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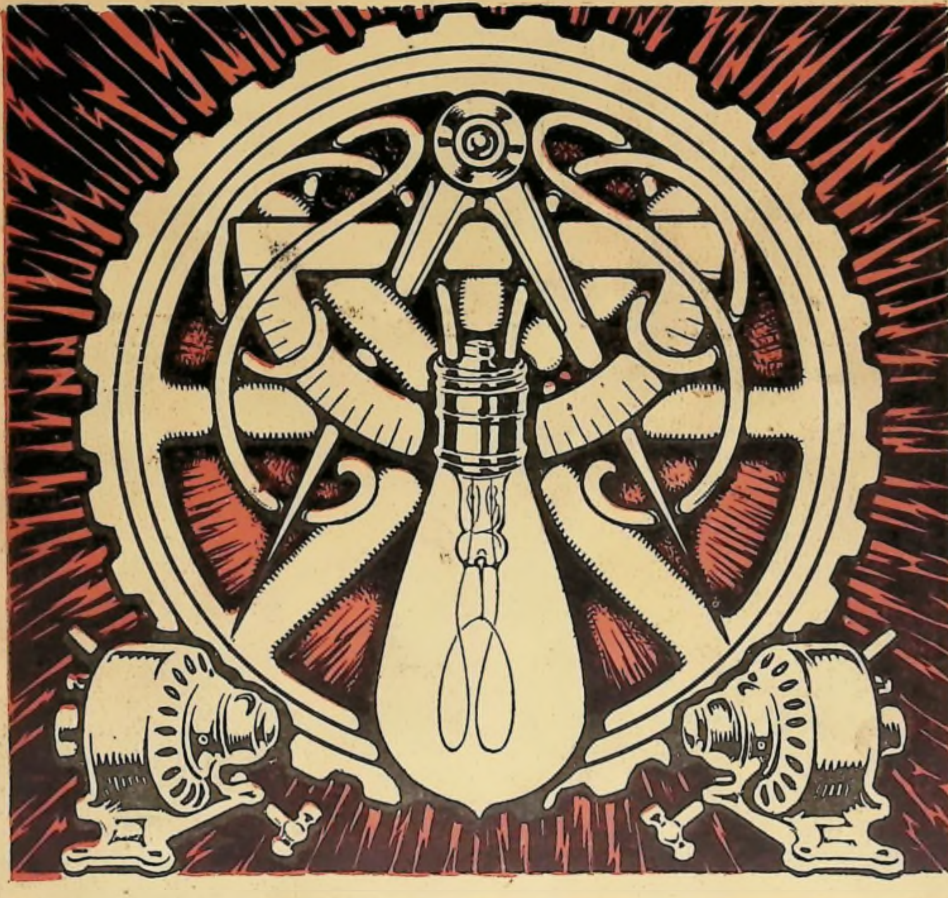

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ELECTRICIAN & MECHANIC

VOLUME XXIII AUGUST, 1911 NUMBER 2

A HIGH-SPEED LAUNCH

CARL H. CLARK

The small launch described in the present article is of the extreme speed launch type and is intended primarily for use on sheltered waters, such as lakes or rivers. With skilful handling, however, the boat will stand a considerable sea, but is hardly to be recommended for use upon other than quiet waters. It should appeal very strongly to those who are fond of canoeing, offering, as it does, a type of boat very similar to a canoe, but with far greater speed and endurance qualities.

To be successful, the boat must be very lightly and yet strongly built, all unnecessary weight must be done away with, and all parts as strongly connected as possible. The canvas-covered type of construction has been chosen, as it gives to the amateur a very easy method of boat-building, and at the same time the lightest possible boat.

The small power required, 1 to 2 h.p., is a very attractive and economical feature, as it is both cheap in first cost and economical to run, a similar launch having attained a speed of 11 miles per hour with a 1½ h.p. engine. Referring to the lines it will be seen the general shape is not unlike a canoe, except for the increased size and the full stern above water.

The general dimensions are: Length on top, 19 ft. 6 in.; length on water line, 19 ft.; beam at deck, 3 ft. 4 in.; draft as designed, 6 in.

The actual draft of the boat will, of course, depend upon the lightness of construction, and upon the weight of the crew carried, but this draft should easily be obtained with two persons, and with three she will trim lower in the water. The maximum speed will, of course, be obtained with the lightest possible load.

To transfer the lines and make ready for building, the usual table of offset is given. The measurements given under "heights" are measured vertically above the base line on the mould corresponding with the number at the top of the column. Those under "half breadths" are measured horizontally out from the center line on the water lines corresponding with the numbers of the moulds given at the top.

The shapes of the several moulds are laid out on thick brown paper, the water lines being spaced 3 in. apart from the base line, a center line is drawn square

TABLE OF OFFSETS FOR 20 FT. SPEED LAUNCH

No. of Moulds	Bow	1	2	3	4	5	Stern
Height of gunwale.........	2' ½"	1' 10½"	1' 9⅛"	1' 8⅜"	1' 8"	1' 8"	1' 8"
Height of keel bottom......	....				⅞"	3"	6"
Height of No. 1 section......	....	4¾"	1"	⅜"	1⅜"	3¼"	6"
Height of No. 2 section......	....		4"	1½"	2"	4"	
Half breadths deck.........	....	1'	1' 5¾"	1' 8"	1' 7½"	1' 3¾"	10⅜"
Half breadths water line 4..	....	9¾"	1' 4½"	1' 7¾"	1' 7¾"	1' 4¾"	
Half breadths water line 3..	....	8⅝"	1' 3½"	1' 7⅛"	1' 8"	1' 4½"	
Half breadths water line 2..	....	7"	1' 1¾"	1' 6⅛"	1' 7¼"	1' 3½"	
Half breadths water line 1..	....	4½"	10⅜"	1' 3½"	1' 4"		

Water lines are spaced 3 in. apart. Sections are 6 in. apart.

No. 1 and No. 5 moulds are 3 ft. from ends of water line, other moulds are 3 ft. 3 in. apart.

with the base line, and the two fore and aft sections line parallel with the center line and spaced 6 in. apart. The object of these section lines is to locate points below where the water lines are useful; for example, in the body plan, Fig. 4, the two points on mould No. 4 below the lowest water line are located by the section lines.

Referring in detail to mould No. 4 in the top line of the table, the measurements given opposite the half breadths are laid off on the proper water lines, and the deck, the "height of sheer" is then laid up, locating the curve below water line No. 1, and lastly, the "height of keel bottom" is set up, locating the center line point. The points should be laid out on both sides of the center line and the curves struck in with a slender batten. To allow for the thickness of the plank, a second curve should be drawn inside at a distance of 5/16 in. The other sections are laid out in the same way. It will be noted that the gunwale runs sheer and level from the stern to mould No. 3, where it rises toward the bow.

The actual outline of the stern is shown by the dotted outline in Fig. 4, and the offsets are: deck, 1⅜ in.; water line 4, 1½ in.; water line 3, 11¾ in.

This outline is laid out the same as the others. The outline of the bow is also laid off; it begins 6 in. forward of a vertical at the forward end of the low water line and has a slight outward curve; the curve below the low water line should be similar to that shown. This completes the laying out.

The method of construction is very similar to that of the canvas boats already described in previous issues. The moulds are constructed to the outlines already laid out, and of comparatively rough stock, but accurately shaped and with the load water line and the sheer line marked upon each. The sternboard is also gotten out of ½ in. stock to the shape laid out, but a small amount must be allowed for the bevel of the sides, about ¼ in. on the sides and ½ in. on the bottom will be sufficient. The two sternboards are joined with a cleat at the center line, and fastened through with brass screws. The angle between them is obtained as in Fig. 9, by measuring out from the center line 8 in. and forward 4 in. on each side; a templet would best be made for setting these, as the shape given is only correct when they are set at this angle. The two boards are beveled at the joint; the cleat is also beveled at the correct angle, and the whole fastened together. In addition to the outline laid out, the upper edge of each board should have a curve or curvature of 1½ in. and the grain should run horizontally.

