface prevents passage of heat by radiation across these cells.

Liquid Oxygen Explosives

A CIGARETTE soaked in liquid oxygen flares up like a firework when lit. Modern safety explosives are a development of this principle. Cartridges of cellulosic material, harmless in themselves, are made explosive by soaking them in liquid oxygen. Unlike dynamite and blasting powder, the mixture does not touch off easily, but requires a definite flash from a detonating circuit to fire it. The explosion develops a powerful disruptive force. The cartridges themselves are inert and can safely be stored without special precautions. Moreover, if they fail to go off they become rapidly harmless again as the oxygen evaporates. Accidents due to delayed firing are thus obviated. A French mining syndicate regards the method with so much favour that it has installed a liquid oxygen plant producing 300 gallons an hour. The plant is situated in the middle of its area of operations.

ALL RADIO QUESTIONS ANSWERED FREE

The PRACTICAL MECHANICS Wireless Experimenter

Every Question must be accompanied by the Coupon on page iii of Cover

THE P.M. BATTERY FOUR

A Modern Battery-operated Receiver with "Mains" Output, Ample Range, and a Degree of Selectivity Sufficient for Most Purposes—and at Low Cost

FOR various reasons, push-pull amplification of the "straight" kind, as opposed to Q.P.P. and Class B, has been very much neglected during the past couple of years, and constant inquiries have been received from readers for a really up-to-date set of comparatively simple type with push-pull output. Push-pull is certainly very desirable when a really large output is required, and particularly when quality reproduction is of prime importance. It is to meet the requirements of many correspondents that we are being so bold as to revive push-pull amplification, and to prove that it is ideal for modern conditions.

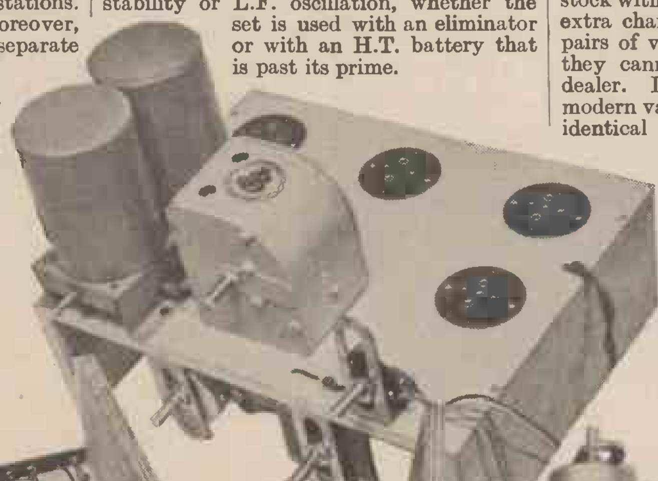
A Modern Circuit

The P.M. Battery Four is in every respect a modern receiver, and provides exactly the type of reception that is being demanded by more and more listeners, who fully realise that quality and punch are of even greater importance than long range and the ability to separate two transmissions emanating from stations situated many thousands of miles away. We are aware that every listener at some time or other likes to have by him a powerful receiver ideally suited to the reception at perfect quality of the nearer stations. There are many constructors, moreover, who find it worth while to have two separate receivers, one with which to go "globe-trotting" and the other for local work and for the benefit of the "family," who place ease of control and quality of reproduction before everything else. This receiver forms an excellent "second" receiver for those who come within the latter category.

It will be seen from the circuit that the arrangement is on very straightforward lines, and that it is entirely devoid of any "extras" that make a circuit look complicated, but which do nothing to improve performance. Air-cored coils of sound design and of a type providing good selectivity are used both in the aerial and in the intervalve circuits. Both coils are of the H.F. transformer type of which the primary is untuned, and both are fitted with built-in wave-change switching so that the number of external connections is reduced to a minimum.

Distortionless Volume Control

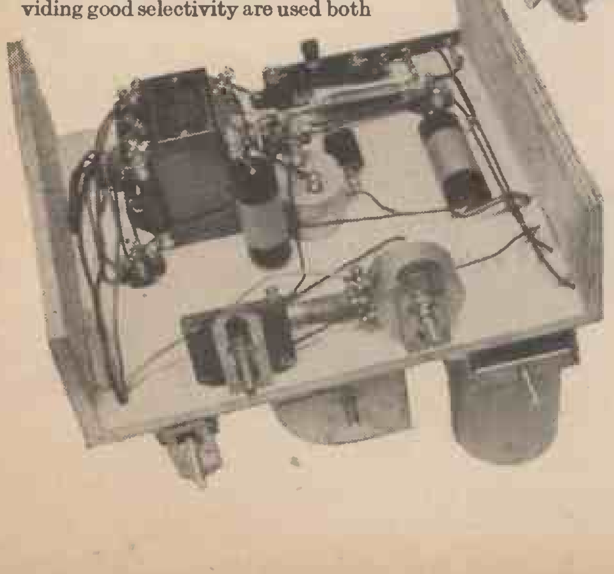
The first valve is a variable-mu H.F. pentode, and this provides a really large measure of amplification besides forming an ideal distortionless volume control. The detector circuit follows conventional lines, and includes a reaction condenser that gives a smooth control of volume and also enables selectivity to be increased when desired. It is also amply decoupled, with a result that there is no danger of instability or L.F. oscillation, whether the set is used with an eliminator or with an H.T. battery that is past its prime.

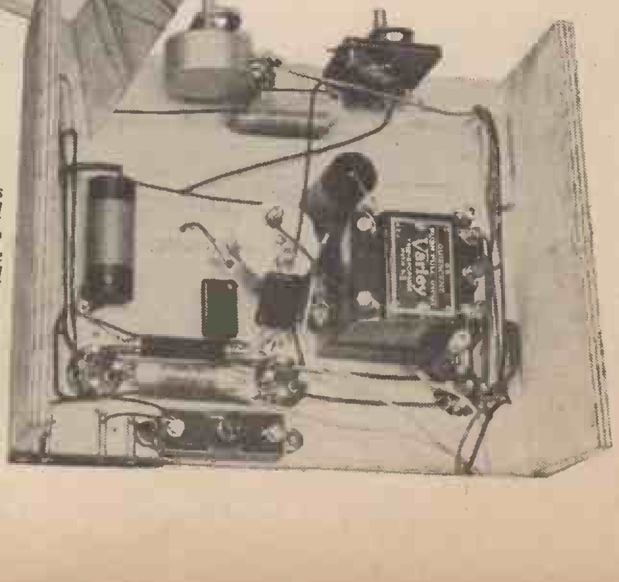


It is the output stage, however, that merits most attention, since this includes two modern valves in a modern push-pull circuit. The degree of amplification given by a push-pull stage is more than double that of a single valve, the output actually being something like two and a half times that of a single L.F. valve. Push-pull has the further advantage that it is practically distortionless, due to the fact that the two valves tend to cancel out any distortion that might otherwise exist.

A Balanced Output Stage

In designing the push-pull output stage of the receiver very great care has been taken to avoid any possibility of instability, and it is for this reason that stopper resistances have been included in the grid leads to the two valves. Still further to ensure perfect stability, however, the two halves of the secondary winding of the input push-pull transformer are shunted by means of small fixed condensers. It might at first appear that these precautions against instability are unnecessarily complete, but this is not the case. Theoretically, two valves used together in a push-pull circuit should be perfectly matched, which means that they should be chosen from the makers' stock with great care. There is generally an extra charge made for accurately matched pairs of valves, however, and besides this, they cannot be obtained from the local dealer. In saying this we realise that modern valves of the same type have almost identical characteristics—but there are slight variations. But by using the decoupling arrangements referred to above, the valves for the P.M. Battery Four need not be perfectly matched, and thus ordinary ones can be bought direct from stock without results being impaired in the slightest degree. Triode output valves are indicated in the theoretical diagram, but pentodes may be used if greater efficiency is desired, and these are specified.





These three views of the finished receiver will help in checking the construction and wiring.

Preparing the Chassis

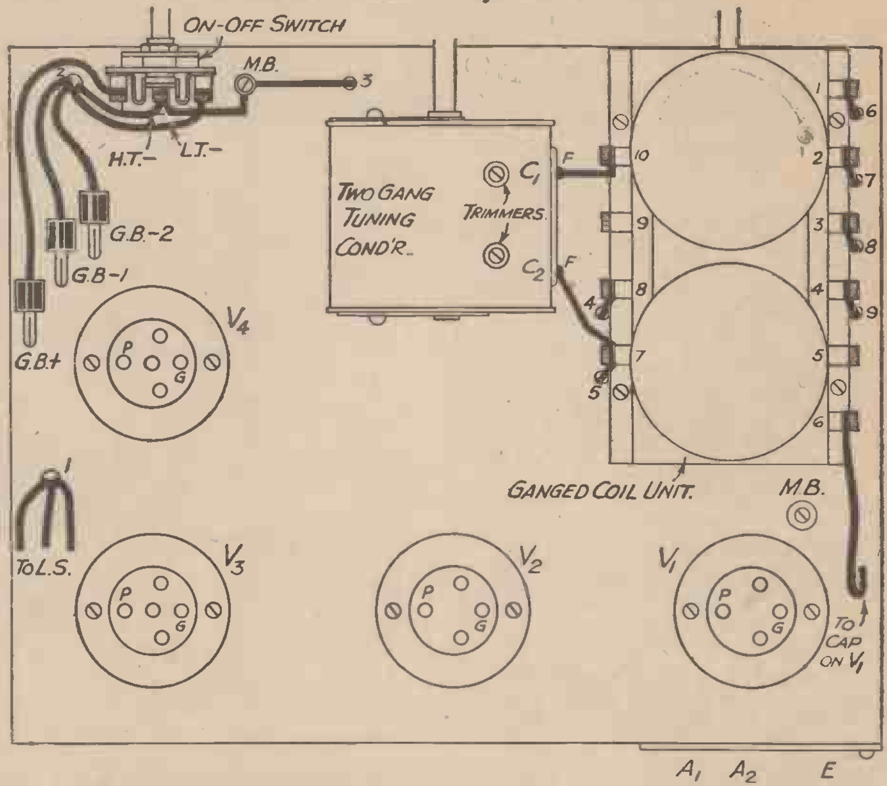
Some readers may prefer to purchase the chassis ready drilled, but those who prefer to drill it themselves should start by marking out and drilling the four holes for the valveholders. These are all 1 in. in diameter, and their positions can readily be determined from the scale wiring plan given. After mounting the valveholders it will be found most convenient to fix in place all those components that are situated underneath the chassis, starting with the push-pull input transformer. After that, the two component brackets can be fitted and the reaction condenser and volume-control potentiometer attached to them.

It will be seen that the fixed condensers and fixed resistances are not attached to the chassis, but are supported by their connecting wires. The next step is to mount the third component bracket, variable condenser, and coil assembly on the upper surface of the chassis. Again the correct positions (which are not too critical, by the way) can be found by making reference to the wiring plan. One point that should be watched, however, is that the condenser must be exactly in the centre, so as to make the drive central. It should also be noted that the end of the condenser spindle should be in line with the front edge of the chassis—not overhanging, as might be supposed. This is because the collar on

List of Components for the P.M. BATTERY FOUR

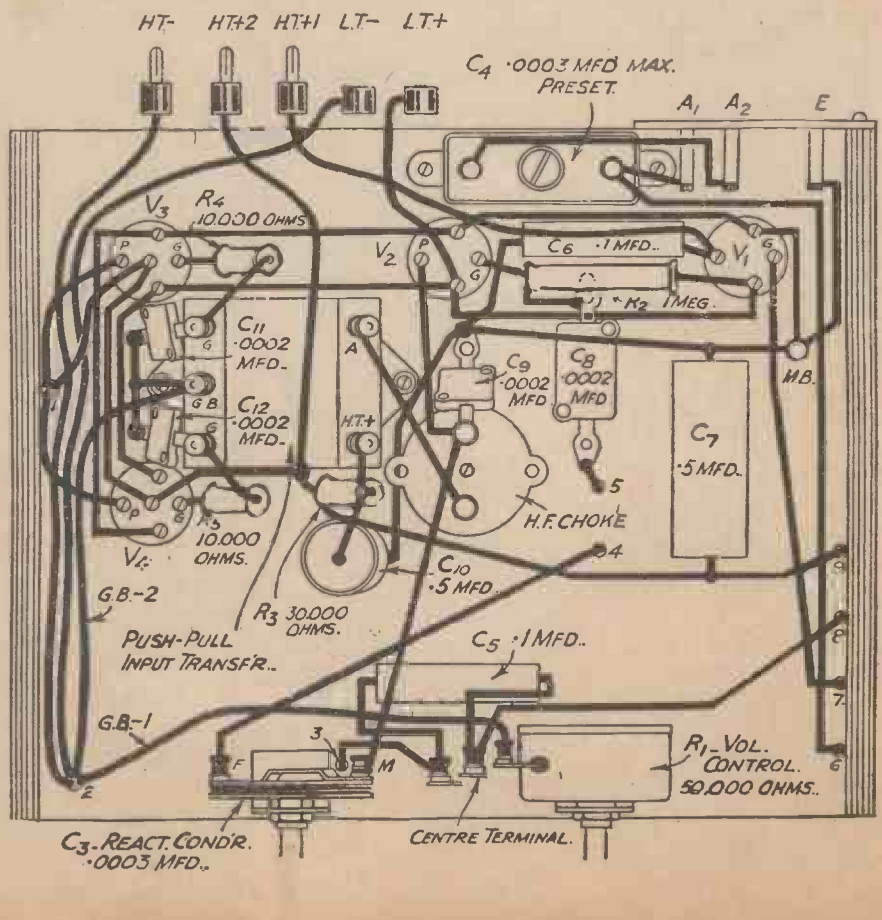
- One Two-gang Condenser, "Baby" type, with dial (J.B.).
- One Two-coil Assembly, type T.D.S. (Colvern).
- One Reaction Condenser, ·0003 mfd., *C*3 (B.T.S.).
- One Pre-set Condenser, ·0003 mfd., *C*4 (Ward & Goldstone).
- Four Fixed Condensers: two ·5 tubular, *C*7, *C*10; two ·1 tubular, type 250, *C*5, *C*6 (T.C.C.).
- Four ·0002 Fixed Condensers, type M, *C*8, *C*9, *C*11, *C*12 (T.C.C.).
- One 50,000-ohm Potentiometer, *R*1 (B.T.S.).
- Four Fixed Resistances: one 1 meg., *R*2; one 30,000 ohms, *R*3; two 10,000 ohms, *R*4 and *R*5 (Amplion).
- One Input Push-pull Transformer, type D.P.36 (Varley).
- One H.F. Choke, type H.F.8 (Bulgin).
- Three Potentiometer Brackets (Peto-Scott).
- Two Terminal Strips: A. E. and L.S., P.U. (Clix).
- Six Plugs: G.B. –1, G.B. –2, G.B.+, H.T. –, H.T.+1, H.T.+2 (Clix).
- Two Spade Terminals: L.T.+, L.T. – (Clix).
- Four Valves: VP215, D210, two Y220 (Hivac).
- One On/off Switch (three-point) (Graham-Farish).
- Two 5-pin Valveholders (Clix).
- Two 4-pin Valveholders (Clix).
- One 120-volt H.T. Battery.
- One Metaplex Chassis, 10 × 8 in., with 3 in. runners (Peto-Scott).
- One 9-volt G.B. Battery.
- One 2-volt Accumulator.
- One Loud Speaker (Amplion Harmona).

Top and Sub-chassis Wiring Diagram of the P.M. Battery Four



SPECIAL NOTE

It is important to use the specified speaker (Amplion Harmona) for the P.M. Battery Four. Details of this high-quality but low-priced speaker appear on page 102.