The stem is ¾ in. thick, cut to the proper shape; it should be about 1½ in. wide and of pine or other light wood.

For the center-piece inside, a piece of pine ¼ in. thick, 4 in. wide and the length of the boat is needed; the stem is fastened on at one end and the board is tapered down to the thickness of the stem at the extreme forward end.

A foundation is now built, consisting of a board cut to the shape of the keel, and set up about 2 ft. above the floor. The proper outline for this foundation is obtained from the laying-off table in the line of "height of keel" by measuring them up on the correct mould points, as laid out by the given spacing. The keel, from mould No. 3 forward, is straight.

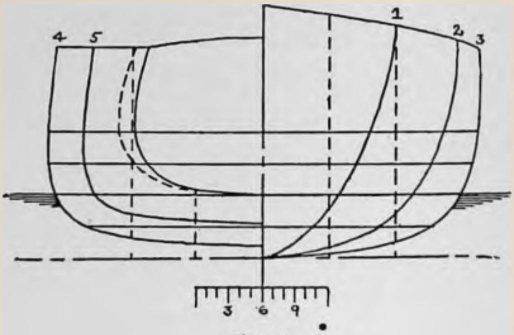
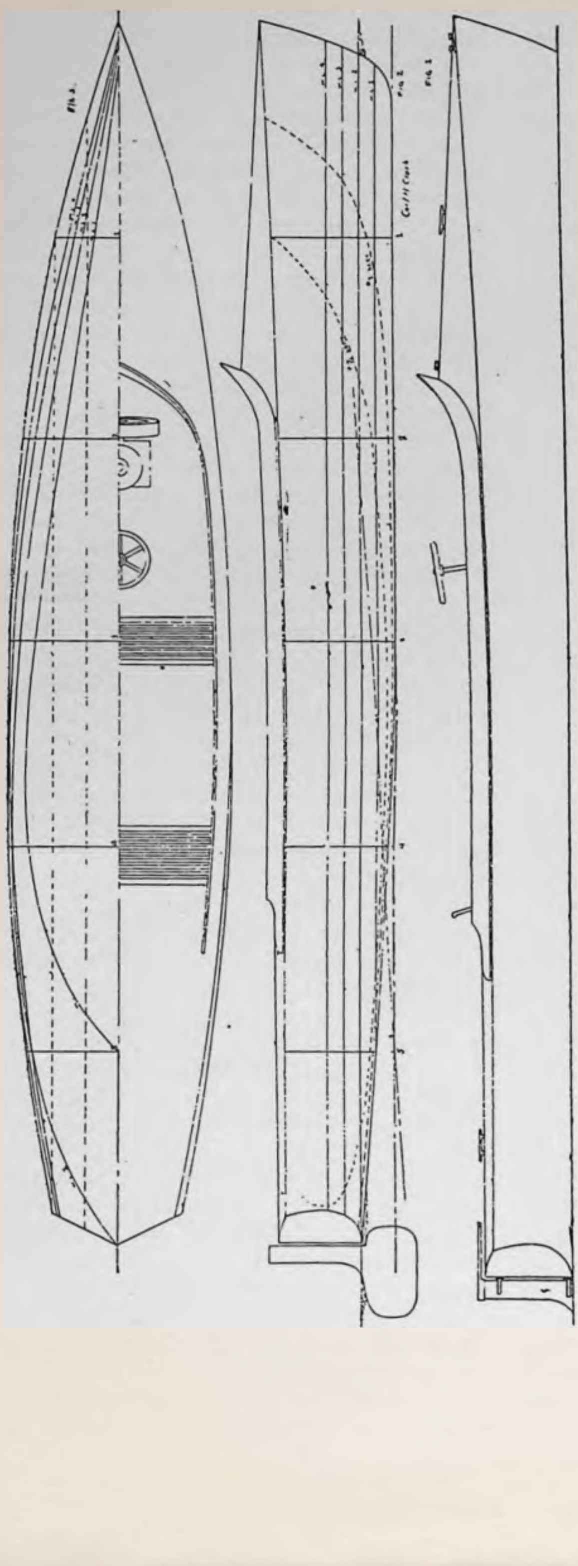
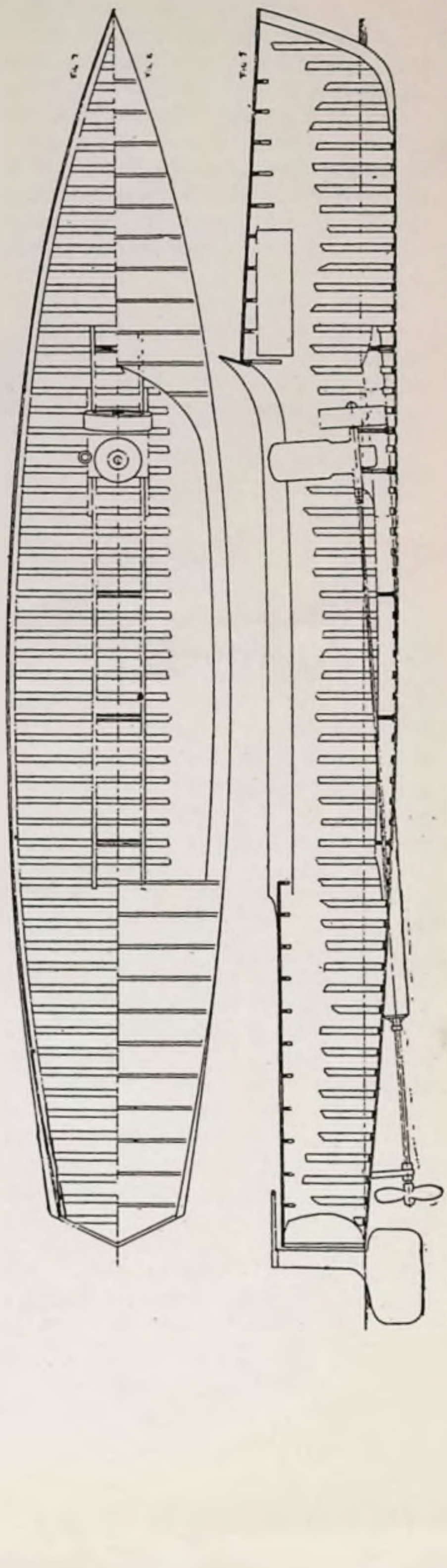


FIG. 4.

The center-piece, with the attached stem, is now laid upon the foundation in the proper position, and bent down into place and held by shores from above. The mould and stern points are also marked on the center-piece. The stern should be shored so as to stand exactly plumb when looking at it from forward. The two connected stern boards are now to be attached to the center-piece. It is to be noted that from the last mould point to the after end of the stern, outside, is 3 ft. The after end of the center-piece is beveled to the proper angle of





the stern boards, and under the cleat joining the latter, which is beveled off to receive it. The stern boards may now be fastened in place, and should be shored, taking care that the after side of the joint is at right angles to the base line and in line with the stern, fore and aft. The moulds are set up in place at the mould points; those forward of the middle being placed with their after faces on the mould point, and those aft with their forward faces on the mould point. They must be set exactly at right angles to the base line and square

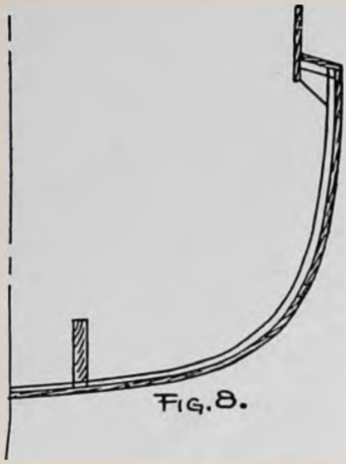


FIG. 8.

with the center line, and the middle points of the cross braces must be in a straight line from the center of the stern to the point of the stem. The setting of the moulds is one of the most important operations concerned in the building of the boat, as any inaccuracy in the setting will result in the two sides being unlike. When correctly set the moulds should be well braced.