You'll need these Exide AND Drydex BATTERIES

specified for the

'BATTERY FOUR'

For L.T. Exide DTG, 2 volt, 20 ampere hours - **4/6**, or with Exide Charge Indicator - - - - - **5/-**
For H.T. Drydex Super-Life, 120 volts - - - - - - - - - **10/6**
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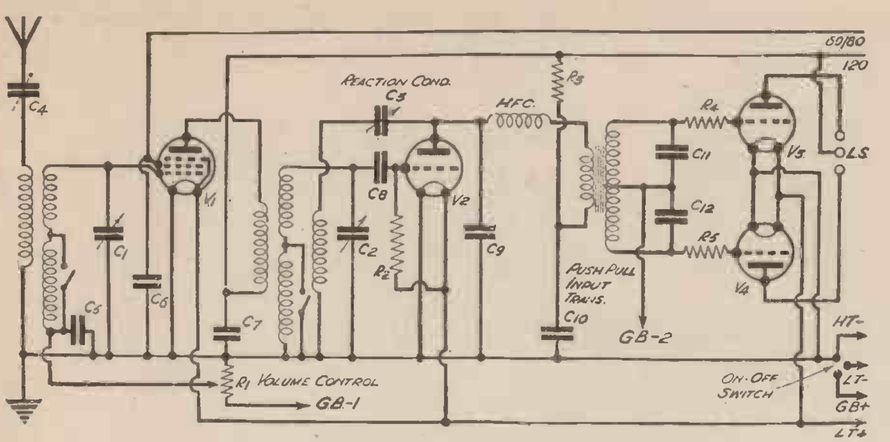


The circuit diagram of the P.M. Battery Four.

the slow-motion drive has to fit over it, the spindle from this actually passing through the front of the cabinet.

The position is rather different in the case of the wave-change switch rod on the coil assembly, since this must project, and the coil base is so placed that it just lines up with the front of the chassis.

Simple Wiring

Having mounted the various components, wiring may be commenced. The method of making the various connections calls for little explanation, since it is evident from the wiring plan, but it should be explained that several wires pass through the chassis from components mounted on the upper surface to others that are underneath. The holes through which the wires pass are numbered on the two wiring plans, so that the "run" of every wire can easily be traced. It will also be observed that two "earth-return" leads are attached to a wood screw fitted into the chassis just beside the on-off switch; one of the leads is from the on-off switch and the other is from the volume-control potentiometer.

To those who are conversant with theoretical circuits it might appear that there are more terminals on the coil assembly than are actually required, and that some of the connections are duplicated. This is explained by the fact that certain of the coil connections are brought out to two terminals, one situated on each side of the coil base. There is a very good reason for this, which is that it ensures short, direct connections to the fixed vanes of the variable condenser and also to the grid circuits of the first two valves.

"Earth-Return" Connections

In making the connections to the components on the underside of the chassis it will be seen that several leads are taken to a bolt (marked M.B.). These are "earth-return" leads, and it is therefore important that the head of the bolt should make good contact with the metallised upper surface. To ensure this it is well to fit a large washer under the bolt head, and also to place a similar washer over the looped ends of the wires before fitting the nut.

Battery Connections

Having completed the construction of the receiver, the valves may be inserted into their respective holders and the aerial, earth, batteries, and loud speaker connected. The correct order for the valves is: *V*1, VP215; *V*2, D210; *V*3 and *V*4, Y220.

It will be clear that the flexible lead from terminal 6 on the second coil should be joined to the anode terminal of the

A three-quarter front view of the receiver showing the neat and compact arrangement of the components.

var.-mu valve.

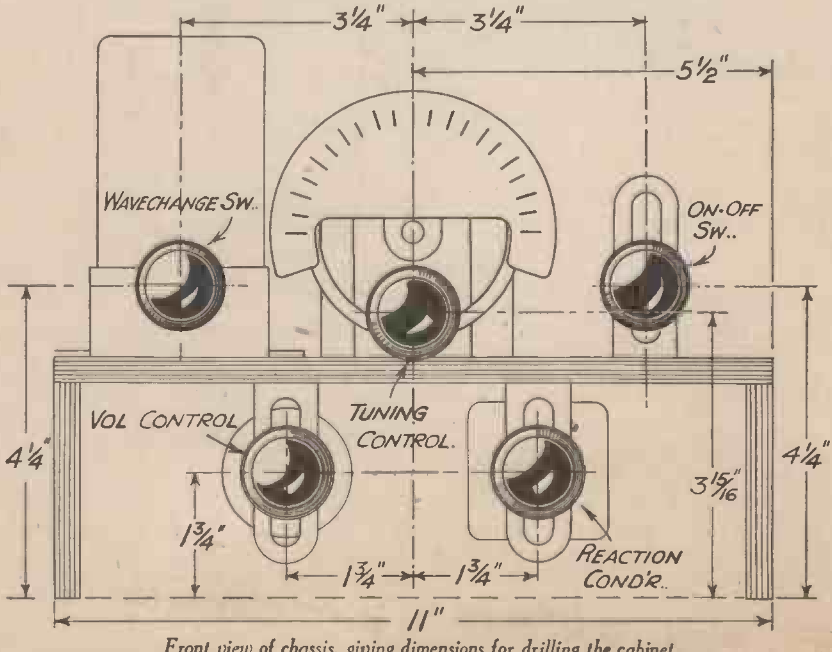
Of the battery leads, that marked H.T.– should be joined to the negative socket on the H.T. battery, that marked H.T.+1 should be taken to a tapping giving about 60 volts, and H.T. + 2 should be given the full voltage of the battery. The two L.T. leads should be joined to the positive and negative terminals respectively of the accumulator. There are three grid-bias leads, of which the positive one should be connected to the positive terminal of the G.B. battery, G.B. –1 should be given the full voltage of the battery, and G.B. –2 should receive about 4½ volts.

Trimming

The first trimming operation that should be carried out concerns the setting of the two trimmers on the two-gang condenser, for much depends upon their accurate adjustment. If they are ignored, or carelessly set, the overall selectivity, as well as the sensitivity, will be reduced.

Before dealing with the trimmer screws, however, the knob of the pre-set condenser, which is situated on the underside of the baseboard, should be turned to its midway position, the aerial being connected to the terminal socket marked *A*2. This will give a good compromise between selectivity and sensitivity, and form a good basis for the more delicate settings. Now tune in a weak station on about 250 metres and turn the reaction condenser to its zero (anti-clockwise) position. After bringing in the transmission as loudly as possible by means of the main tuning knob, slowly turn the trimmer screw on the section of the gang condenser marked *C*2 on the wiring plan by means of a long narrow-bladed screwdriver. It should be found that there is a slight increase in signal strength as a certain point is reached and that volume falls off to a certain extent on each side of that optimum point. Find that point and then repeat the trimming operation on the first section (*C*1) of the condenser. Variation of this trimmer should in all cases reduce signal strength, but if not, find the best setting.

Now tune to a station higher up the wavelength scale and repeat the operations.



Front view of chassis, giving dimensions for drilling the cabinet.

Undercarriages And Wheels For Petrol Model Aircraft

By Captain C. E. Bowden
(Holder of British R.O.G. Record for Power Model Aeroplanes)

It is essential that the undercarriage of a model aeroplane be reliable and also strong enough to absorb the shock of landing without breaking itself or the fuselage. Below are given some suitable designs

IT may be thought that the subject chosen for this article is the least important of all the component parts that go to make up a successful petrol-driven model aeroplane.

From my own experiences, however, and from observations of other people's petrol models, I feel that a sound undercarriage with suitable wheels makes or mars an otherwise good model.

It is essential that an undercarriage should be reliable, and not require repairing after every landing. Also, it must absorb the shock of landing without breaking itself or the fuselage, and it must go on carrying out these functions without attention. Furthermore, I consider that one should attempt to eliminate all points of unreliability both in the engine and the machine itself. A petrol model that will regularly take off, fly in a wind and land without damage, is to my mind an ideal machine. Having obtained that ideal, the designer can then cast about for ways and means to beautify his model.

Fig. 1.—Showing a strong and serviceable undercarriage fitted to one of the author's petrol-driven aeroplanes.

I fear too many constructors start from the other end. They copy a pleasing looking full-sized design and hope for the best. This method seldom succeeds where petrol-driven model aeroplanes are concerned. In my early models, I suffered from three main troubles, carburation (*i.e.* easy starting and reliable running in the air), damaged engine mountings, and undercarriage troubles. I accordingly set about attempting to analyse the reasons for these troubles, and to devise methods of obtaining reliability in each of these departments.

The "Split" Type of Undercarriage

Firstly, let me say that, as in the case of practically all the other petrol models I have seen, I tried designing a sprung leg "split" type undercarriage, rather after the style of the full-sized article. My reason then being, that I considered a heavy petrol model would require some useful springing device, and yet have a clear space between the wheels without an axle to hit long grass and so turn the model over when taking off or landing.

I conjectured rightly that this undercarriage must be positioned well in advance of the centre of gravity, and just behind the engine, to prevent damage to it, and to keep the model from nosing over on landing and in taking off. I have noticed one or two examples where the undercarriage has been positioned farther back, as in full-sized practice, but in every case that I have observed, difficulty has been experienced in taking off in long grass or rough ground, and the model has nosed over on landing. It is therefore very important to place the undercarriage as far forward as possible, with the wheels almost under the engine, in a tractor model.

I originally feared that with the undercarriage so far forward, the tail might not rise when taking off. However, if the model is correctly designed with the thrust line in the right position and a tail plane of slightly lifting section, it will be found that this expected trouble does not exist. A tail wheel will help to get the model going in the first place. In Fig. 2 is shown a sketch of the undercarriage of the split type. For those who must have an undercarriage resembling the full-sized affair of to-day I can say this

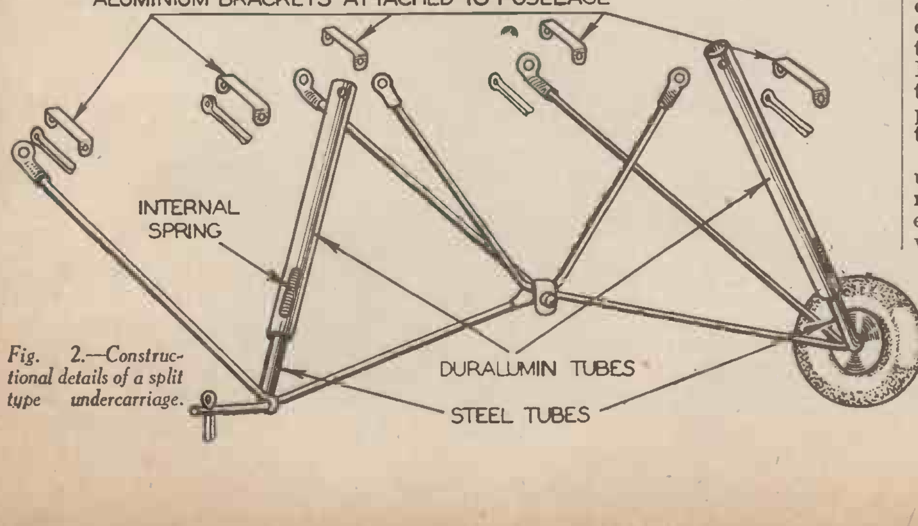


Fig. 2.—Constructional details of a split type undercarriage.

type functions fairly well up to a degree. But I soon found that I had to carry spare rear legs with me, as after almost every flight these legs and their fastenings to the fuselage were damaged.

I then tried placing the spring telescopic legs at the rear, but I found that there was not enough movement, and after the springs had fully compressed, the legs were forced into the fuselage and the plane suffered from broken fuselage longerons.

It then became obvious to me that a petrol model with even a good flat glide does not land in the stalled position, for there is no pilot, as in the full-sized machine, to conveniently pull the nose up at the last moment and "hold off" so that the aircraft practically drops down with a vertical and downward motion just before touching the ground.

The model, however, glides into the ground, thus first imparting a backward blow, which is then converted into an upward movement (see Fig. 3).

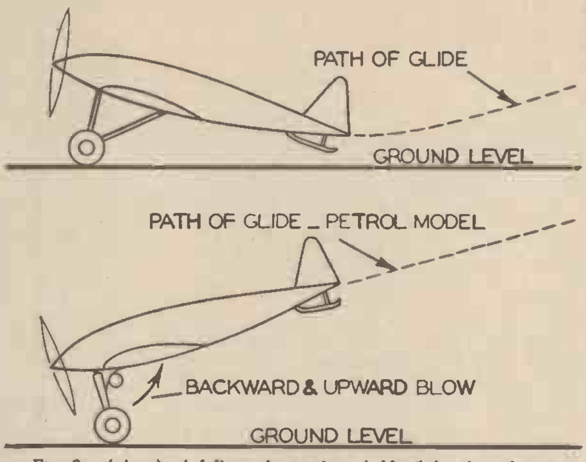


Fig. 3.—(above) A full-sized aeroplane held off by the pilot to make a 3-point landing, and (below) a model aeroplane landing.

The Two-legged Type of Undercarriage

The type of undercarriage about to be described is specially recommended to anyone who is building a new petrol model.

Reference should be made to Fig. 4 in order to follow details of construction.

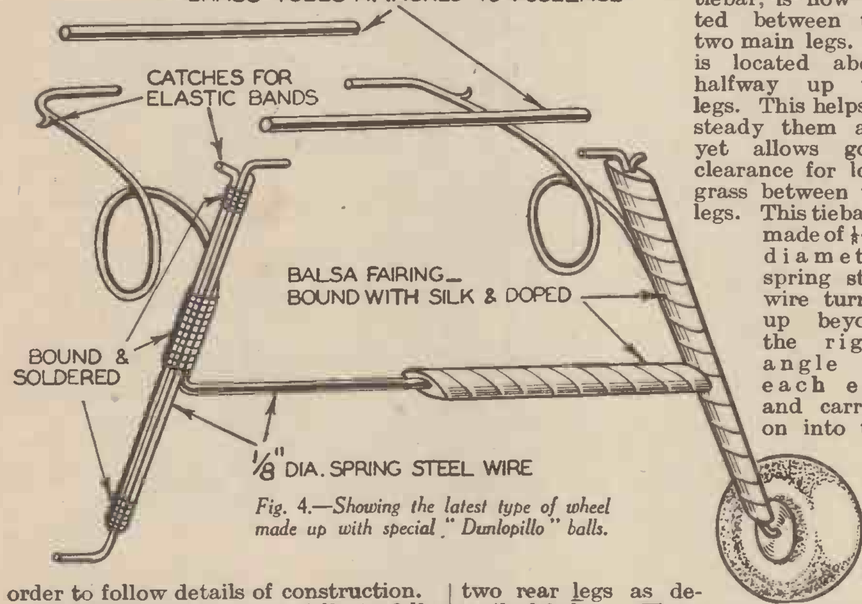


Fig. 4.—Showing the latest type of wheel made up with special "Dunlopillo" balls.

The undercarriage for a 6-lb. to 8-lb. petrol model is composed of two main legs of ⅛-in. diameter spring steel wire turned out at the lower ends to form steel axles for the wheels. The upper ends may be either carried across to join the legs and then eventually bound on to the floor of the fuselage, by thread and glue, if the undercarriage is to be a permanent fixture; or the ends may be turned in and cut off 1½ in. after the bend. These projections can then be fitted into a brass tube which has been bound across the bottom of the fuselage. The undercarriage will then be detachable if the rear legs are similarly treated. In Fig. 4 is shown a detachable type of undercarriage, as this is the most convenient for transport purposes.

On my model, the "Blue Dragon," which won the 1934 Sir John Shelley Power Cup and holds the power driven R.O.G. record, I used a non-detachable type for complete reliability for competition work. I have flown this model a great deal, but no damage has ever occurred to the undercarriage.

However, on all subsequent petrol models I have used the detachable type, and have experienced no trouble.

A crossbar, or tiebar, is now fitted between the two main legs. It is located about halfway up the legs. This helps to steady them and yet allows good clearance for long grass between the legs. This tiebar is made of ⅛-in. diameter spring steel wire turned up beyond the right angle at each end and carried on into the two rear legs as described below. These turned-up portions are then bound with florists' wire to the main legs and soldered.

Next the two rear legs are formed as continuations of the ⅛-in. diameter spring steel wire used in the crossbar and are in the form of large circular springs. This allows the main legs to go backward and then upward on the forward impact of the model with the ground. These circular springs are bent by hand in a vice,—not an easy job if the wire is a good spring steel, as it must be to do its shock-absorbing work, but it is quite possible. The rear legs are then bent inwards at right angles to form detachable prongs 1½ in. long to insert into the rear brass tube, in the case of the detachable undercarriage, or in the case of the permanently fixed undercarriage the two rear legs are joined across the fuselage and bound and soldered, and then bound with thread and glue to the bottom of the fuselage. The details shown in Fig. 4 will make this clear.

The two main legs are now reinforced by two more straight pieces of ⅛-in. diameter wire for each leg. These reinforcing lengths of wire are bound in several places with florists' wire to the main legs and soldered.

For the detachable undercarriage one of the reinforcing pieces on each leg is turned out at the top to form a catch to keep the strong elastic bands in position that are used to keep the two legs firmly into the ends of the cross-brass tube. Small wire catches are also soldered to the rear circular spring legs for the same purpose.

Fairing the Undercarriage

The final stage in the construction of the undercarriage is now entered into. The two main legs and the cross-bar are faired off for neatness and to reduce head resistance by a fairing of balsa wood, which is then sanded to streamline form, bound with silk strips, doped, and finally painted to the desired colour.

Firstly, the fairing for the main legs is carried out by cutting two lengths of flat balsa ⅛ in. thick, the length of the legs, and 1½ in. wide. These strips are placed on either side of the wire leg, with a strip of ⅛-in. balsa sandwiched between in front and at the rear of the leg. Plenty of glue is also placed in the balsa "sandwich." The whole is then bound with model aeroplane elastic and left to set dry. After the fairing is dry and the elastic removed a sharp razor blade is used to shape the fairing to a streamline form, the final finish being given by sandpaper.

Strips of silk are then cut approximately ¾ in. wide and the legs are covered with a coating of a good photopaste. The silk strips are then carefully bound round the fairing with

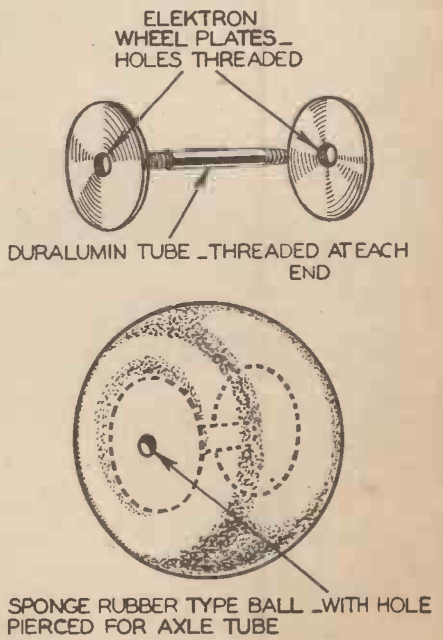


Fig. 5.—The "Dunlopillo" doughnut wheel.

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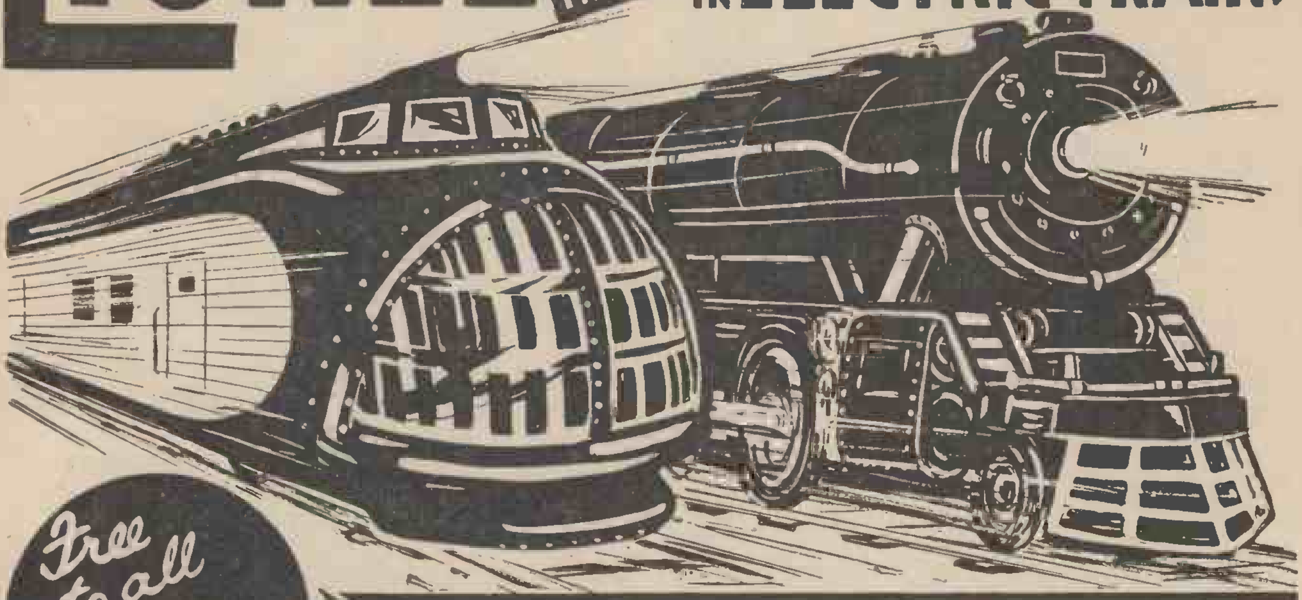

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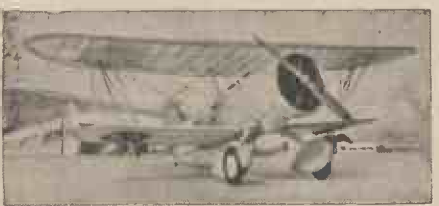

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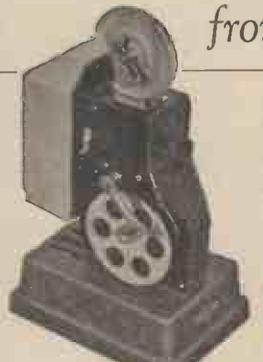

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just overlapping edges. The whole is sprayed with water and smoothed down and allowed to dry nearly hard. A coat of full-sized aeroplane clear dope is then applied, after which the legs are painted the desired colour.

The crossbar between the main legs is faired in the same manner. The rear spring legs are, of course, not faired, but are merely painted to match.

It will be found that the balsa fairing bound in this way with silk and doped weighs practically nothing but strengthens up the legs tremendously.

The above type of undercarriage can be used for "pusher" petrol models as well as tractor. In fact, the writer fitted a detachable one to a flying amphibian boat with success.

The Wheels

The next problem to be considered is the type of wheel to be fitted.

There have been many different types produced by petrol model enthusiasts. I will therefore content myself with describing briefly my own experiences, and leave the reader to judge for himself.

I originally had some aluminium disc wheels made up for me by the Dunlop Rubber Company. These were formed by two spun aluminium discs with a duralumin axle sandwiched in the centre and hollow rubber tyres with a flange inside sandwiched between the outside circumference of the aluminium discs. Rivets were then placed through the discs and the rubber flange to prevent the tyre pulling off in a cross-wind landing.

These wheels are still in operation. They were 4½ in. diameter and weighed 4½ oz. each. Their chief fault lies in the damage that is done to the edges of the aluminium discs.

Next the Dunlop Rubber Company turned up some elektron wheels of a smaller diameter, and made me hollow air-inflated tyres to spring on to the rims.

These frequently came off during landings across wind with drift on, and the tyres also became deflated after a time.

They were light, however. Dunlop's then made me up some tyres of solid but light "Dunlopillo" rubber. These did not deflate but easily came off and were inclined to be lost.

I then asked the Dunlop Rubber Company to make me up some solid balls of special light "Dunlopillo" rubber with holes pierced through the centre, the balls to be of 4½ in. diameter.

Two small discs were then made from elektron and holes threaded in the centre. A duralumin axle bush was then made 1¾ in. long and threaded externally. The two discs were then screwed on each end with the rubber ball between (see Fig. 5). The ball was thus squeezed up and formed a perfect "doughnut" wheel, that cannot be punctured or torn off, and is also very springy and has excellent shock-absorbing powers.

It is certainly rather heavy. A wheel weighs over ½ lb. complete. But I found on my eight-foot span "Blue Dragon" monoplane with Atom Minor engine, that whereas the model had been very stable and a good glider before, it became superstable; the reason of course being that the C.G. is now lower. Fig. 5 shows the wheels fitted to the "Blue Dragon."

I fitted a pair of these wheels to an 8-ft. low-wing monoplane that is being flown by a 9-c.c. Brown Junior engine, and the result is excellent; the extra weight low-down being a great advantage for a low-wing model.

Altogether I am most satisfied with the result, and have now asked the firm to produce me some special balls of the same light rubber but of only 3½ in. diameter and pierced in the centre. These will be slightly lighter and make up smaller wheels for the small 9-c.c. engined models now becoming popular, and yet be of sufficient diameter to ensure good landings and happy take-offs.

The Dunlop Rubber Company of Birmingham inform me that they can supply anyone with the larger balls ready pierced in the centre for 2*s*. each. Anyone requiring these balls should ask for exact replicas as made in the mould especially produced for me. No doubt they will also be prepared to supply the smaller ball shortly.

Before having these balls made for me I searched everywhere for a light-weight rubber ball of the desired diameter, but without success. I also tried making wheels up on the same principle but with hollow rubber balls. I gave these up owing to the constant trouble experienced through deflation of the hollow ball.

A New Metal-Spraying Process

THE recommendation by the Radio Interference Bureau of zinc-sprayed coatings as a means of suppressing interference caused by electro-medical apparatus is the latest development of a comparatively new industry.

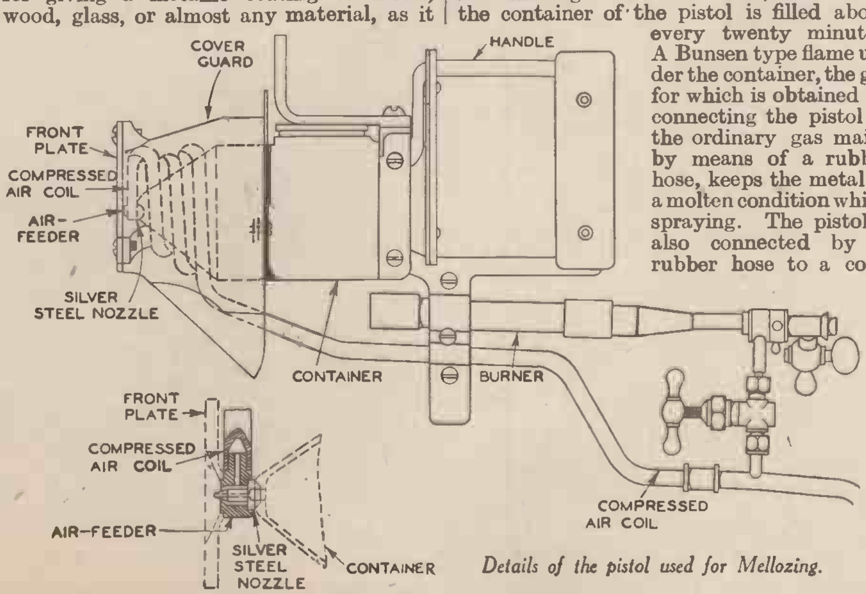
Metal spraying is carried out by means of a pistol which is patented and manufactured by Mellowes & Co., Ltd., Sheffield and London.

The process, which is known as Mellozing has been found valuable by many industries for giving a metallic coating to metal, wood, glass, or almost any material, as it is possible for a delicate fabric, such as silk, to be Mellozed without damage.

Rust Removed

All metal-work is sand-blasted before Mellozing to remove any rust or scale and to provide a suitable surface to which the metal spray can adhere. With other materials, such as wood, plaster, brick, etc., it is only necessary for the surface to be dry and free from grease.

The metal to be sprayed is first melted in a small gas-heated crucible, from which the container of the pistol is filled about every twenty minutes. A Bunsen type flame under the container, the gas for which is obtained by connecting the pistol to the ordinary gas mains by means of a rubber hose, keeps the metal in a molten condition whilst spraying. The pistol is also connected by a rubber hose to a compressed air supply of 60/75 lb. per square inch, and when the molten metal flows to the nozzle, it meets the preheated compressed air, which very finely atomises it so that minute particles of metal are blown at a tremendous velocity against the surface to be covered and adhere firmly, forming a continuous metallic coating with a fine matt finish, which is decorative in itself, and an ideal base for paint. The thickness of this coating is approximately ·004 in., and the speed of application 8 to 10 sq. ft. per minute, but this coating can be increased to any desired thickness by allowing the pistol to travel at a slower rate across the surface to be Mellozed.



Details of the pistol used for Mellozing.

Owing to the comparatively low temperature of the metal spray when deposited on the surface to be Mellozed, it is possible to treat glass, wood, cloth, and inflammable goods with safety.

One of the largest wireless valve manufacturers in the country has been using Mellozing pistols for five years for metallising the outer glass bulb of wireless valves, and has found the process very successful. Other branches of the radio trade have found Mellozing useful for giving a metallic coating to wood panels for screening purposes, and for the manufacture of radio chassis from metal-sprayed plywood.

For the protection of iron and steel from corrosion by spraying with a coat of corrosion-resistant metal, such as zinc or tin, the Mellozing pistol is unequalled, and at a comparatively low cost, iron and steel products may be made impervious to corrosion.

More industries are becoming aware of the possibilities of the process for protective and decorative purposes.

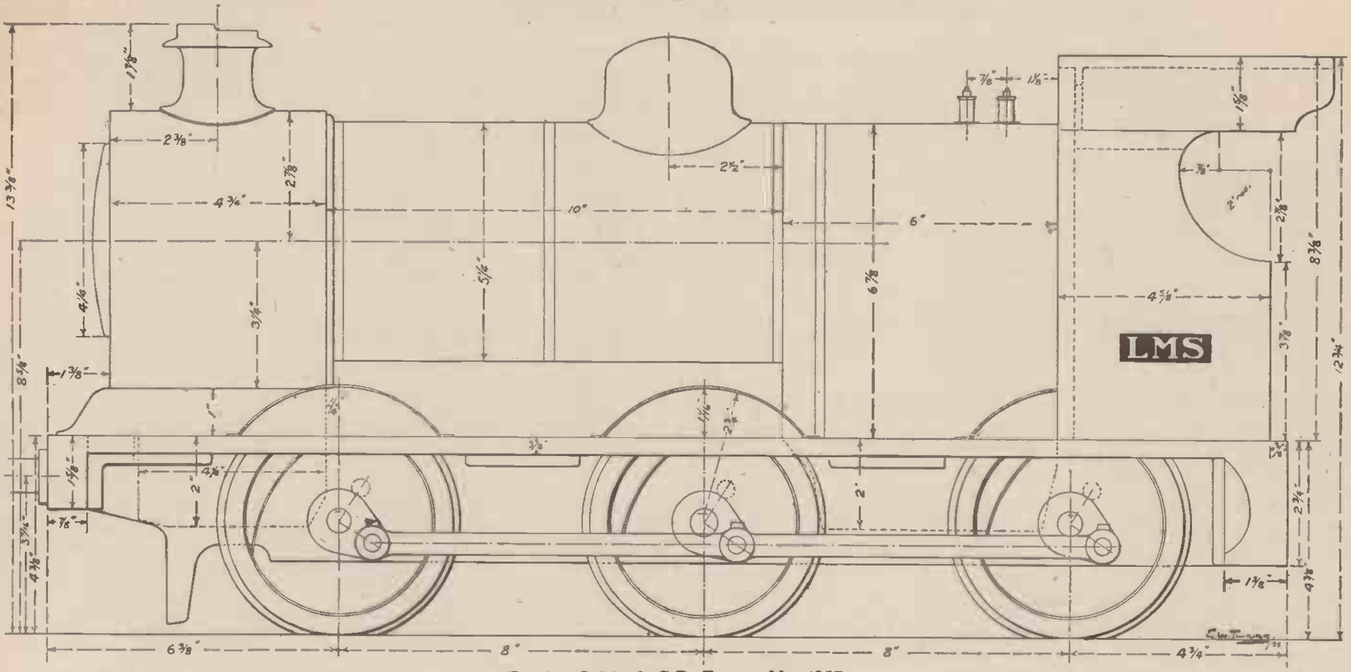


Fig. 1.—L.M. & S.R. Engine, No. 4357.