A few battens should now be bent around the moulds and the edges beveled so that the bottom will lie smoothly on the faces of the moulds. The edges of the stern boards and stem are also beveled at the same time. A permanent bottom should be fastened around on the sheer line, and be allowed to remain until the plank is put on.

The planking is of pine or cedar 3/16 in. thick. Starting at the keel, it is put on in as wide boards as possible and fastened wherever necessary to the moulds with small nails. At the stem and stern it is strongly fastened with small copper or brass nails. The first plank fits alongside of the center plank already in place. The plank cannot be obtained in lengths sufficient to allow each one to be of a single length, but there should not be more than one joint in each plank and the joints in neighboring planks should be well separated. The frames are to be spaced, one at each mould and nine between, making the spacing just under 4 in. The spaces should be laid off, in order that the joints or butts in the plank may be made on the frames.

The planking may be continued, making each plank wider amidships than at the ends. The girth around all the mould, should be divided into the same number of nearly equal parts for guidance in planking. By making the plank sufficiently wide amidships they can be run around without a great amount of spiling or curvature, and should, if possible, be run the same as in the ordinary construction. If this is not possible or convenient, it may be arranged as in the canvas boat described in a previous number, with the short, wedge-shaped piece on the bilge; the former method is, however, to be preferred. After planking as high as the turn of the bilge, the tops or sheer streak should be put on and the planking continued below. The plank should be cut to fit closely, and no attempt made to force them in place, as there would be a tendency to warp later. The butts of the plank can be fastened temporarily with blocks until the frames are in place.

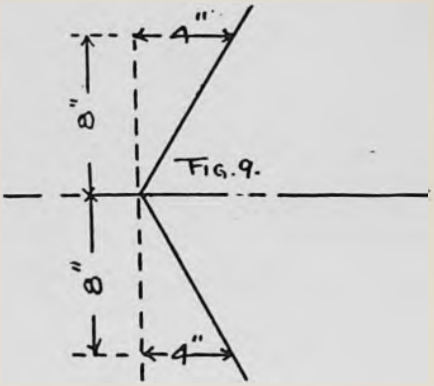
The frames are 1½ x ¼ in., of spruce bent in flatwise. They are steamed in the usual manner before bending and should be at least partially fastened while hot. The frames extend from gunwale to gunwale continuous across the center line, and the two outer corners should be neatly rounded, as no sheathing is fitted. Fastenings for the frames consist of copper tacks about ½ in. long with flat heads; they are driven from the outside and clinched inside the frame. They should be used plentifully, and carefully clinched to avoid splitting the frame, and should be clinched across the grain, not with it; they should also be driven as near the edge of both plank and frame as is convenient without risk of splitting either. A small brad awl may be handy in boring holes for them. In clinching these points, a heavy hammer is held on the head and a light hammer used for clinching; the point should not be nearly turned over flat, but a small hook should be formed and the point forced down into the wood.

Whenever a butt occurs, a piece of the frame upon which it occurs is omitted to allow the fitting of the butt-block. The latter should be about ½ in. wider than the plank it joins, and about ½ in. thick, it extends from one frame to the second beyond this, cutting the intermediate frame; it should be a neat fit between the frames against which it butts and also against the ends of the frame which is cut. The ends of the plank are nailed to the butt-block with the usual copper nails, care being taken not to split either the ends of the plank or the block. It will be noted that the copper nails are slightly tapered, and therefore have a tendency to split when driven home; if this tendency is noted, a small hole should be bored for each. The boat should be allowed to set for a day or two to allow the frames to set in place before removing the moulds. When the latter are removed a frame is bent into the place of each and allowed to harden. The shores may be removed and the boat should be quite stiff and strong.

As the moulds are removed braces must be fitted to avoid any chance of change of shape, and they should be left in place until the deck beams are fitted.

The outside should now be well smoothed up with sandpaper and all nail heads set well in. Although not entirely necessary, it is advised that the seams on the outside be covered with strips of rather thick paper fastened on with shellac and smoothed up; this keeps the canvas smooth and also tends to stiffen the boat somewhat.

The engine bearers should now be fitted, running, as shown, about the length of the cockpit; they are of ⅞ in. pine, and should stand about 4 in. above the plank at the engine and taper to 3 in. at the ends. They are placed apart a distance equal to the width of the engine bed, and should be carefully fitted down over the frames so as to rest upon the plank. To obtain the curvature of these keelsons a straight piece of board is put in the proper position and at certain points the distance from the straight-edge down to the skin is measured. The straight-edge is then transferred to the stock to be used, and the distances re-measured from it, thus reproducing the curve. The piece is cut out and beveled to fit along the top of the frames; the cuts for the frames are then made, and the final fitting done. For fastening these bearers in place copper or brass



nails about 1½ in. long are used, driven from the outside. These bearers are really the backbone of the boat and must be well fitted and well fastened. In about the positions shown, short floors or blocks should be fitted between the bearers to hold them upright and also to stiffen the bottom; they are of ¾ in. pine and are fastened through the bearers and up from below.

The deck beams are of spruce 1 in. deep and ⅜ in. thick, with the exception of those of the cockpit, which are ½ in. thick. The forward deck beams should have a crown of about 6 in. in 2½ ft., the same curvature being used for all. The after deck beams should have a crown of 2 in. in 3 ft. Deck beams are all spaced about 6 in. apart. To support the beams at each end a clamp is fastened on the inside of the frames; they are of pine 1½ in. wide and ½ in. deep, and are set down 1 in. below the gunwale, so that the deck plank will rest evenly upon the top edge of the top streak when laid upon the beams. The clamps are laid in horizontal, as shown in Fig. 10, and should be notched over the frames so as to bear both upon frames and plank, and are fastened in place from the outside. These end clamps should extend about 1 ft. beyond the ends of the cockpit. Alongside of the cockpit the clamp is fitted even with the top of the top streak, so that the

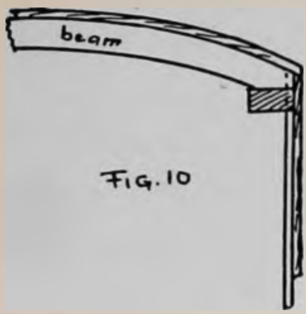


FIG. 10

FIG. 11.

deck will lie upon it; it should also be notched over the frames and should extend beyond the ends of the end clamps already fitted, so that the deck will lie evenly upon it after leaving the beams.

The deck beams are now fastened in place at the proper intervals, and are held in place by nailing down into the clamps, and, if desired, through the plank into the end of the beam. The beams at the ends of the cockpit are heavier, to take the extra strain at these points. The cockpit extends from 12 in. forward of No. 2 mould to 8 in. aft of No. 4 mould.

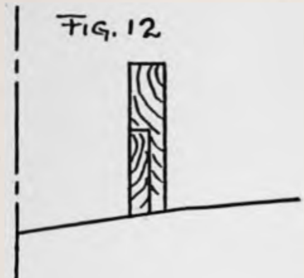
The upper edge of the top streak is now beveled off to the curves of the beams to allow the deck plank to lie evenly.