A Model Electric Garden Railway

By E. W. TWINING

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FROM time to time, articles on garden railway plants operated by manual power, and also by steam locomotives, have appeared in these pages. The first is, of course, a very simple system; cheap, but somewhat tiring for the person working the engine, which is driven by a handle moved by the hand of the driver and linked to a single-throw cranked axle on which the driving wheels are mounted. The second, where steam locomotives are employed, is generally too complicated for children to work unassisted, and, therefore, an electric scheme is described below which any person of average intelligence can work without supervision.

Current from Mains

As the current supply will be taken from the ordinary house electric light mains, the whole system must be foolproof, and be capable of being handled without risk of shock. As most readers know, the usual method of transmitting current to the motor of the engine and returning it to the source of supply, is by making the running rails, that is to say, the rails on which the locomotive and rolling stock travel, carry the return current to the battery whilst the outgoing current is passed through a conductor rail on which a brush (carried by the engine) rubs. One side of the motor is connected to this brush and the other to some part of the frame of the engine, which, of course, is in contact with the wheels, and they in turn are contacting with the rails. Now, if 220-volt mains current were used to drive the motor, such an arrangement would be extremely dangerous, as the person operating the engine may receive a severe shock by touching one or other of the conductors whilst his feet are earthed.

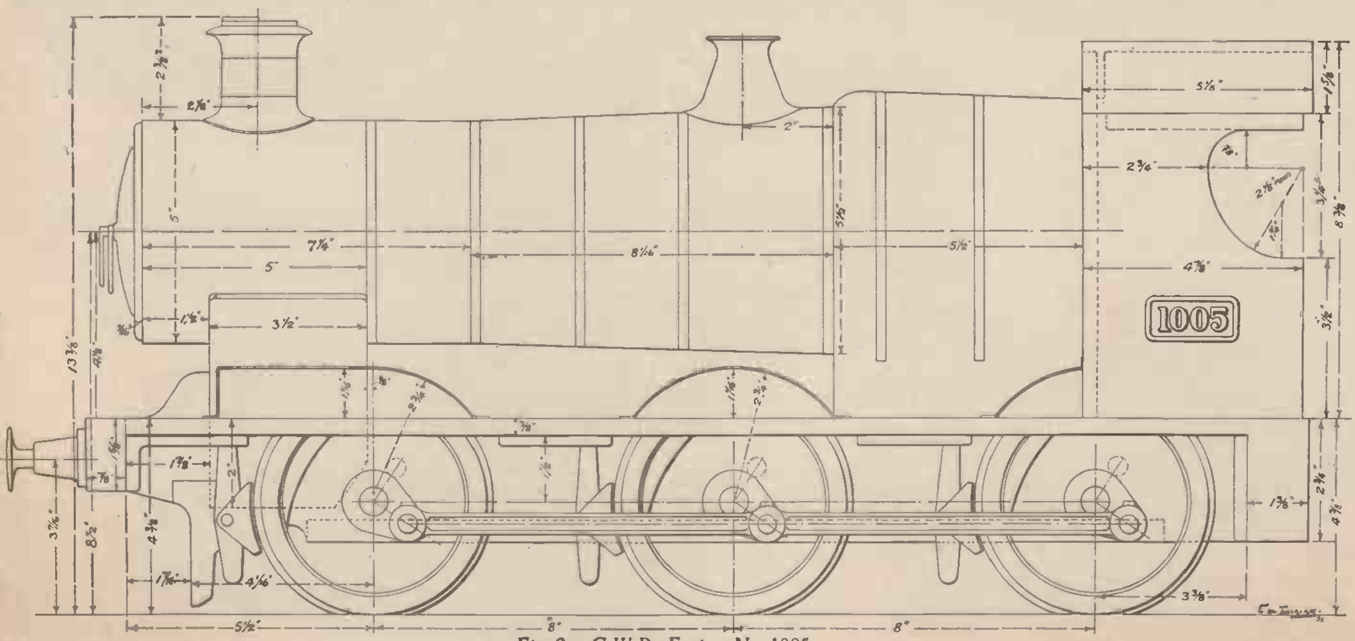


Fig. 2.—G.W.R. Engine, No. 1005.

Protected Conductor Rails

The obvious thing to do, in order to render the system safe, is to avoid passing current through the running rails, but to run two conductors, provide two brushes on the engine, and to cover the conductors in such a manner that they cannot be touched by hand.

The layout of the motor and the necessary gearing in the engine is shown in the illustrations.

For all-round purposes no scale is more suitable for carrying passengers than 1 in. to 1 ft., which gives a gauge between rails of approximately 4¾ in. Of course, if a more powerful locomotive were built we might very well go to 1½ in. to 1 ft. and a gauge of 7¼ in., but the 1-in. scale is the smallest which can conveniently be adopted: the width of rail is sufficient for stability. On narrower gauges the trucks are liable to overturn because passengers do not realise the necessity for sitting centrally on the truck and balancing themselves.

Engine Prototype

Although it may not be universally popular amongst model-makers, the 6-coupled goods engine is one of the most simple types which can be adopted. It has the smallest number of wheels which can be fitted to a main-line engine, the whole weight of the engine is available for adhesion and, if painted in proper colours, has a very good appearance. In Figs. 1 and 2 are shown elevation drawings of London Midland & Scottish and Great Western 6-coupled locomotives.

Of course some of the railway groups paint all their goods engines black, but it is suggested that the prototype be departed from in this matter of colour. I would certainly paint the London Midland & Scottish engine the usual passenger colour, crimson red. The Great Western will, of course, be middle Brunswick green, the London & North Eastern also Brunswick green of a slightly lighter shade, and the Southern the well-known olive green.

The Electric Motor

Coming now to the motive power, in Fig. 3 is shown a general arrangement of the mechanism in the after part of the locomotive. The motor is, as will be seen, supported in the firebox and back part of the boiler barrel. The particular motor illustrated is the Klaxon type EKU-SWR. These machines are made integral with a gearbox, and this gearbox carries the motor. The particular type, bearing the code letters mentioned, is made with quite a large number of gear ratios in the gearbox, and the ratio selected is that bearing the number 20119, which number is part of the code reference. The output speed of the shaft, projecting from the gearbox, is 160 r.p.m.

Intermediate Gearing

It is perhaps unfortunate that it is not possible to drive direct from this shaft down to one of the axles. There is not room, as will be seen from the cross-section on the right-hand side of Fig. 3, to pass a chain straight down over the side of the gearbox so that it will come between the frames carrying the driving wheels; so it is necessary to introduce an intermediate shaft. The method of transmitting the power is through the medium of bicycle sprocket wheels and bicycle ½-in. pitch roller chains. There will be on the gearbox shaft two sprockets of 14 teeth each, and on the intermediate shaft two sprockets of 17 teeth, these driven from the motor. From the intermediate shaft only a single chain is carried down to the rear coupled wheels, and here there will be no gear reduction; both the sprockets on the shaft and on the axle will have 17 teeth.

For fixing all these sprockets, a special fitting will have to be made for each, since, when the sprockets are purchased, they will be found to have a screwed hole through them of approximately 1⅜ in. in diameter. Steel bosses will have to be made and screw-cut for mounting the sprockets, the inner bore of the diameter of the boss being equal to the diameters of the shafts on which they are required to fit. To prevent the sprocket from unscrewing from the boss a keep ring is turned and secured by about six cheese-headed screws. The arrangement of these bosses may be seen in the cross-section on the right-hand side of Fig. 3. The bosses are secured to their shafts by tapered steel pins.

Materials for Engine Construction

With the exception of the driving wheels, their axles, and the coupling rods, the rest of the engine can be made of wood, but if wooden frames are made, metal bearings are necessary for the axles, but it is strongly recommended that the frames of the engine be made of metal.

The little Klaxon motor is not sufficiently heavy to drive the engine and a truck carrying one child passenger at a greater speed than 2 miles per hour. It is upon this rate of travel that the gear ratio of 160 r.p.m. in the gearbox and the chain reduction to the wheels has been calculated. These latter will make 134 r.p.m., which will result in the rate of travel mentioned with driving wheels of 5-in. diameter. If higher speeds are required, then some other and larger motor would have to be adopted, introducing perhaps an Opperman gear. By increasing the size and scale of the engine and railway to 1½ in. to 1 ft. it would be possible to fit a ½-h.p. motor, which would be capable of hauling three or four passengers at a speed of perhaps 6 m.p.h.

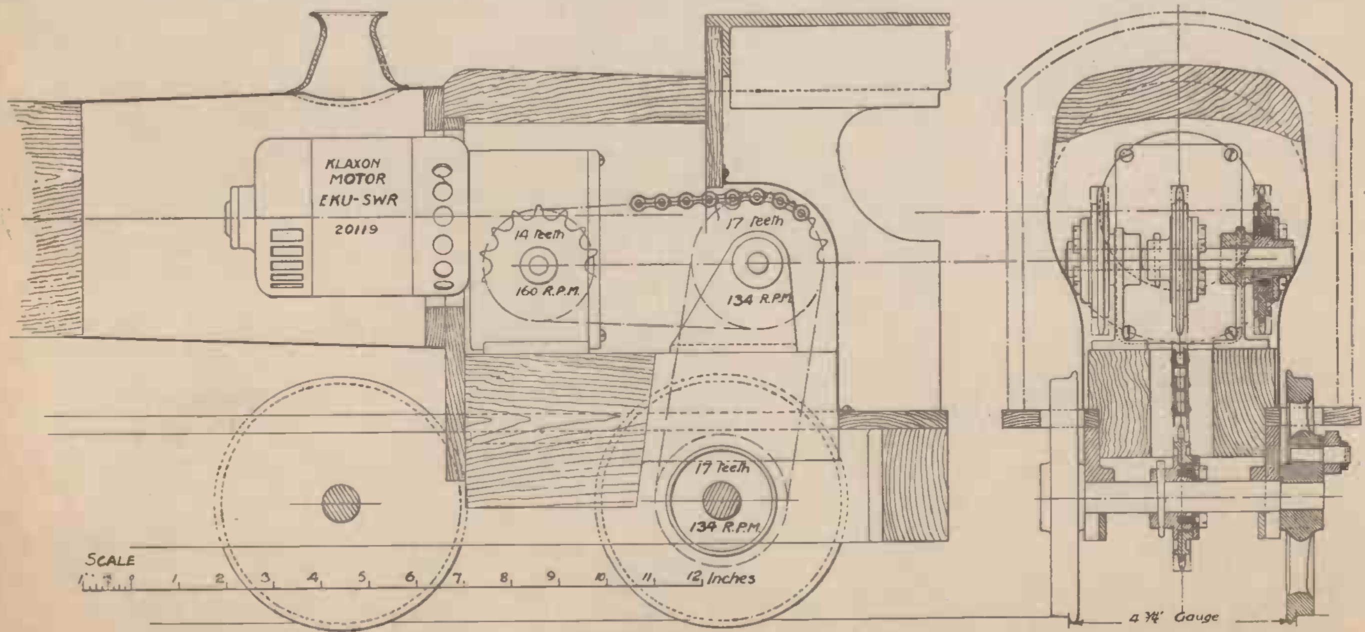


Fig. 3.—The arrangement of the motor and gearing.

(Left) The Floating Harbour, Bristol, and (right) the earliest harbours were like this. Hamble, to-day, is the same as when the Saxons landed.

Havens of the Sea

The Evolution of Docks and Harbours forms the Subject of this Interesting Article. It is Easy to Trace the History of Harbours in our Own Country and we Find that the First Docks of which we Have any Record are the Saxon Hithes on the Thames

WATER transport is the oldest and still the cheapest method of conveying goods or passengers for long distances, and its origin is lost in the mists of time. Probably the earliest navigators tried out their crude craft on such inland waters as lakes and rivers, and it may not have been till centuries later that some forgotten hero first ventured far out on the stormy ocean. When once sea voyages had commenced, however, men soon learned that this form of travel was impossible without safe harbours. A harbour is defined as a sheltered area of water where ships can lie safely, and most of the world's greatest harbours have been naturally formed, and demand but little artificial aid to make them safe. No doubt the first natural havens were estuarine, i.e. situated at the mouths of rivers, since such a position offered the advantage of sheltered water, whilst the upper reaches of the river afforded a natural highway for small craft to penetrate far inland. Such advantages have caused the building, and have fostered the growth, of many of the world's chief cities; indeed, the two greatest cities the world has ever known—London and New York—are both situated at or near the mouth of a great river, and the same applies to a large number of the world's chief ports, and especially to Rotterdam, Antwerp, Hamburg, Bremen, Liverpool, Bristol, Hull, Glasgow, Southampton, Le Havre, Bordeaux, Lisbon, Oporto, Montreal, Quebec Toronto, and many others.

The Bay of San Francisco

There is another important type of natural harbour, consisting of a sheltered bay of deep water, having a narrow entrance. The finest of such in the world is that of Sydney (Australia), which boasts an internal shore line of 188 miles, and the splendid bay of San Francisco has 420 square miles of sheltered water. Greater New York Harbour has 150 square miles of sheltered water outside the actual river area, i.e. beyond the East and Hudson Rivers. Portsmouth, Hong Kong, and Rio de Janeiro are all examples of splendid natural harbours. A third group of harbours are those possessing natural shelter, but which are dangerous in certain directions of the wind, and these have been made safe by artificial breakwaters; well-known examples of this type are Plymouth, Table Bay, Marseilles, and Cherbourg. Finally we come to harbours which are *wholly*

(Right) The entrance to the Floating Harbour at Bristol, which is more than 4 miles long, and supplies deep water at every wharf throughout the city.

(Left) An aerial view of a picturesque harbour, the Golden Horn, Istamboul.

artificial, such as Madras, Panama, Las Palmas, and Zeebrugge of immortal memory.

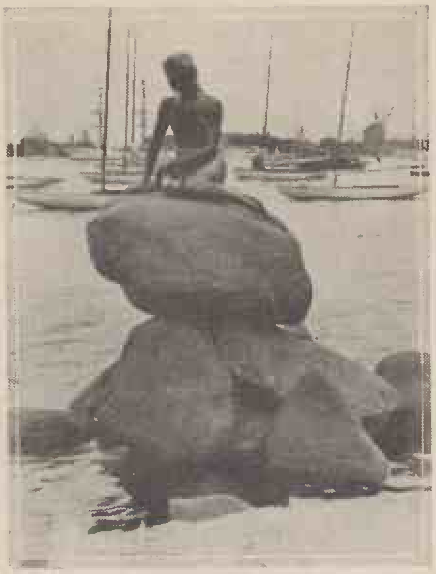
The engineers designing a wholly artificial harbour have many difficult problems to consider in planning their enterprise. Soundings are taken to ascertain the depth of the surrounding sea and the slope of the sea bed. Certain mountainous islands cannot have a harbour because the sea is too deep at the shore, as for example, Madeira.