The deck planking is ⅛ in. thick, of pine, and should be in as wide pieces as is possible, not more than three pieces being used for the whole. A wide, nearly parallel, piece is fitted in the middle of the deck, and the two side pieces are fitted tapering. It is fastened to the beams with nails about ¾ in. long, and the joint between the boards should be close and even. Midway between each two frames, which, as before stated, are 6 in. apart, a binder or thin strip about 1¼ x ¼ in. is fastened on the under side in the same manner as a frame to support the deck between the beams. The edges of the deck and the top streak are fastened together with slim brass nails, very carefully driven about 2 in. apart. The forward end of the cockpit is curved as shown, and the raw edge of the deck is to be reinforced by a piece of ⅜ in. stock cut to the proper curve and fastened on the under side. A piece of ½ in. pine is fitted under the deck at the point of the bow to take the bow chocks and another piece under the position shown for each of the two cleats. The deck may or may not be covered with canvas, as desired, the latter course is, however, preferable, as the woodwork does not require to be as carefully done and the deck is more easily kept tight. In case it is not covered it should be 3/16 in. thick, and it may be finished bright, in which case a mahogany deck is very ornamental. The entire boat should now be carefully smoothed over with fine sandpaper, and all nailheads well set so that there shall be no unevenness in the canvas.

The hole for the shaft will pierce the hull about 10 in. aft of No. 4 mould. In preparation for this a hole should be made in the canvas at the proper point and a ring of tacks driven around it after filling it with thick paint. This is to prevent the water leaking in between the canvas and the hull. This must be done before the wearing piece is fitted on the outside.

For covering the boat about 10 oz. canvas is to be used; if, for any reason, 10 oz. cannot be obtained, 8 oz. may be used, but the former is to be preferred, as it makes a stronger boat; two 36 in. widths will be required, one for each side, the length of the boat. Specific directions can hardly be given for stretching the canvas. It should, however, be laid on and stretched out lengthwise along the bilge, and a little consideration will decide in which way it can best be laid. It is most likely that it will best stretch out along the bilge,

FIG. 12.



taking wedge-shaped pieces off at each end to fit the center line. The outside of the boat should be covered with thick paint just before laying the canvas. The latter is well stretched fore and aft, and the tacking begun at the center line amidships; a few tacks should be driven at the center line, and then the canvas stretched very tight and a few driven at the gunwale; some more are then driven at the center-line, and so on. The first piece to be laid should lap over the center line about ½ in., so that the other piece will overlap it and form a tight joint. The first piece need only be tacked sufficiently at first to hold it, as the tacks driven through the overlapping piece also hold the first. The tacking should thus work gradually towards the ends, always stretching the canvas tightly in both directions. At the bow the canvas is drawn across and tacked to the forward face, and on the stern it is drawn inside and tacked on the flat of the stern boards inside of the line of the plank. The tacking should be about ½ in. apart.

The deck is covered with lighter canvas, 8 oz. being sufficiently heavy. It is stretched in the same manner and laid in paint; it is drawn over the edge of the gunwale and tacked over the other. The raw edge of the canvas is covered with a ½ in. half round moulding.

A wearing strip of ¼ in. pine 3 in. wide is now to be run outside the entire length of the boat; at the bow it is tapered to the width of the boat and is fastened with small brass screws. A stem piece of ¼ in. oak is bent around the stem, joining the rubbing strip just fitted.

The coaming is of ¼ in. oak and stands 3 in. high above the deck and is curved up at the forward end, as shown. It is fitted and supported by small blocks, as shown in Fig. 11. At the after end it runs out on to the deck and is curved off as in Fig. 5. The forward end of the coaming is sloped forward somewhat to shed the water and also to enable it to be more easily fitted; at the point a small block is fitted on the inside to join the two sides together.

The skeg is shaped as in Fig. 5, from 1½ in. pine, and bored with a ¾ in. hole for the shaft, to match that already made in the hull. It is fastened through from the inside and must be carefully lined with the center line of the boat. A very thin lead pipe is now to be fitted inside of the shaft hole extending from the after end of the skeg to the inside of the boat.

The inside of the hole is well covered with paint before inserting the pipe, which is then turned over on end and hammered down close upon the wood, thus making a water-tight joint all through.

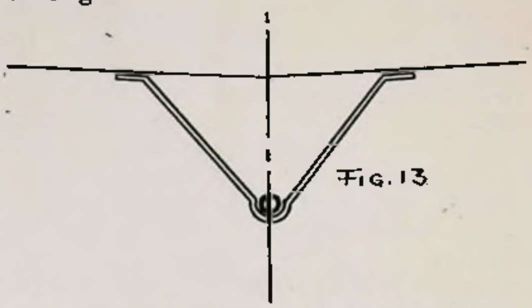


FIG. 13

The rudder is of ½ in. stock of the shape shown and is 16 in. long; the part forward of the forward edge of the stock being 2½ in.; the straight stock is 3 in. wide. A cleat is fastened along the lower edge to prevent its warping. The rudder is swung upon either the usual rudder braces or upon brass screw-eyes. In the latter case four eyes are used and a brass rod is passed through, the lower eye taking the weight of the rudder. By so fitting the eyes that those on the rudder just fit between those on the hull, the rudder is held exactly in place. For a tiller a light brass casting may be made, or a wooden tiller may be used, with a strap of sheet brass passing around the rudder stock and fastened to the sides of the tiller.

The outside of the boat should be painted several light coats of lead paint, to fill up the pores and lightly rubbed with sandpaper after each coat is dry. The inside and the stern boards may be finished bright, being first given a coat of shellac.

The seats are best made of narrow slats, as shown; the positions may be noted in relation to the mould points. They should be supported upon strips fastened along the side of the boat, and should have braces near the middle. Across the deck, aft of the cockpit, a finishing strip is run, covering the corner.

If desired, a light floor may be laid over the engine bearers, but it is advised to leave it open and finish the bearers the same as the inside in order to save weight.

The engine foundation is constructed, as in Fig. 12, of 1½ in. pine plank cut out to fit alongside the keelsons already fitted, and is fastened to them. This gives the necessary width for strength, and for fastening with the lag screws. The cross braces between the bearers before mentioned should extend as high as possible and cut out to fit around the engine base. In fitting the bed a line should be run through the stern tube and extended forward over the engine bed, and by reference to the engine the necessary position of the bed may be determined. The position of the extreme after end of the shaft should be also noted for use in fitting the propeller.

Lining up the engine should be a rather particular piece of work, as the shaft must enter the engine coupling perfectly straight, as otherwise it will bend at every revolution and add friction. The engine, after being lined up, is fastened down with lag screws. The propeller will probably come fitted to the shaft, so that all that should be necessary is to put propeller in place on shaft and fasten with either nut or pin, as is provided. The propeller, when in its proper place, should be 10 in. from the point of stern to center of propeller, and the inboard end of the shaft is cut off to bring the propeller in the proper place.

The propeller strut is shaped as in Fig. 13, from a piece of flat brass 1 x ¼ in. It is bent to the shape shown, of sufficient depth to suit the shaft, and with a spread of about 6 in. For the bearing a piece of extra thick brass tube, which is a running fit for the shaft, can be used. It is fitted into the eye and soldered in place. The strut is then adjusted until the bearing is free on the shaft and the arms have a good bearing on the hull, and it is then fastened in place with two copper rivets in each arm. If the rivets cannot be made to come through a frame, a piece of oak should be put inside to take them.

The gland on the after end of the skeg is fitted in place with plenty of thick paint underneath to make it water tight.