The engineers must also search for rocks or shoals which can serve as a foundation for breakwaters, and for headlands which can give some natural shelter. The tidal drift must be carefully studied, or the new harbour may be silted up before it is even finished, and the size and direction of waves must be fully observed. When there are two breakwaters, one usually overlaps the other so as to give protection to ships passing the harbour entrance. This entrance must be narrow so that the inner part of the harbour is well sheltered, but not so narrow that it is dangerous to enter in stormy weather. The wreck of the S.S. *Berlin*, some years ago, is an example of the risks of entering a narrow opening between two breakwaters when a violent storm is raging.

Crude Havens

The earliest sea Powers were Crete, Tyre, and Carthage, and it is likely that the first named constructed some crude havens as long as 6,000 years ago, and we know that the splendid city of Carthage had a magnificent harbour many centures before Christ. It was founded 850 B.C. Turner has painted Dido's fleet at anchor in a marble basin of old Carthage, and the haven was a wonder of the ancient world until its destruction by the Romans about 146 B.C. To-day only the partly-filled-up and ruined harbour remains, and shipping has left Carthage and now ties up at Tunis. The harbour of Tyre was also ruined by enemy action, and the oldest ports which are still in use are Ostia, Taranto, and Brindisi, all of which were employed during the Roman Empire, while the first mentioned is said to date from the seventh century B.C., though now but a shadow of its former importance.

It is easy to trace harbour history in our own country. London, Southampton, and Portsmouth still stand on, or near, the place where Roman galleys anchored 2,000 years ago, but no trace of the Roman harbour works remain. The first *docks* of which we have any record are the Saxon hithes on the Thames, whose name lingers in such places as Rother*hithe*. A hithe was a cut in the bank of a river to admit a ship, the sides of which were held up by stakes and brushwood. It had the advantage that carts could come close up to the ship's side, and the vessel was not separated from hard ground by an expanse of soft mud. We see the importance of *hard* ground in the earliest name for a port—the Hard—as at Gosport. A modern dock resembles a hithe, but is far bigger and is constructed of concrete instead of wood.



Part of the harbour and Hans Aandersen mermaid, Copenhagen.

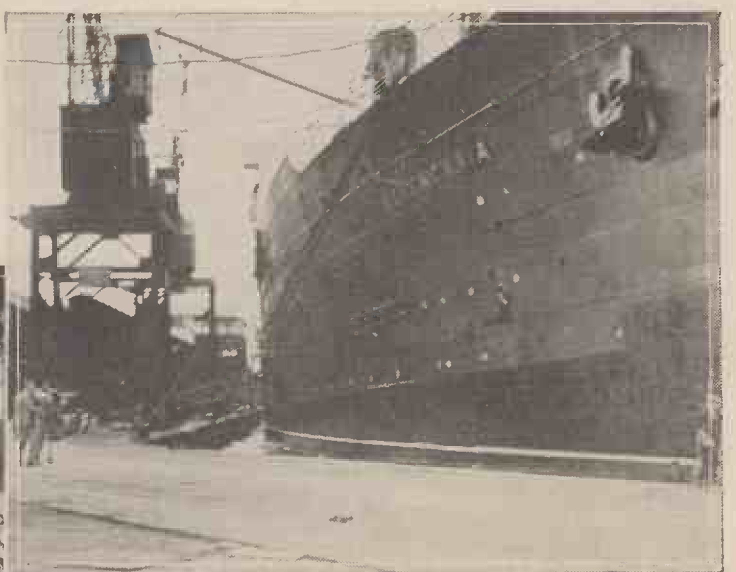
Wet and Dry Docks

There are two kinds of dock, the wet and the dry. The first is full of water and enables the ship to tie up alongside, and the second is used when it is necessary to work upon the ship's hull. The vessel enters when the dock is full of water; the gates are then closed and the water is pumped out, leaving the ship high and dry. Dry docks are of two kinds, *Floating* and *Graving*, and the wonderful port of Southampton boasts the largest of each kind in the world. The floating dock is built of steel, with huge tanks below the floor of the dock proper. When not in use the whole structure floats with the inner floor above the level of the water outside; but when a ship is to be admitted the dock must sink low enough to admit her. This is done by admitting water into the tanks, and when the ship has entered, they are pumped out, and the dock rises to the surface holding the ship high and dry. The advantage of the floating dock are twofold: firstly, it is *mobile*, and so can be transferred elsewhere if no longer required in Southampton, and, secondly, being mainly built of steel, the work of building it helped our two most depressed industries—coal and steel. This advantage was clearly shown in the case of the Singapore floating dock, which was made by British labour, whereas a graving dock would merely have employed cheap Asiatic labour to our own disadvantage.

A Stupendous Dock

The King George V Graving Dock at Southampton (opened in 1933) is simply stupendous. Its length is 1,200 ft., width 135 ft., depth 59 ft., and its construction required 750,000 tons of concrete. The floor of the dock is 25 ft. thick; this is necessary, not only to sustain the enormous weight of a 100,000-*ton ship*, but also to prevent the water pushing through from outside. The dock holds 58,000,000 gallons of water when full, and can be pumped dry in four hours. It is the only dry dock in the world which can hold the *Queen Mary*, which is only 75,000 tons, and it will take ships of 100,000 tons, if and when they are built.

Of British ports, only two (London and Liverpool) exceed Southampton in tonnage, but these figures are made up chiefly of small cargo boats, and no European port can approach Southampton's record for the number of big liners it accommodates, and only New York in the whole world can exceed these figures. Even Manhattan Island—wonderful as it is—is beaten by our



(Right) The town of Southampton has developed into our finest port, and can accommodate the world's greatest ships. The illustration shows the "Berengaria" at Southampton.

(Left) A classical harbour; entrance to the Hyllaen port at Corfu, where Ulysses was wrecked (Canone, Corfu).

Hampshire port in the matter of tides, for Southampton has four tides in twenty-four hours, instead of two. This is due to the shape and position of the Isle of Wight at the end of Southampton Water, which causes each high tide to last for two hours. This advantage, and the small rise on spring tides of 13 ft. only, means that the port can accommodate the world's biggest ships at all states of the tides, an enormous advantage.

Where the difference between high and low tide is very great (as at Bristol, where it is about 40 ft.) serious difficulties arise, and they become greater when bigger ships are built. Not only are vessels unable to enter or leave the docks at low tide, but they cannot float alongside the wharf, and fall over on the mud. This does not matter with small ships, but may cause serious damage to the hull of a large vessel, or injury to the cargo by shifting. The ancient port of Bristol has very cleverly overcome this by the idea of a "*Floating Harbour.*" The channel of the River Avon, which passes through the city, is deep and winding, and, at low tide, almost empty. This caused much damage through flooding in wet seasons when the river was high, and as early as 1239 a new channel was cut to short-circuit the bends—it was 18 ft. deep and 120 ft. wide. Since then the winding main stream has been closed by huge gates at Hotwells—just below Clifton Bridge—so that the water can be kept at top level all day and ships can ride alongside. A lock permits entry or egress at all times when there is enough water outside. This floating harbour is more than four miles in length, and gives deep water at every wharf throughout the city.

A Floating Landing Stage

Liverpool boasts a remarkable floating landing stage, 2,643 ft. long, by which passengers can enter and leave great liners at almost all states of the tide. It rests on 200 iron pontoons, and is connected with the shore by 8 hinged bridges. Big liners start from the north end and ferry or pleasure steamers from the other end, so it sometimes happens that careless passengers for the Isle of Man find themselves en route for New York or Sydney! Such incidents have actually occurred!

Although by no means our greatest port, the City of Glasgow deserves mention for the enterprise by which it has overcome natural difficulties. A little over half a century ago, the Clyde near the city was only 180 ft. wide and 3 ft. deep, but since then by continual dredging it has become 500 ft. wide, and is deep enough to permit the *Queen Mary* to sail out when she is completed.

Modern docks are very rich in up-to-date machinery, dredgers, floating cranes, fire appliances, grain-suckers, and many others, but the subject is so vast that it would easily make a book by itself.

Smokeless Explosions in Coal Mines

BECAUSE large chunks of coal are more valuable than small ones, and in order to escape the fumes which hamper work and endanger life, certain coal-mining areas in America have discarded dynamite in favour of compressed-air "blasting." Specially-designed compresser-drives, motors and control devices for a new equipment built and introduced into the mining districts, have met with outstanding success. With the new equipment the coal is "pushed" out of place by air-pressure.

Absence of Fumes

The coal-dust and chips which are broken out by the dynamite are difficult to handle and they bring much lower prices on the market. With the absence of fumes, under the new method, miners can start loading coal immediately after the "shooting" and do not have to wait until the air clears. The mine level does not have to be vacated, as is the case when explosives are used.

15,000-Pounds Pressure

With the new method, a portable compresser stores up to 15,000-pounds' pressure in a long metal cartridge. The latter is inserted in a hole drilled in the face of the coal and a valve suddenly releases the air, which, in expanding, pushes out the coal in big chunks. The steel cartridges are specially designed and may be used over again. The entire operation is conducted at the coal face, and cartridges are filled in 90 seconds. Miners retreat to a distance of 100 or 150 feet during the explosion.

Blasting coal with a compressed-air cartridge.

Facts About Electroplating

ELECTROPLATING to-day is an almost perfect science and has wide application in both the decorative and the useful arts.

The art of making a bond of very great mechanical strength between the plating and the underlying metal has been acquired. By scrupulous care in the precleaning of the metal the bond can actually be made stronger than the plated metal itself. Experience in the use of correct amperage, voltage, and composition of the plating bath enables thick layers of plated metal to be built up, and it is an accepted engineering practice to rebuild in this way such articles as ball-races, cylinders, pistons, big-ends, crank shafts, and gudgeon pins which otherwise would have to be scrapped. Nickel is the plating metal used in such cases. As pure nickel is of extreme hardness, the repair often provides a better wearing job than the original.

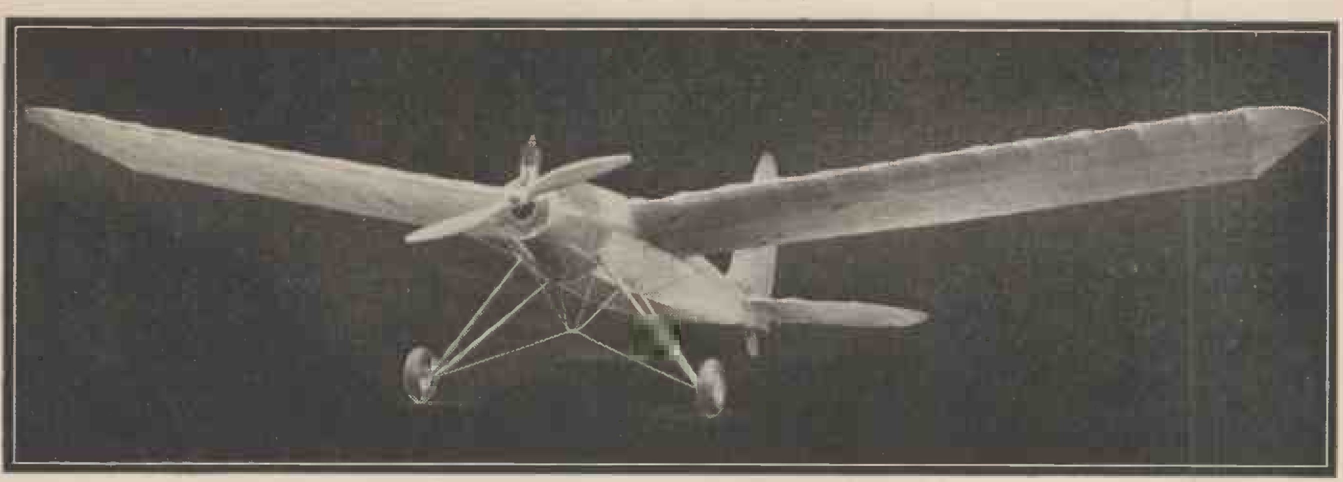
Protective coatings for steel are not confined to nickel and chromium. Zinc, tin, cadmium are extensively used as platinum metals. Cadmium, a silvery metal very like zinc in properties, is used by wireless manufacturers to give the silvery finish to the chassis of wireless sets. The Post Office uses zinc to plate the steel parts inside telephone systems. Tin-plate manufacturers find that a pre-treatment with tin in the electroplating bath improves the coherence of the thick coat which is afterwards put on by dipping in molten tin.

For purely decorative work ordinary silver plate is being displaced by silver plate plated over with platinum or rhodium. Either of these metals have the silvery white lustre of silver, but they are untarnishable. A final thin plating of electroplated nickel silver with rhodium therefore gives the job a permanent polish.

A material of very definite value in architectural decorative schemes is anodised aluminium. It provides a material for highly-polished metallic surfaces capable of taking lustrous coloured finishes. If aluminium is made the anode in a bath of sulphuric acid it acquires a thin hard coat of aluminium oxide. By using dyes in the bath the film may be given permanent shades of great iridescent beauty and made to appear exactly like coloured metal. Dyed or undyed, any degree of polishing may be applied from matt grey to bright silver. A further elaboration is provided by machining the aluminium before treatment. Aluminium oxide is the hard material of corundum, the ruby and sapphires. Its extreme durability as a surfacing can therefore be well understood.

Aluminium itself is originally made by electro-deposition from its fused salts.

A Petrol-driven Model Monoplane



The completed model—the first concerning which detailed designs and full-size blueprints have been published.

Final Details of this Fine Flying Model

By F. J. Camm.

AS mentioned last month, I loaned the model shown in the photograph above to the Model Engineer Exhibition, and I have not had an opportunity of photographing the model in flight since then. It is difficult to launch a petrol-driven model and then to endeavour to pick hold of a camera and photograph it. I have made arrangements, however, for the services of a photographer on the next fine week-end.

The Ignition Circuit

I HAVE received dozens of letters from readers who are building it, and one or two of them have asked for details of the ignition circuit. This I have pleasure in giving this month in the diagram on page 110. It will be seen that one lead from the coil goes to the sparking plug, one primary lead being connected to one lead of a fixed condenser, and then earthed to any convenient point on the engine cradle. The other side of the condenser passes to the insulated contact breaker and the two leads to the battery and switch are led off as shown. This arrangement is far better than that normally adopted where the accumulator is left in circuit, and in parallel with the dry cell when the switch is thrown over. In my arrangement the accumulator is cut out and the dry cell cut in instantaneously, since the switch is of the quick make-and-break type. I would repeat that the full-size blueprints listed on this page will facilitate construction. The supply is limited, and is running short. The positions of the wings shown on the blue prints are very approximately correct, and only a slight movement of the dry cell is necessary in order to make the centre of gravity coincide with the centre of pressure. I have found that the thrust line is ideal, although in some cases it may be desirable to bend the tail flaps up to improve longitudinal stability. A negative angle on the whole tail also improves stability, and this can be arranged by adjusting the tube fixed to the rear of the tail before soldering it.

The size of the model can be estimated from this photograph.

Inverted Engines

A LOT of readers have written to me asking whether it would be advisable to invert the engine, as is sometimes done. My answer to this is an emphatic No! It serves no purpose whatever to do so, and merely provides one of the humorous aspects of model aeroplaning. It places the cylinder in its most vulnerable position, and it enables oil to drain down on to the plug, thus giving rise to misfiring and other ignition troubles. It does not lower the centre of gravity of the machine at all, and I have failed to discover any sound reason for placing the engine in any other than the correct position. Another disadvantage is that you will put yourself to a considerable amount of trouble inverting the carburetter and tank arrangements.