An additional bearing should be arranged about half way between the engine and the stuffing box; it can be made of a piece of extra heavy brass tube, the same as the strut-bearing, and secured in a wooden block. When all is set up and made tight, the engine should turn over freely and easily, otherwise there will be undue friction and the full power of the engine will not be realized.

The engine selected for use should be of 1½ to 2 h.p., of high-speed type, and should not, for best results, weigh over 80 lbs. complete with pump.

The installation is made in the usual manner, according to the directions which accompany each engine, or can be obtained from the engine makers on request. The gasoline tank should hold about 5 gallons and be located under the forward deck, supported by straps from the deck above, as in Fig. 5.

The filling pipes for the tank should extend through the deck with a screw cap. The connection from the tank to the engine is ¼ in. pipe size, lead pipe, with a stop cock near the vaporizer.

A fixture of much value is a sediment trap quite near the tank, made by fitting a brass T to the tank and to the lower end of the T fitting a coupling and plug. Any sediment from the tank will collect in the neck having the plug, which can be removed at times when the tank is nearly empty.

The exhaust pipe should pass through the muffler, and then directly outward through the side of the boat. A brass collar is fitted to cover the edges of the canvas around the hole. The suction to the water pump must be below the water line, with a brass strainer over the end to prevent weeds or sand from being sucked into the pump; the discharge from the engine may be above water.

The batteries and spark coil are located in a box under the forward deck, as it is very essential that they should be kept dry; the switch is located on the side of the boat opposite the engine.

The steering gear may be arranged as shown, with an automobile type wheel steerer, or may consist simply of the usual wheel with ropes running around the cockpit with a block at the forward end, two blocks on the deck opposite the tiller, and a few screw-eyes between. The cleats and chocks, backboard for the rear seat, and other furnishings are fitted to suit the builder.

In all this work it must be borne in mind that lightness and strength are necessary for success, and everything should be done with this end in view, and as little extra material added as possible.

The final painting and finishing is now to be done; when the final coat is put on the boat should be entirely smooth, with no sign of the grain of the cloth; the final coat may be of enamel paint, giving a glossy appearance. When well constructed the boat will present a very ornamental appearance.

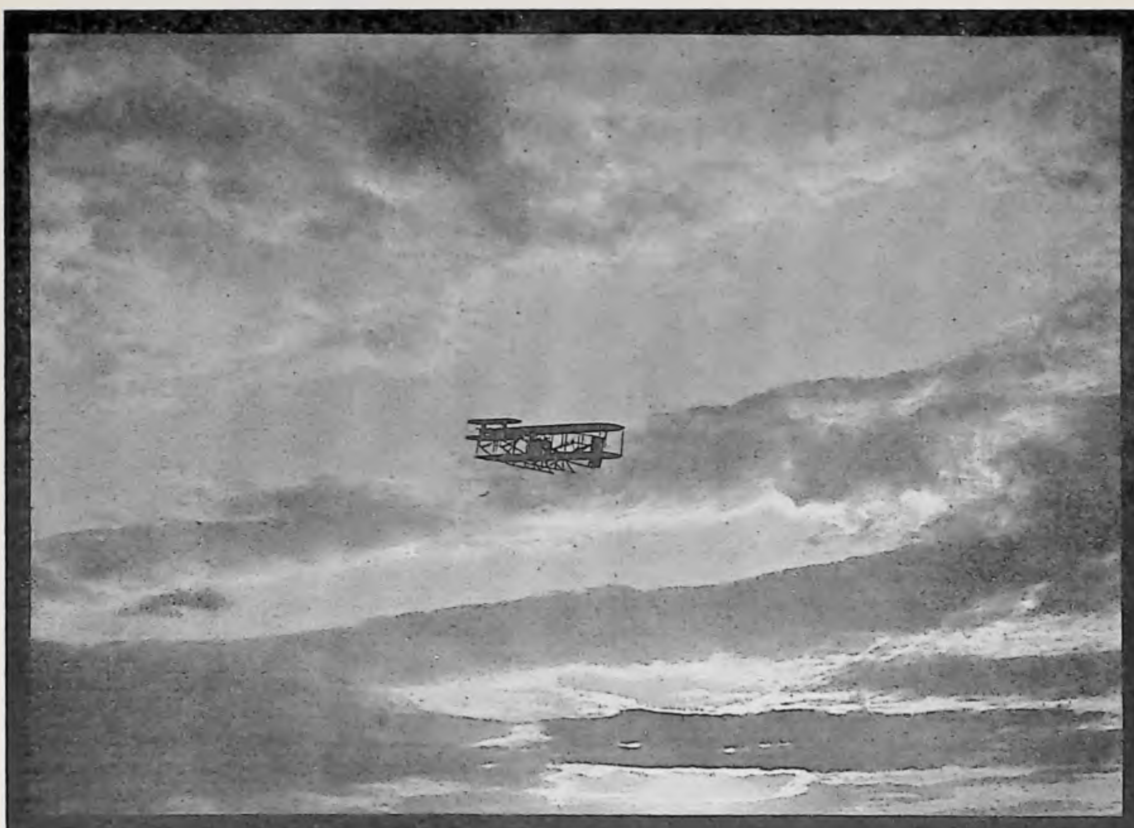
In handling this boat it must be remembered that it is of light construction and must be carefully handled, and when so treated it will be very durable. It should not be left afloat for long periods, and should be kept in a boat house under cover, if possible; this should be readily done on account of its light weight. It will, however, be found to be very satisfactory for the purposes for which it is intended.

Getting Ready

Washington Irving tells a story of a man who tried to jump over a hill. He went back so far to get his start for the great lead and ran so hard, that he was completely exhausted when he came to the hill, and had to lie down and rest. Then he got up and walked over the hill, says *Success*.

A great many people exhaust themselves getting ready to do their work. They are always preparing. They spend their lives getting ready to do something which they never do.

It is an excellent thing to keep improving one's self, to keep growing; but there must be a time to begin the great work of life. I know a man who is almost forty years old, who has not yet decided what he is going to do. He has graduated from college, and taken a number of post graduate courses —but all along general lines. He has not yet begun to specialize. This man fully believes he is going to do great things yet.



A Wright Biplane at Sunrise *C. H. Claudy*

A MODEL MONOPLANE

E. W. TWINING

On July 27th of last year a model aeroplane flying contest was held at the Crystal Palace, London, under the auspices of The Aerial League, and under the rules and regulations of the Kite and Model Aeroplane Association. The meeting was the most important one held during the year, the competition being open to the world, and was to decide the question of which was the best all-round model.

The stakes fought for were a fine silver challenge cup and gold medal put up by A. W. Gamage, Esq.

We were flying on a spot situated between high trees with a strong cross wind blowing. Well, I launched the machine for its first flight, and it started well, traveling gradually upwards, when a strong gust sweeping over the trees from one side and then, striking upwards, caught the main plane on its underneath side, bending up the two ends and allowing the warping cords to hang loose. These, owing to the speed of the machine, trailed backwards, and were caught by one of the propellers. The cord was then wound up around the spindle until both the main spars on one side of the plane and one of the spars on the other snapped, and the machine dropped to earth. It certainly looked as if it had made its last flight, but, although my heart was in my boots, and I felt inclined to make a doormat of the beastly thing, I pegged away at it for about an hour, and by the end of that time had got three splints laced with thread on each of the breaks in the spars. I also re-arranged the warping cords and braced the ends of the planes down to the skids at the back. I just managed to get done in time for what was, to other competitors, the third series of flights, but which was, of course, only my second.

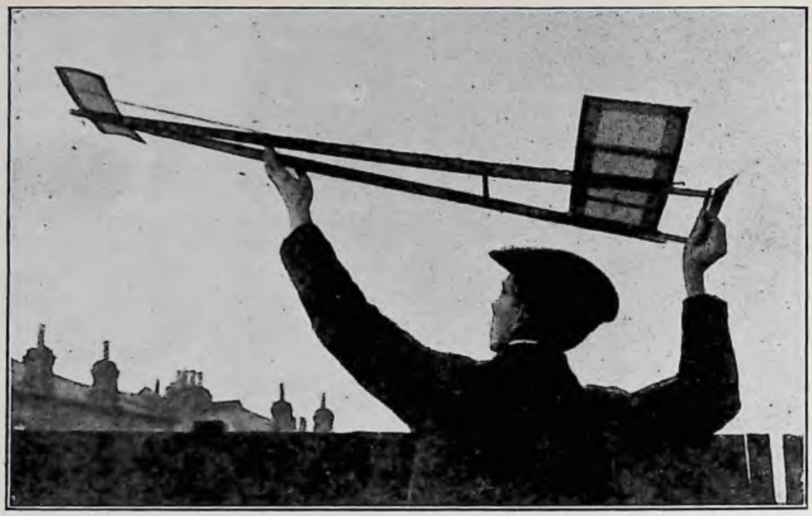
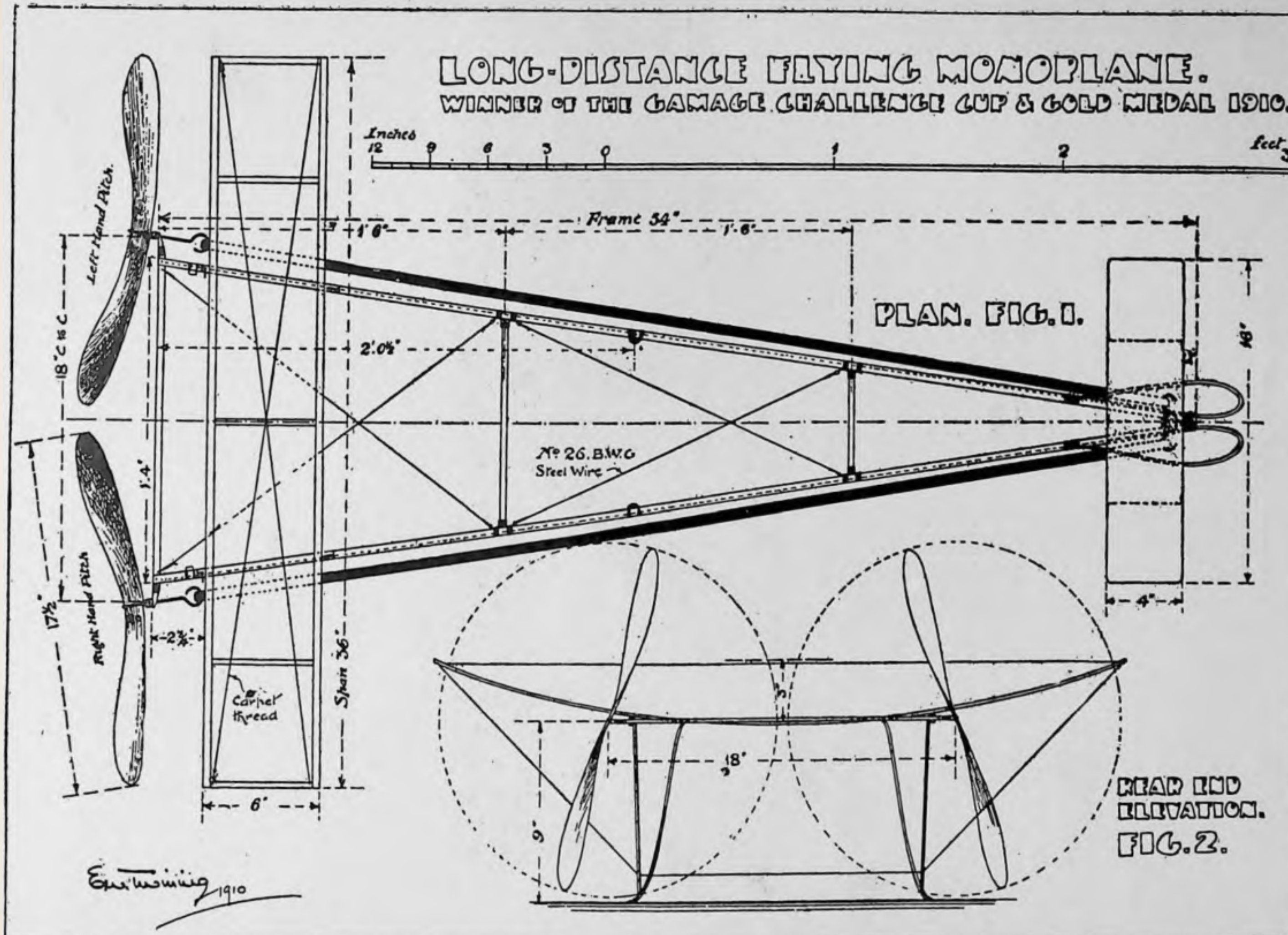


Fig. 10. Launching a Twining Model

Now, although the monoplane entered and flown by the writer, says the *Model Engineer*, was the one with which the longest flight was recorded, which fact made me the winner of the coveted prize, it was, at the time it was flown, in my own opinion, not the best all-round machine. The model was only finished on the very morning of the meeting, and was only given one trial flight before it was time to make tracks for the Palace.

Each competitor was entitled to three flights, and in my first, the machine met with an accident in mid-air, which I thought at the moment had placed me *hors de combat*.

The mishap was a most curious one.


LONG-DISTANCE FLYING MONOPLANE.
WINNER OF THE GAMAGE CHALLENGE CUP & GOLD MEDAL 1910.
Inches
12 9 6 3 0 1 2 3
feet
Frame 54"
1' 6"
1' 6"
PLAN. FIG. I.
Left Hand Pitch
Right Hand Pitch
18" C to C
2' 0¼"
1' 4"
17½"
2⅜"
No 26. B.W.G
Steel Wire
Carpet thread
Span 36"
6"
18"
4"
18"
5"
9"
REAR END
ELEVATION.
FIG. 2.
1910

This second flight was my last; there was no need to make another, for it was the longest of the day. It was only 236 yards, short by nearly a hundred yards of my own record with a machine of similar type flown about a week before the competition; but I am sure that had it not been for the too light construction of the framework of the main plane and the lack of sufficient stiffness in the spars to resist such wind gusts the accident would not have happened and the machine should have, and would have, flown between three and four hundred yards. I have had flights since last July with models of this size and type of a quarter of a mile *in calm air*; while, traveling *with the wind*, these machines have flown between six and seven hundred yards.

Readers must be good enough to pardon me for taking up so much space with the foregoing preamble, but the opening of the present article seems a fitting occasion on which to mention the difficulties under which the Gamage Cup was won. I believe few, even of the competitors, knew the condition in which the machine was when it made that flight. It points the moral that *nil desperandum* is a capital motto to adopt when one plays about with model aeroplanes.

Fig. 1 is a general plan of the model, while Fig. 2 is a rear end elevation. These two drawings show the threads attached to the main plane—the crossed ones on the top for warping the plane when circular flights are required, and the single one attached to the skids underneath for trussing down the ends of the plane in the manner in which they were put on at the Crystal Palace. I might say that after the competition a new main plane was made for the machine, having stiffer spars, and these proved satisfactory without the trussing down cords; but, nevertheless, I recommend readers to put them on—that is to say those readers who decide to make a copy of the model.