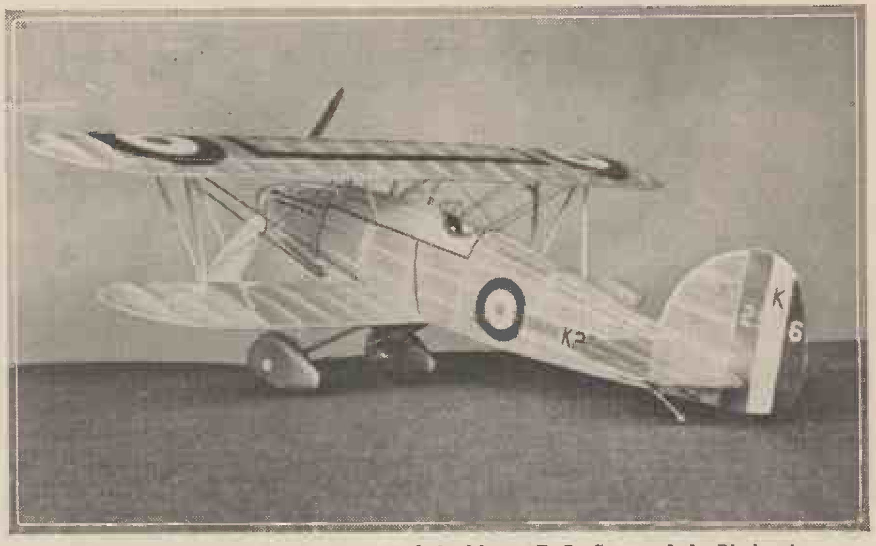
A Starting Tip

I HAVE found that the engine will start at the first swing every time by injecting a few drops of petroil (one part of oil to eight of petrol) in the induction pipe, and opening the jet about 2¼ turns. Allow the engine to run for about five seconds in this way and then gradually close it down until it fires evenly and is two-stroking properly. The note of the engine will rise as the jet is closed. The correct setting is somewhere round about one full turn.

I omitted to mention in my previous article that the hinges securing the transverse chassis numbers to bulkheads *D* and *F* are bolted through blocks of wood glued behind each bulkhead for that purpose. The three-ply bulkheads alone would not be sufficiently strong.

Model Aircraft at the Model Engineer Exhibition

I SHOULD like to congratulate my old friend, Percival Marshall, on the success of this year's Model Engineer Exhibition. He is doing work of national importance in encouraging interest in mechanics, and he may truly regard himself as the high priest of the model and small-power engineering world. Quite frankly I was disappointed with the model aircraft exhibits, particularly with the petrol-driven models shown. Quite obviously most of them had been built as units without any consideration for the complete design. Nearly all of them were built on the unit principle, the designers having first built a fuselage before considering how the chassis and wings were to be attached. The wings had then been built before the fittings for them had been designed, the general result in most cases being a clumsy-looking square-section fuselage to which wings, tail, and engine were attached as obvious afterthoughts. The Club Exhibits were definitely poor in design and in workmanship, and with only one notable exception could I award any marks for ingenuity. Pins and glue were used where small fittings should be made, and too much reliance was placed upon the covering and the dope tastefully to camouflage careless and unskilled work. There was too much decoration on them, some amateurs apparently being unable to leave the paint-brush alone once they get to work. The lines in general were disproportionate, and many of the models were not up to exhibition standard. If I may make a suggestion in all sincerity, it is that in future exhibitions the organisers have a Selection Committee and ruthlessly reject models not up to exhibition standard and which only encourage derisive remarks from members of the public who do not appreciate the patience, lack of equipment, and probably lack of skill of those who make them.



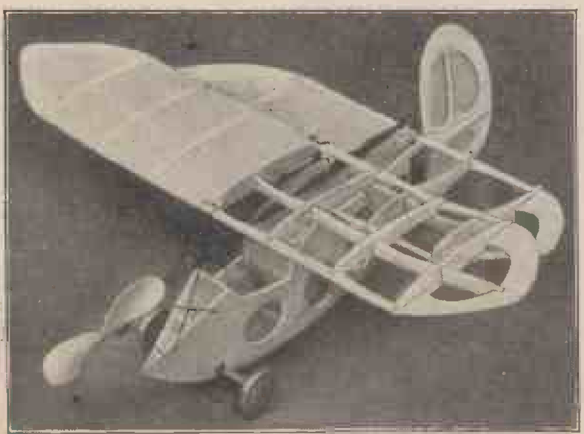
A fine model of the Hawker Fury, made by Messrs. F. P. Sweeten Ltd., Blackpool.

Encourage Model Makers

IT is, of course, a nice thought to encourage model makers who are less fortunate than others in these respects, but after all an exhibition is intended for the public and as such should be designed to advance its traditions. These remarks apply strictly to the Model Aircraft Section. In the other sections one could but admire the remarkably high standard of workmanship, ingenuity, originality, and finish displayed in the model locomotives, boats, stationary engines, machine tools, and the almost unlimited variety of models on view. I hope that the influence of what I may call the Model Engineering Section of the exhibition will inspire aircraft modellers to depart from the thread, pins, and glue methods, the parts being held together more or less by unskilled methods, of which faith and hope form the strongest part.

An interesting exhibit was that representing the joint efforts of Mr. H. H. Groves and Mr. Trevithick—a small steam-driven model, powered by a flash steam plant. When I saw this model at Fairey's Great West Aerodrome it failed to make a flight, and part of the fabric was burned away from the fuselage. Quite obviously the power plant needed to be enshrouded with aluminium, an improvement which has since been effected.

It is to be regretted that the Model Aircraft exhibits were not more representative of the provinces; the same old names with the same old designs keep cropping up year after year, the idea apparently being that if they alter the shape of the wing they have produced a new "design." Some do not apparently know the difference between designing and copying, alas! I make these passing comments from an unbiased and disinterested point of view, feeling that an exhibition of model aircraft should not be parochial in its character and embrace only the work of local London clubs.



Showing the assembled model of the "Flying Flea" with half the skeleton framework covered.

The old London Aero Model Association was the precursor of the S.M.A.E. and it was at my suggestion at one of their meetings in Great Windmill Street, Piccadilly, some years ago that they approached the R.Ae.C. for recognition as the body to govern the hobby of model aeronautics in a national way, and in succession to the old K.M.A.A. They have done very little to advance the call outside of London, and I suggest that the Royal Aero Club might usefully look into this situation, particularly as so many well-known people have donated cups for *National* competition.

Competitions

MANY readers write to me asking whether it is advisable to enter the model aeroplane competitions held during the summer. My advice to them is that if they are pure amateurs they will be competing against professional model makers and as such start off with a heavy handicap. I suggest that the S.M.A.E. while it is the controlling body should rigidly exclude all models made by professional model makers and confine competitions strictly to amateurs. It should not be permitted, moreover, for one competitor to enter two models merely by placing one of them in the hands of a nominee. At present there is little to stop a competitor so minded from doing this.

Flying Scale Models

MR. F. P. SWEETEN, of 38 Bank Hey Street, Blackpool, has sent me his catalogue of realistic flying scale models. The Hawker Fury kit costs 6*s.* 6*d.* complete, with a full-size plan and all material. Other kits include the Curtiss Goshawk, the Boeing, the Pursuit, the Douglas Observation, the Curtiss Falcon, the Curtiss Swift. There is an easy-to-build series, and a complete range of material. The well-illustrated catalogue is free to readers.

Model of the "Flying Flea"

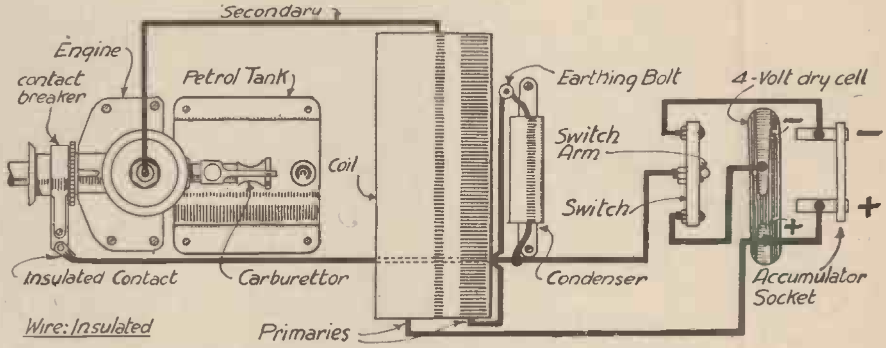
A MOST interesting model of the "Flying Flea" has been produced in kit form by Messrs. Williams, Ellis & Co. The complete kit costs 3*s.* 6*d.*, and it flies when correctly assembled. All parts are ready-made and finished, and the price includes a plan and full instructions.

Air-minded Modellers

HERE is something to interest all air-minded readers who are clever with their hands. The Skybird League have offered to co-operate with Skybird agents throughout the United Kingdom to run a

Local Competition open to all, for the best assembled Skybird Model Aeroplanes. Competitors may enter one or more models, the only stipulation being, the purchase of the materials from the local agent. Five hundred Skybird Airports, value one guinea, 500 books value 5*s.*, and other prizes, together with Certificates of Merit, have been reserved for this competition.

The competition closes on October 31st—get in touch with the nearest Skybird agent at once for full particulars of this splendid opportunity.



Details of the ignition circuit of the petrol-driven model monoplane.

There are now 325 clubs registered in the Skybird League and many hundreds of associate members. The movement provides a most instructive and interesting hobby, the value of which is demonstrated by the success of the League, and the number of well-known people connected with aviation who have interested themselves in its welfare. Sir Harry Brittain, K.B.E., C.M.G., LL.D., is president of the League, and Squadron-Leader Burge, O.B.E., vice-president. The list of honorary members includes such well-known names as Capt. G. de Havilland, Capt. H. Broad, Mr. K. Waller, Mr. C. W. Scott, Mr. Cathcart Jones, Capt. W. E. Johns (Editor of *Popular Flying*), Lieut. Ira Jones (author of *King of Air Fighters*), and many others.

Congratulations!

I HAVE received the following letter from W. Rigby: "May I remark that I think your petrol job at the Model Engineer Exhibition a very fine job indeed, certainly one of the best looking on show."

Suggestions Wanted

I SHALL be glad to hear from readers as to the type of model they would like me to design and make next. Do you want another petrol model? A duration monoplane or biplane? Do you prefer a fuselage or pusher machine? Are you interested in compressed-air models? I should appreciate a post card from you. You will recollect that I promised to design and build a Canard petrol-driven model, but deferred it owing to requests from many readers for a design such as that just completed. If you are not building the present design and are waiting for the Canard machine, write and let me know.

Two Useful Handbooks

FRESH impressions of my two books *Model Aeroplanes and Airships* and *Power-Driven Model Aircraft* (obtainable from us for 1*s.* 2*d.* each by post) are now available. The first contains chapters on materials for model aeroplanes, how an aeroplane flies, methods of construction and design, construction of model airscrews, designs for tractor monoplanes and biplanes, a fuselage monoplane, a tail-less monoplane, model helicopters and ornithopters, spar machines, gliders, flying model aeroplanes, building airships, kites, full-size gliding, etc.; whilst the second volume deals with the commercial petrol engines, how to make petrol, steam and compressed-air engines, ignition systems and carburetters, compressed-air models, steam-driven models, petrol-engine models, and wheels.

MATERIALS FOR THE FLYING FLEA

THOSE readers who are building the "Flying Flea" should remember that advertisers in this journal are supplying the correct material at specially low prices. The Luton Aircraft Co., Ltd., who are designers and constructors of aircraft at Luton Aerodrome, Barton, Bedfordshire, supply the complete set of materials as listed on page 7 of our October issue for the sum of £25. The material is specially selected. This company is, of course, proprietors of the well-known Dunstable Sailplane Company.

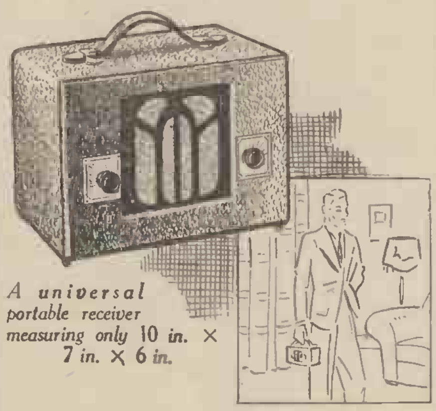
The Luton Aircraft Co., Ltd., will supply the "Flying Flea" complete with a Scott 34-h.p. Aero Engine and ready to fly for £170 10*s.* The aeroplane complete, but less engine and airscrew, costs £110; the front mainplane, complete with tank fitting and covered with dope, for £29; the rear mainplane complete for £19; the fuselage, complete with fitting, for £23; the rudder, complete covered and doped, £3 18*s.* 6*d.*; the chassis, complete with wheels and tyres, £6 5*s.*; tail chassis, complete with special wheels, £3 12*s.* 6*d.*; the Scott Aero Engine, £50; the airscrew hub, £4; and the airscrew £7 10*s.* They issue a price list of all the other parts which will be supplied separately or *in toto.*

The LATEST Novelties

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

All-mains Portable Radio

MEASURING only 10 in. × 7 in. × 6 in., and weighing approximately 8 lb., this efficient little receiver may be used wherever electric mains are available. It employs five valves (one of which is a ballast resistor) and operates on either A.C. or D.C. mains of 100 to 250 volts. A 5-in. moving-coil speaker is incorporated and two wavebands are covered; the medium from 200 to 550 metres and the long from 1,000 to 2,000 metres. Strong plywood cases, covered in washable fabric, are available in black, brown, blue, green, red, and tan. The price of the instrument complete is £3 15*s.* carriage paid. **[153.]**



A universal portable receiver measuring only 10 in. × 7 in. × 6 in.

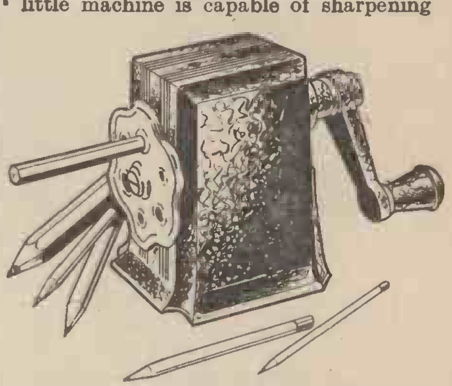
A Lightning Stamp Affixer

CAPABLE of stamping 150 letters per minute, this amazing little machine is operated by a single stroke of the plunger. It picks up, moistens, severs, attaches, and counts the stamps and is so accurately constructed that it never cuts the stamps. The model illustrated costs 4½ gns., and is heavily nickelled, with a coloured bakelite handle. A lighter model, with an aluminium case, is available at a guinea less, whilst either model is available without the enumerator at a reduction of 10*s.* 6*d.* **[154.]**

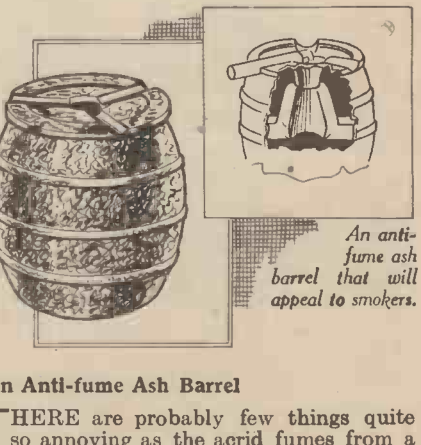
This ingenious device will affix stamps to envelopes at the rate of 150 letters per minute.