The main framework is of birch, the two long spars each being 54 in. in length, 7/16 in. deep, and 5/16 in. wide. They each have a channel running their whole length, measuring 1/4 in. by 3/16 in. At the front end of the frame, where the two spars unite, a triangular block is introduced, and glued and bound in with the spars. The angle of this block should be such that the spars at the rear end are 1 ft. 4 in. apart outside.

At the rear the spars are forked and a crossbar 17 1/2 in. long glued and bradded in the slotted ends. A sketch of the fastening of the other two crossbars shown in the plan is given in Fig. 4, whilst Fig. 4*a* shows the rear or propeller crossbar just referred to. This sketch also shows the method of securing the brass bearing plates to the ends of the crossbar by a lashing of strong thread. Carpet thread, either white, red, green, or black, being the best for all bindings.

The plates by which the middle bars are jointed to the main spars are of tin, cut slightly narrower than the spar and nipped at one end to a V-shape, then bent at right angles in the center; lugs are to be left on one end as shown. These are to take the No. 26 gauge steel wire by which the whole frame is braced.

To stiffen the frame vertically two outriggers are bound to the spars, as shown in the side elevation Fig. 3, and in detail in Fig. 5. They should be 6 in. long.

At their centers they are notched to fit on to the spar, and at each end are fitted with a wire double loop bound to take the bracing wires.

I think the method adopted of fixing the main plane will be made sufficiently clear by the sketches in Fig. 6, where *A* is an outside elevation, *B* a sectional plan of the frame spar, *C* a plan of one end of the plane ribs, and *D* a perspective view of the whole fastening.

It consists simply of forking the extended ends of two ribs of the plane, the ribs being so placed that they rest upon the main frames when the plane is in position. These forked ends fit over four pins passing through the spars, the pins being bent over at right angles and fitting with sufficient slackness in the wood to be capable of being turned with the fingers.

The main spars should be strengthened where the pins pass through them by small blocks fitting the channel tightly and glued in.

The main plane is shown in perspective in Fig. 7, curving upwards at the ends. This curvature is the means of

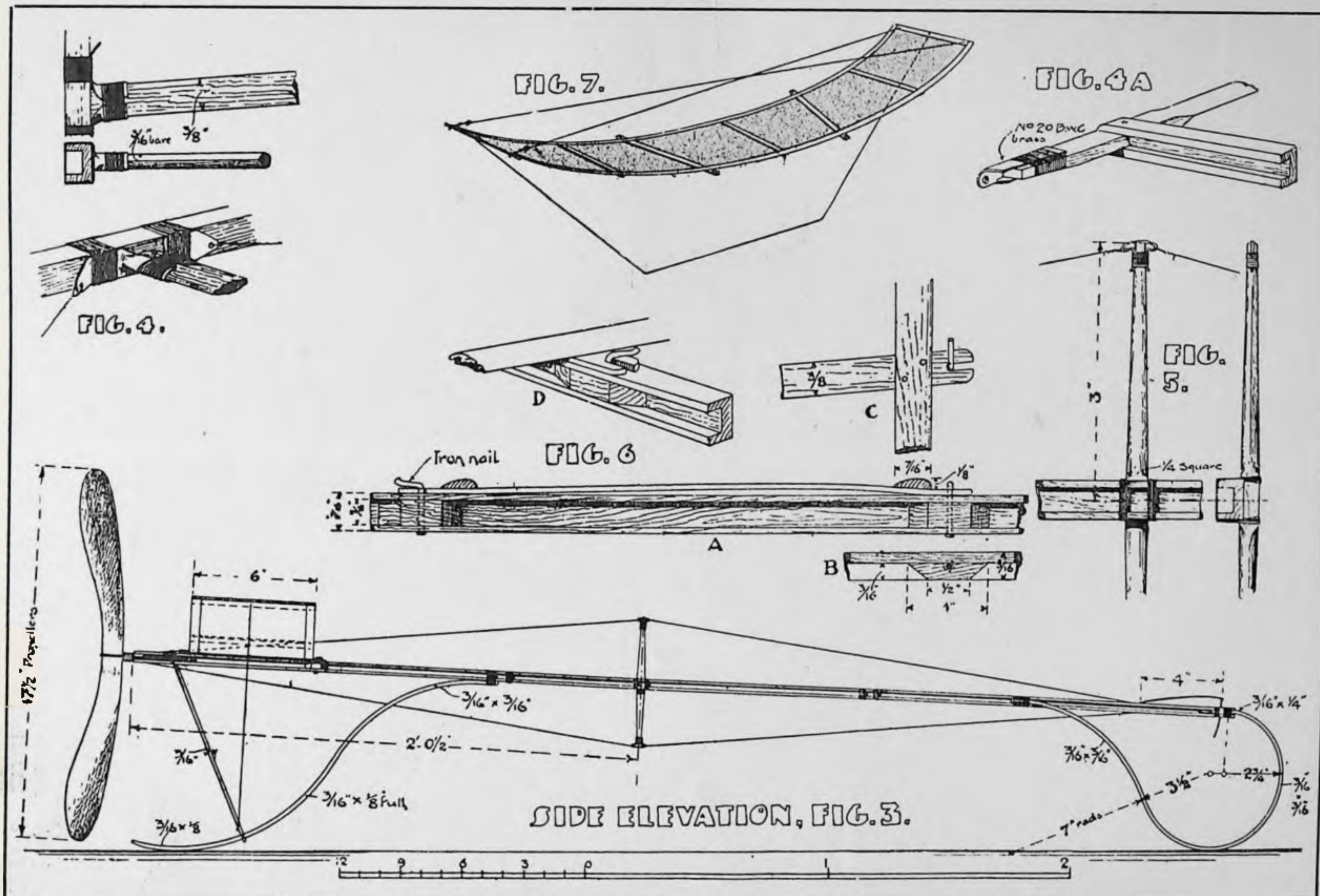


FIG. 7.
FIG. 4A
No 20 B.w.G brass
3/16" bare
3/8"
FIG. 4.
FIG. 5.
3"
1/4 square
D
C
3/8
FIG. 6
Iron nail
7/16"
1/8"
A
B
3/16
1/2"
1"
6"
17 1/2" Propellers
3/16" x 3/16"
2'. 0 1/2"
3/16"
3/16" x 1/8" full
3/16 x 1/8
4"
3/16" x 1/4"
3/16" x 3/16"
3 1/2"
2 3/4"
7" rads
SIDE ELEVATION, FIG. 3.

giving perfect lateral stability to the machine, and is far more effective than the usual V-shaped dihedral angle. The plane is held to this shape by the warping cords, and there is, therefore, no necessity to steam the spars. The cross-sectional form of the two main spars at back and front should be as shown at *A*, Fig. 6, and should measure 7/16 in. wide by 1/8 in. thick.

In order that the main plane shall pass into its place underneath the top wire braces between the rear crossbar and the outrigger, it will be necessary to make the warping threads removable. This is done by means of fine wire hooks, as shown in Fig. 7. The thread, where it passes through the rib on the opposite end of the plane, is continuous—that is to say, it does not terminate at each hole. Further, the thread is capable of sliding in the holes and there is sufficient friction between the thread and the wood to hold the plane with any amount of warp which may be required. By warp I mean, of course, twist, the twist putting a greater angle of incidence on one side of the plane than on the other. The object of attaching the holding down cord to the center of the end ribs is so that it shall not interfere with the warp.

The elevator of this machine is made of No. 16 gauge steel wire, and shaped as shown in Fig. 8. All joints in the wire are bound round with fine tinned iron wire and soldered. The fastening of the elevator in position is most simple and effective. It consists of a wire stem projecting downwards in the center of the front edge and making a slight angle backwards. This stem makes a sliding fit into a hole bored through the front angle block. When the wire is pressed down far enough to give the elevator its required angle of incidence (about 1 in 7) the rear edge will be pressing hard on the frame spars and will only move should the machine strike any fixed object or the ground.