A Universal Pencil Sharpener

FITTED with solid steel twin cutters, this little machine is capable of sharpening pencils of any diameter. The disc, shown in the illustration, is rotated until the required hole is at the top, the pencil is then inserted, sharpened by turning the handle, and a flush-fitting drawer at the base of the sharpener catches the trimmings. The attractive marbelite casing is obtainable in walnut, rosewood, mahogany, or black, and the price is 12*s.* 9*d.* post free. A special clamp is supplied for 1*s.* 6*d.* extra. **[155.]**



A pencil sharpener that can be adjusted to take pencils of all sizes.



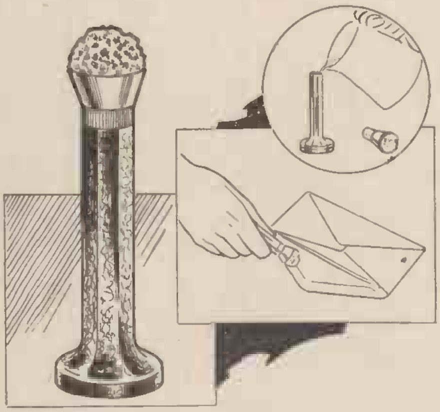
An anti-fume ash barrel that will appeal to smokers.

An Anti-fume Ash Barrel

THERE are probably few things quite so annoying as the acrid fumes from a partly extinguished cigarette. The ash container, sketched on this page, is especially designed to overcome this nuisance, as once the cigarette has been dropped into it the fumes are trapped in the upper part of the barrel as is shown in the cut-away inset sketch. The barrel unscrews in the centre and is thus easily cleaned. Moderately priced at 1*s.* 9*d.* post free, the container may be obtained in red, mahogany, black, walnut, green, or rosewood bakelite and is practically unbreakable. **[156.]**

A Letter Damper and Sealer

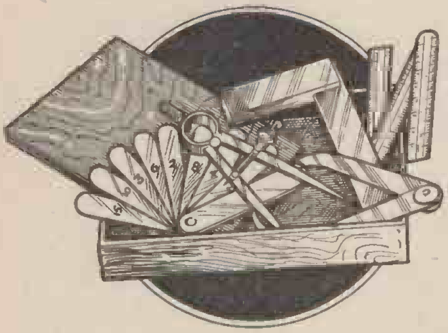
THE illustrations clearly illustrate the usefulness of this little gadget, which will be found a great time saver when a large number of letters are to be sealed. The sponge rubber damper is gripped in a nickel ferrule which prevents any possibility of breakage, and the large base of the reservoir handle forms a convenient method of sealing the envelope after damping. Supplied either in chromium-plate finish or in bakelite, they cost 1*s.* 3*d.* post free. [157.]



Details of the letter damper and sealer.

A Handy Measuring Outfit

CONVENIENTLY housed in a strong wooden box, this set of tools will be found extremely useful to every handyman, and comprises a pair of spring dividers,

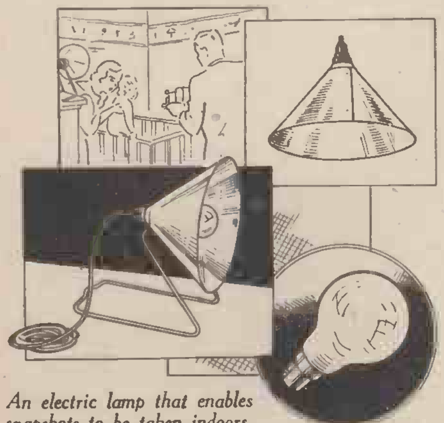


A complete measuring outfit suitable for the handyman.

outside callipers, a steel try-square, a 9-in. three-fold steel rule, and an eight-bladed set of feelers which range from ·002 in. to ·015 in. All the tools are of first-rate quality and the complete kit may be obtained for 11*s.* post paid. [158.]

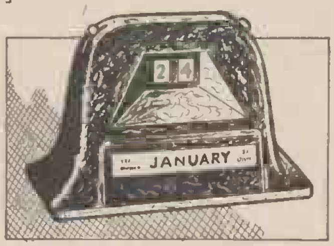
Snapshots after Dark

SIMPLE, safe, and efficient, the photographic lighting apparatus illustrated on this page enables even the amateur to take delightfully clear and natural snapshots indoors, and eliminates the risk of that



An electric lamp that enables snapshots to be taken indoors, thus dispensing with the use of flashpowder.

startled expression on the face of the sitter, which is usually associated with flash-powder photographs. The lamp, which plugs into an ordinary electric-light socket, gives an intensely brilliant and continuous light, is made to suit all standard voltages, and costs 2*s.* 6*d.* The collapsible aluminium reflector is designed to increase the efficiency of the light by four and a half times, and used in conjunction with the special wire stand enables the light to be focused in any direction. The reflector is priced at 3*s.*, and the stand at 4*s.* 6*d.* A useful outfit, comprising a reflector, stand, lamp-holder, bayonet adaptor, and 9 ft. of well-insulated flex is marketed at 7*s.* 6*d.* [158.]



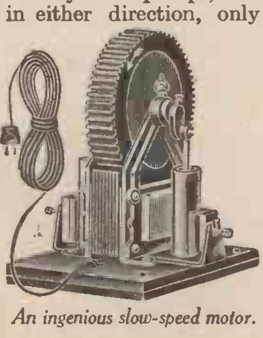
A neat and compact perpetual calendar.

A Perpetual Calendar

MADE in a variety of colours to harmonise with almost any type of desk fitting, the calendar illustrated is operated in a flash, for by simply pressing the lever at the top the dates change automatically. It has a great advantage over the "slip-in" type of calendar as no sorting and arranging is necessary. The price is 2*s.* 9*d.* post free. [159.]

Slow-Speed Synchronous Motors

A WELL-KNOWN firm has just introduced an interesting synchronous motor, which operates on quite a different principle from the orthodox fractional horse-power type, and is in fact very similar to the motor employed in a synchronous electric clock, working at a dead-beat rate of revolutions, 100 r.p.m. on 50 cycles. A motor such as this has varied applications, such as aerating water, driving models, scientific apparatus, etc., where a slow and perfectly constant speed is required. Current consumption is practically negligible, and there is no interference with wireless reception. The motors are available with one-cylinder and twin-cylinder pumps, and run equally well in either direction, only requiring the impulse of the hand to start them when switched on. They are 5¼ in. long × 4 in. wide × 6½ in. high, and as supplied are suitable for 230 volts direct off the mains without resistance. [161.]



An ingenious slow-speed motor.

A Glass Which Prevents Glare

Interesting Facts Regarding a Scientific Medium for Diffusing Light and Heat in the Home or Factory

OPPRESSIVE heat and blinding glare in summer and icy down-draughts in winter are two serious discomforts produced by ordinary window glass. The absence of a satisfactory glazing material, which transmits light without involving these discomforts, has hitherto proved a serious check to the fulfilment of modern demands for good natural lighting indoors.

After exhaustive experiments, Dr. P. Modigliani, a chemist and an acknowledged expert on glass in Italy, has discovered a satisfactory method of opposing the heat rays of the sun. He has incorporated his ideas in a special glass known as "Thermolux," now marketed in England. This material transmits sunlight without sun heat and yet provides undistorted transmission of the visible wavelengths of the spectrum, giving all colours indoors their true values. It is best described as a compound glass of a three-ply nature with smooth, brilliant surfaces. Between two sheets of glass is a central lamina consisting of numerous glass silk threads regularly arranged. This centre is porous, and, so that the air contained within may remain undisturbed, the edges are hermetically sealed.

The advantages of this porous quality are: (1) it has a very low coefficient of thermal conductivity; (2) a much lower weight than sheets of other glass of equal thickness; (3) a marked ability to absorb high-frequency sounds. The lamina of glass threads also prevents the transmission of incident heat waves by deviating and reflecting them. The thickness of the interlayer varies from 1 mm. to 3 mm., according to the purpose required. Normally white in appearance with a satin-like sheen, "Thermolux" is also available in pale or dark shades of coloured amber, blue, pink, and marbled effects. Colouring is effected by introducing special threads into the glass-silk interlayer between the two panes of glass.

Even Illumination and Uniform Heating

In a room where the windows are glazed with this glass, light diffusion is complete. Rays of sunlight are distributed instead of forming patches on the floor. As light and heat rays do not pass in or out of a room in the same way as they do with ordinary glass, great lighting economy is effected in the winter. Heat and glare are avoided in the summer; conversely heat and light are conserved in the winter. At night this glass viewed from inside an illuminated building gives the impression of finely-fluted mirrors. No curtaining is needed to ensure privacy, and it is possible to obtain artificial lighting effects closely approximating to daylight.

Previous Methods

Heat insulation is obtained in three ways: by reflection from the outer polished surfaces; by diffusion; by the opposition encountered by the three-ply construction and the interlayer of glass silk. Tests have shown that the coefficient of heat transmission is about the same as that of a brick wall.

Hitherto there were two well-known methods employed to obtain light-diffusing glass. The first consisted of altering the condition of one or both surfaces of a clear glass by grinding, sand-blasting, acid treatment, or by impressing a rough pattern on the glass during manufacture prior to cooling. In the second method, opaqueness was obtained by a suitable adjustment of the working and melting temperatures, the glass being allowed to cool in a disturbed condition in which it thereafter remained. These glasses are generally known as opal glasses.

The particles which impart its milky appearance to the glass are themselves transparent. It is the same as the breaking up of the sun's rays by cloud or fog, although the individual particles of moisture are clear and transparent. In other words the diffusion is really due to the repeated reflection and refraction of the light rays, in turn dependent upon the difference between the index of refraction of the particles in suspense, and that of the surrounding matter. In "Thermolux" glass transparent glass threads of very small diameter take the place of these particles. This makes light volume control possible or adjustment according to requirements of the main factors of illumination: diffusion, refraction, and reflection. Various grades of this glass are produced giving different proportions of these three values.

Insulation of Sound

In addition to the efficient diffusion of light and heat, glass of the type described also provides effective insulation of sound. The transmission of sound through a material is governed by three principles: (1) its air tightness; (2) its rigidity; (3) the non-homogeneous structure of such material. It has been proved that most of the sound striking glass is reflected back, but owing to the low thickness-to-area ratio of the panes themselves, and the windows as a whole, that portion of sound energy which is not reflected back vibrates the panes, causing them to act as sources of sound. The heavier, thicker, and smaller the panes, the less will this membrane factor operate. Experts agree that if double glazing is employed, two separate frames (preferably of dissimilar glazing) should be fixed to avoid conduction of vibration of the outer panes to the inner ones through the material of the frame.

The Glass of the Future

To sum up: glass has now been produced that will permit a good gradation of light intensity. By this means rooms can be divided into brilliantly and softly lit zones without sharp demarcations. Practical insulation for sound and heat can be secured with glass of the same thickness and yet infinitely lighter than ordinary glass.

The characteristics of this interesting material can be preserved indefinitely because all exposed surfaces are highly polished and therefore easily cleaned. Prismatic, cast, and figured glass are subject to rapid discoloration because of dirt trapped by their irregular surfaces.

Around the Trade

A Tool Chest for Handymen

THE hundred-and-one jobs that occur in most households are undoubtedly simplified if the householder is properly equipped with tools. The best thing is to have a complete set such as the G.T.L. tool chest and home repairing outfit. Here in one chest is everything likely to be needed, actually well over fifty finest grade Sheffield tools, each neatly fitted in its place and fully guaranteed. An illustrated instruction book on the use of tools is also included. Interested readers may obtain free of charge from Guaranteed Tools (1933) Ltd., 12-13 Chiswell Street, Finsbury, London, E.C.1, a sixteen-page booklet describing the G.T.L. tool chest and home repairing outfit.

Modern Lathes

THOSE readers interested in lathework should certainly write to Messrs. Ward and Pollard, High Street, Plumstead, S.E.18, for details of their "Duplex Tailstock" 3½-in. centre, back-geared, screw-cutting, boring, milling, and sensitive drilling lathe. A feature of the machine is the tailstock, which is a combination screw-operated and lever-feed tailstock. It can be changed from one to the other in three seconds. When using the lever feed the hand wheel may be used as a dead stop to limit the travel of the barrel, thus providing an accurate method of controlling the depth of the holes. Each machine is tested with standard test bars and sensitive dial indicators before dispatch, and run on a test bed to ensure that all bearings, slides, etc., are properly adjusted.

A realistic model aeroplane made by F. P. Sweeten, Ltd., 38 Bank Hey Street, Blackpool.

A Correction

ON page 577 of our September issue we gave under the heading of "Latest Novelties" details of a useful photographic device. The price of the device was given as 2*s.* 6*d.*, but this should have been 5*s.* 6*d.* The number at the foot of the paragraph was 141.

Lionel Trains

S. GUITERMAN & CO., LTD., 35 and 36 Aldermanbury, London, E.C.2, have recently produced a fine well-illustrated 18-page booklet under the title of "The Book of the Lionel Trains," covering a comprehensive range of model railway accessories. The care and precision in the engineering and construction of Lionel "O" gauge and Lionel standard (wide) gauge makes them outstanding in the electric train field, and they incorporate many ingenious features in their design. All trains have 3-position automatic reverses, that is, by pressing a button supplied with each set, at any distance from the track the train may be stopped with headlight alight and coaches illuminated. Another press of the button will send the train either backwards or forwards. Some models are also fitted with chug-chugging devices which produce the sound made by a real train going along the track.

The "Scruit" Connector

ON page 63 of last month's issue appeared a short article under the above heading. Unfortunately the name of the manufacturer of the particular device described was given as J. M. Blair; this should have been the V.G. Manufacturing Co., Ltd., Gorst Road, Park Royal, London, N.W.10.

Universal High-voltage Receivers

THE usual all-mains receiver employs valves having a heater operated at a low voltage, the necessary step-down from the mains voltage being obtained by means of a resistance or a transformer. In the Ostar-Ganz receivers special valves operating with the full mains voltage on the heaters are employed and there are several advantages to be obtained from this type of valve. The receivers which are obtainable with these valves range from simple single-valve converters to ten-valve all-wave superheterodyne receivers, and there are also some interesting amplifiers available for use with pick-ups or microphones. There are also a number of kits for home constructors and these include receivers, radiograms, and amplifiers ranging in price from £5 5*s.* to £15 15*s.* Details of the receivers may be obtained on application to Universal High Voltage Radio Ltd., of 28-29 Southampton Street, Strand, London, W.C.2.

PATENT ADVICE

THE following information is specially supplied to PRACTICAL MECHANICS by Messrs. Hughes & Young, British and American patent and trade mark agents, of 9 Warwick Court, High Holborn, London, W.C.1., who will be pleased to send to readers free of charge a copy of their handbook, *How to Patent an Invention.*

2006979. Electric Valve Excitation Circuits. E. F. W. Alexanderson, Assignor to General Electric Co., New York, U.S.A.

This invention can be regarded as a converting apparatus for transmitting energy from a source of current. A plurality of electric valves is employed, each provided with an anode, a cathode, and a control grid. A grid-excitation circuit is adapted for each of certain of the valves which impresses upon the grid an alternating potential of the corresponding value to maintain the selected valve normally non-conductive. The phase of this grid potential is retarded with respect to the said anode potential by more than 180 electrical degrees, and an arrangement is provided for periodically overcoming the grid potential to render such valve conductive.

2007662. Valve Transmitter for Short Waves. W. Prinz, Assignor to Telefunken Gesellschaft für Wrahtlose, Telegraphie M.b.H., Germany.

In this invention a plurality of pairs of electron-discharge devices is employed, each device having a grid and anode, the anodes of the tubes of each pair being connected together through a linear connection devoid of lumped inductance and lumped resistance. The grid of each tube in a pair is connected to the grid of a tube in an adjacent pair through a similar linear connection.

2009834. Electric Valve Converting Apparatus. B. W. Bedford, Assignor to General Electric Co., New York, U.S.A.

This is another recent American invention for an electric valve converting apparatus for transmitting energy between a supply circuit and a load circuit. The invention contemplates the use of a transformer network and a plurality of electric valves for interconnecting disc circuits through the said network. A special method for rendering the said valves alternately conductive and non-conductive in a predetermined sequence is employed, a source of commutating potential tending to rapidly transfer the load current of the apparatus between the said valves. Inductive winding is connected in series with each of said valves, and a damped circuit is combined therewith for substantially short circuiting the potential induced in each of the said windings by a decrease of current in its associated electric valve.

REPLIES in BRIEF

D. R. (New Tredegar).—It is unusual to have a 3-pole motor; you probably mean a 3-pole armature. In any case, if the machine is fitted with a wound field it will run from the transformer providing that it can supply the necessary power. If the machine needs rewinding then send us a sketch of it, indicating the sizes of both the field and armature, etc. A tripolar machine with a permanent magnet will not run on an alternating supply.

F. W. (Colchester).—A 4-blade fan would increase the noise. We therefore do not recommend the change. A 2-valve wireless set will, of course, work from a 60-volt H.T. battery, but not very efficiently.

J. G. H. (Sheffield).—The "Flying Flea" is designed for the Scott engine, and we do not recommend you to depart from this. Full details are obtainable from the Scott Motor Cycle Co., Shipley, Yorks, who also supply the airscrew and the airscrew hub. The engines you have are quite unsuitable, too heavy, and of insufficient power. Many thanks for your appreciation.

BUILDING A BALSA MODEL AEROPLANE

(*Continued from page* 84)

shaft to engage in it. Before bending the shaft to the correct shape, a small spring is slipped on to the front.

The Action of the Free Wheel

The end of the shaft is placed into the hole in the metal plate, thus compressing the spring, and as the rubber motor is wound this keeps the spring compressed and the propeller engaged to the shaft. On releasing the prop, the rubber motor unwinds and turns the propeller, and when fully unwound, the spring expands and disengages the end of the propeller shaft from the metal plate, thus allowing the propeller to free wheel. The undercarriage is made from 18-gauge wire, shaped as shown in the drawing, the rear legs being soldered to the front. Balsa or celluloid wheels (bushed) are put on and the ends of the undercarriage bent up as shown.

For the wing, cut ten riblets and twelve ribs, the riblets being the shaded part on the side elevation drawing.

Pin down the trailing edge and the two bottom spars, glue into position the ribs which have been cut from $\frac{1}{16}$-in. balsa sheet, and insert the riblets and the leading edge; the sizes required being leading edge $\frac{3}{16}$ in. × $\frac{1}{8}$ in., trailing edge $\frac{3}{8}$ in. × $\frac{1}{8}$ in., and the spars $\frac{1}{8}$ in. square balsa.

The wing tips are next added, and are made from $\frac{1}{16}$-in. bamboo. The dihedral is now steamed in, the wing tips being 3in. above the centre section. The two diagonal struts are then cut so that the trailing edge is $\frac{5}{8}$ in. above the leading edge, this measurement being at the point where the struts are glued to the trailing edge. Allow the glue to set firmly, and finally insert the top spar. The machine is covered with medium weight jap tissue, and given one coat of dope. The rubber motor consists of 20 ft. of $\frac{1}{4}$ in. × $\frac{1}{30}$ in. elastic divided into eight strands (four loops), making the motor short but powerful. The wing position is approximately that shown on the side elevation.

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.

POLISHING SILVER PLATING

"I AM making up a preparation for polishing silver plating, chromium plating, etc. It contains no acids and is thinned out with water.

"Could you advise me as to an ingredient to hasten drying, which can be mixed with water to make it volatile, and the proportion to volume of water necessary to be effective? It must not be costly, as I wish to keep the expense of the preparation as low as possible." (F. S. W., Oxted.)

YOU are up against a very difficult task in endeavouring to incorporate a quick-drying agent in your polishing preparation. As a matter of fact, no really satisfactory agent of this nature exists, and this for the reason that if you mix a volatile liquid with water, the volatile liquid evaporates first, leaving the water behind. It is true, of course, that the volatile liquid, provided it is completely miscible with the water, entraps some of the latter liquid and thus tends to hasten its evaporation. Nevertheless, when solid ingredients are present, as they will be in the case of your polishing preparation, it is very doubtful whether the addition of a volatile liquid will have much beneficial effect.

You might try adding about 20 per cent. of methylated spirits to your preparation. Better still would be methyl alcohol or iso-propyl alcohol, the latter being the less volatile of the two, but the cheaper because it is not subject to excise duty.

Methylated spirits, you will be aware, contains heavy ingredients which tend to make its rate of evaporation slow. It scores, however, in point of cheapness.

LEAD AMALGAM

"AS an experiment, I melted about 1 oz. of lead in a crucible over a Bunsen burner. I then poured into this about the same amount of mercury, which caused the mixture to splutter violently. I then let the mixture cool, which set into a greyish, brittle substance which I easily crushed into a powder. What is this substance, and what is it used for? (I. H., Oxford.)

THE material which you prepared by adding mercury to molten lead is *lead amalgam*, and, since you used equal parts of lead and mercury in its preparation, it will be a 50 : 50 lead-mercury amalgam. Various lead amalgams can be prepared by varying the proportions of mercury added to the molten lead. As the proportion of mercury is increased, the melting-point of the resulting lead amalgam is lowered, until, with a high percentage of mercury, the lead amalgam becomes almost plastic at ordinary temperatures.

There is little use for lead amalgams on account of their brittleness. The only uses which these amalgams have been put to are the following:

1. As a substitute for an artist's drawing and shading pencil, the greyish lead amalgam being soft enough to give a peculiar greyish shade to paper when rubbed on the latter.

2. In the autogenous soldering of lead. The lead surfaces to be soldered are well cleaned and made bright and a layer of lead amalgam is melted over them. They are then brought into firm contact and a hot soldering iron is passed over them with heavy pressure several times. The heat volatilises the mercury in the amalgam but the lead remains behind, thereby effecting a firm union of the two surfaces.

This method is not much employed at the present day on account of the considerable expense of mercury. In experimenting with the method, great care should be taken not to breathe the mercury fumes given off by the soldering operation, since they are poisonous.

THE MANUFACTURE OF CELLOPHANE

"(1) IS it possible to make ordinary cellophane, i.e. cellulose xanthate, in thick slabs at least ¼ in. thick, and, if so, to whom should I write for a quotation?

"(2) Text-books on mineralogy deal with the crystalline form of minerals. Can you refer me to any text-books describing the physical characteristics of artificial crystals and the different systems of crystalline architecture to which they belong?

"(3) Can you refer me to any works on 'liquid crystals'? Can you give me the name of a 'liquid crystal' of the nematic class normally obtainable which exists in that form at (a) ordinary temperatures, if possible, or (b) slightly above? Where can these be obtained?" (H. H., Epsom.)

(1) WE doubt whether it is possible to procure cellophane sheets of at least ¼ in. thick. However, you might write to the Cellophane Company, 6-9 Bird Street, Oxford Street, London, W.1, for a possible quotation.

(2) Any text-book of crystallography will give the information you desire concerning the forms of artificial crystals. You might try the following:

Evans & Davies: *Elementary Crystallography*, 9s. 6d. net.

Tutton: *Crystallography and Practical Crystal Measurements*, 2 vols., each 50s. net.

Tutton: *Crystalline Form and Chemical Constitution*, 10s. 6d. net.

(3) There do not appear to be any exclusive works on liquid crystals. A. E. H. Tutton, the well-known crystallographer, in his *Crystals* (1911), devotes a chapter to their description. They are also mentioned and described in all other crystallographical works. Ammonium oleate, para-azoxy-phenetol, and para-azoxy-benzoic acid are substances which can exist in the form of

(*Continued on page* 118)

REPLIES TO QUERIES AND ENQUIRIES

(*Continued from page* 117)

small liquid crystals at ordinary temperatures and slightly above these temperatures. Ammonium oleate (and, also, other oleates) can exist in liquid crystal form at considerably elevated temperatures. Liquid crystals as such are not procurable commercially. They are generally formed on the microscope slide. The above materials may be obtained from any chemical wholesaler, such as The British Drug Houses, Ltd., Graham Street, City Road, London, N.1.

PHOTO-ELECTRIC CELLS

"ARE the photo-cells used in the different forms of photographic exposure meters of a vacuum, gas, or liquid type, and are they permanent?

"Is it possible for me to construct a liquid cell sufficiently sensitive to work in conjunction with a low-reading milliammeter on the lines of those described in 'Practical Mechanics,' and does the size of the container and amount of solution have any bearing on its sensitivity or life? Is its sensitivity dependent on the area of the plates, and can these be paralleled in any way to reduce the area? Will you please tell me what metals, solution and method of preparing either are the most sensitive and would it be permanent if the cell were made watertight?" (R. D., Regent's Park.)

THE photo-cells used for photographic exposure-meter purposes are of the "self-generating" type, i.e. they generate a current of electricity which is proportional in intensity to the intensity of the light falling upon the sensitive surface of the cell. The cells are of the vacuum type, such cells being very constant in action although the current which they deliver is less than that produced in a gas-filled photo-cell. All photo-cells used for measurement purposes are supposed to be quite permanent, although, in this respect, it will be realised that they have not been in general use for a sufficient length of time for this claim to be fully substantiated. A good vacuum photo-cell, however, is a constant and reliable article.

Liquid photo-cells are not practicable for constant service. For one thing, their sensitivity varies very greatly, they are not very portable, and they are not sensitive to weak illuminations.

You can make a liquid photo-cell by taking two pieces of copper foil (about 2 sq. in. in size), thoroughly cleaning these through immersion in a solution of caustic soda, and afterwards thoroughly washing them. The copper elements are then immersed in a very dilute solution of copper sulphate (prepared by dissolving a ½ grain of copper sulphate in 2 pints of water) and allowed to remain therein for about 8–10 days—in sunlight, if possible. During this time, a delicate bluish film of cuprous oxide will form on the surface of the copper. If, now, the plates, still remaining in this liquid and separated from each other, are connected together externally and matters are so arranged that one plate is kept in the dark whilst the other is strongly illuminated, it will be found that a small current will pass in the external circuit as long as the illumination persists. Immediately, however, the illumination ceases, the current will also stop. The sensitivity of such cells is mainly dependent upon the efficiency with which the sensitive coating on the plates is formed. Within reasonable limits, the sensitivity of the cell is not dependent upon the area of the plates. Unfortunately, liquid photo-cells are not permanent, this fact constituting one of the many reasons why they are not employed in practice. With a very delicate milliammeter, a reading could be obtained, but more satisfactory results would accrue from the use of a microammeter or a microvoltmeter.

ELECTRO-DEPOSITION

"I AM interested in electro-deposition and I would be pleased if you could tell me the conditions necessary for the anodic oxidation of aluminium. The electrolyte, I think, contains chromic acid, but I do not know the proportions. Could you tell me:

"(1) Composition and proportions of electrolyte?

"(2) Composition of cathode?

"(3) Is it necessary for the aluminium anode to be clean or does it matter if it is already thinly coated with oxide?

"(4) Particulars of current needed?

"(5) What kind of dyes can be used for colouring the oxide sheet?

"(6) What dyes will colour it (a) green, (b) blue, (c) red, (d) orange?

"(7) Can the process be carried out at home?" (J. H., Hampstead.)

THERE are two general methods in which the anodic oxidation of aluminium may be carried out, viz.:

(1) *Chromic-acid method.*—Three per cent. solution of chromic acid as the electrolyte. A carbon rod or a strip of stainless steel (the latter is preferable) as the cathode. The bath should be maintained at a temperature of 45 degrees C. For the first fifteen minutes, the voltage of the current is steadily raised to 40 volts. It is maintained at 40 volts for thirty minutes. During the following five minutes it is raised to 50 volts and kept at 50 volts for a further five minutes.

(2) *Sulphuric-acid Process.*—In this process a dilute solution of sulphuric acid forms the electrolyte and a strip of lead forms the cathode. The electrolysis is conducted at room temperature and a steady current of from 10 to 20 volts is passed for thirty minutes.

In order to obtain the best oxide films on aluminium it is absolutely essential that the metal should be well cleaned previously, especially when it is intended to colour the oxide film.

To obtain the best results from the colouring of the oxide film on aluminium, the dyeing process should take place *immediately* after the oxide film has been deposited. Remove the metal from the oxidising bath, wash it well, and immerse it in a 2 per cent. dye solution in the cold. During half an hour gradually raise the temperature of the dye bath to boiling-point, maintain it at that temperature for a quarter of an hour, and finally wash the dyed metal-coating in warm water.

Any *basic* dyestuff may be used for the dyeing of oxide films prepared as above, as, for instance:

Green . Malachite Green, Brilliant Green.
Blue . Methylene Blue, Methyl Blue.
Red . Acid Scarlet, Lake Red D, Cerise.
Orange . Methyl Orange, Orange II, Auramine, Acid Orange, Safranine.

Provided that the necessary direct-current supply can be obtained, there is no reason why the anodic oxidation of aluminium should not be carried out in the home workroom.

BOOKS worth READING

"Wood Carving for Amateurs," 5th Edition, by David Denning. Revised and Enlarged by C. F. Callow, F.R.I.B.A. Price 1/6, 80 pages, well illustrated. Published by "The Bazaar, Exchange and Mart" Ltd., Link House, 4-8 Greville Street, E.C.1.

WELL illustrated with half-tone plates and line sketches, this handy little book will prove ideal for the woodworking novice. It deals fully with the numerous tools used in wood carving, and contains many interesting designs which can be made by the average handyman. That the subject is thoroughly covered can be ascertained from the following chapter headings; Tools: Wood; Bench, and Methods of Holding Work; Sharpening Tools; Panel Carving; Various Examples of Carving, and Ornament and its Application.

"Tuning-in Without Tears," by Frank Boyce. Price 2/6, 75 illustrations. Published by Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London.

THIS book will enable readers to appreciate the brighter side of wireless, and also gives really practical and clear details about the detection, cause, and remedy of receiver faults. The author, who has been service manager to a well-known firm of wireless manufacturers, knows the things that puzzle and irritate listeners, and in this book he helps his readers out of their troubles. Humorous sketches by C. H. Lomax appear on most of the pages.

"Gibbons Air Stamp Catalogue." Price 1/6, 193 pages, 774 illustrations. Published by Messrs. Stanley Gibbons, Ltd., 391, Strand, London, W.C.2.

THE growth of public interest in aviation and everything connected with it explains the phenomenal popularity that air-stamp collecting is experiencing to-day. There was an interval of two and a half years between the second and third editions of *Stanley Gibbons' Air Stamp Catalogue*, but since then the demand has been so great that a fourth edition has now been published, only eleven months after the third.

A glance through the new volume demonstrates the immense interest that is to be found among air stamps, for so many of them are actual souvenirs of great and historic flights (such as the Hawker, Alcock, De Pinedo, Columbia, and DO-X stamps of Newfoundland, the Kingsford-Smith issue of Australia, the Ulm "Faith in Australia" New Zealand stamp, etc.), while others bear striking designs of famous aircraft (the 'planes of the Wright Brothers, Blériot, and Lindbergh among others), or portraits of early pioneers (Santos Dumont, Count Zeppelin, Lilienthal, etc., and even Leonardo da Vinci).

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"FILMCRAFT."—Here is a fascinating series of authoritative textbooks for everyone interested in the Cinema as the newest of the arts. The Filmcraft series, each 3s. 6d. net, includes volumes by Pudovkin, Adrien Brunel, G. E. Kendall, D. Charles Otley, Percy W. Harris. From all Booksellers and Newsagents.—George Newnes Ltd., 8-11 Southampton Street, Strand, London, W.C.2.

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