The fabric with which the Gamage Cup model is covered is a fine waterproofed Jap silk. It is applied to the underneath side of the frame of the main plane, a margin of an inch being allowed to turn over onto the top. Each of the ribs are covered on the top side by strips of the fabric glued on, the width of the strip being about twice that of the rib it covers. The fabric should nowhere be pressed down into the angle formed by the edges of the ribs; the object of the strips and the wide turnover at the edges being to form pockets over the angles, and so render the plane as smooth and uninterrupted a surface as possible.

On the elevator the fabric is put on the top side, the turnover being underneath. About 1/2 in. should be allowed for sticking. Ordinary glue is used as an adhesive, though Seccotine may, perhaps, be found most convenient by the amateur.

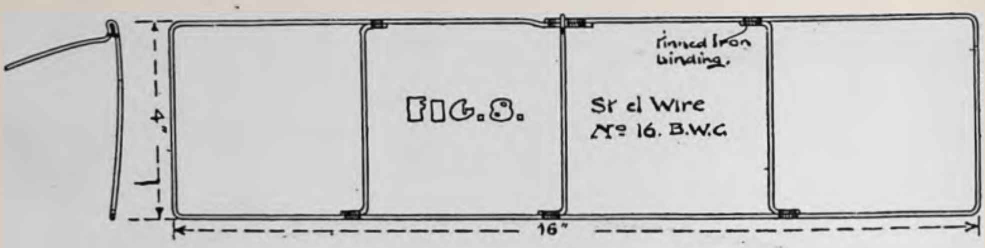
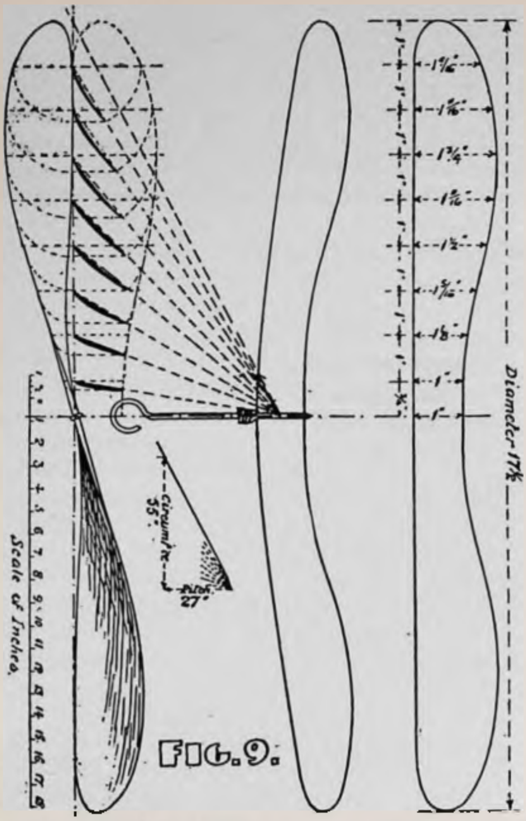


FIG. 8.

The propellers come last, but not by any means least. Indeed, they are the most important parts of the machine. In Fig. 9 I show one of them in detail. On the right-hand side of the drawing is a dimensioned outline of the piece of wood cut to shape before being twisted. The thickness is 3/16 in. bare at the center where the spindle comes, and tapers off to about 1/32 in. at the tips and edges.

The center figure is a side elevation, and that on the left-hand side a back elevation, while between these two I have drawn the method followed of setting out the pitch angles at nine points along the blades. On the vertical line is set out the circumference of the propeller disk, in this case 55 in.; while on the horizontal line the pitch length is marked off, both being drawn to a reduced scale. A small sketch placed over the figure number will perhaps



DETAILS OF PROPELLERS.

render the idea clear. If the angles at the various points are copied on to pieces of card and these cards set upright on a baseboard, an accurate templet can be made by which both propellers can be steamed to shape.

I need scarcely say that both propellers should be of exactly the same pitch, and, indeed, exactly alike in every respect, excepting that the right-hand propeller should be of right-hand pitch and the left-hand one of left-hand pitch. Further, the rubber which drives them should be of exactly the same weight and tension. If these points are not all attended to the machine will never fly straight.

My propellers were made of birch, but some other woods are suitable, such as maple or walnut. The spindles are made of No. 14 gauge tinned iron wire, as are also the hooks for rubber formed of one piece of wire at the front end of the frame.

Rubber should be put on by weight, 3 oz. being required on each propeller. This quantity allows of about 400 turns being given on each skein.

The method of launching is illustrated in Fig. 10. Although the model shown in the photograph is not the Gamage Cup machine, it is one of exactly the same size and type, but without the bracing outriggers and skids; the outriggers being dispensed with by reason of the form of main frame spars, which are carved by machinery. I give the photo only for the purpose of showing how these models should be held preparatory to launching them. The fingers of the right hand hold the rear crossbar at its center and embrace the tips of the blades of each propeller.

The model should be launched upwards at about the angle shown, giving it a pretty hard push off.

Machines of this type are remarkably stable, both longitudinally and laterally. Indeed, their lateral stability is such that they can be launched edgewise or even upside down and they will right themselves and continue flying.

Tree Cutting by Electricity

In some parts of the French forests a platinum wire kept at a white heat by an electric current has been employed instead of a saw, for felling trees.

It is claimed that by this plan a tree can be felled in one-eighth of the time required by the old sawing method. The entire absence of sawdust and the beneficial effect of the slight carbonization of the ends of the cut timber in preserving the wood are reckoned as decided advantages.

"Of late years the value of prickly pear or cactus as a stock food has become known, the only obstacle to its greedy consumption by cattle being the spines and needles in the cactus. These can be easily removed by burning them off, which is done by the use of oil and a special apparatus, which is said to do the work effectually. As cactus is known to be nearly all water, the introduction of it as a stock food in arid and semi-arid regions means much to the stockmen of those sections. Thus oil enters an entirely new field of industrial economy."

FOR THE LABORATORY

EXPERIMENTAL HIGH-FREQUENCY APPARATUS—Part III

STANLEY CURTIS

There are two practical methods of producing alternating currents of high potential and high frequency in use today. The high-frequency alternator, which is now receiving much attention among scientists and investigators, is practically out of the question for our purpose; therefore, we must needs have recourse to the more available method which uses the oscillatory discharge from a condenser to produce the high-frequency oscillations. The condenser was described in the July issue, and it is the object of the present article to give specifications and practical directions for building a high-potential transformer with which to charge the condenser.

There are three distinct types of high-tension transformers in use today for the purpose of charging condensers; or perhaps more properly speaking, there are two types, and one of these may be sub-divided into two general forms. Commercial lighting and power transformers are so designed as to supply more and more current as the load increases. In the transformer to be used for charging condensers, this condition is to be avoided, for the discharge of the condenser across the spark gap reduces the resistance of the gap to a few ohms, and thus the transformer secondary is practically short-circuited. The tendency of the transformer is, then, to deliver a maximum amount of current right across the spark gap, with the result that an arc forms and the condenser is prevented from charging again. This arcing feature has been the cause of much annoyance, in the way of overheated spark gaps, if not the actual failure of the apparatus.

The open-core transformer, although very low in efficiency as compared with the closed-core in lighting and power work, has met with considerable favor among high-frequency workers, and, indeed, until the advent of the Type "E" transformer, it was justly given a position at the top of the list, for such purposes. There is very little tendency to arc in the open-core type of converter, and for amateur use it may be considered as ideal, especially in sizes of ½ kw. and upwards. With the smaller sizes, the ordinary closed-core transformer will give greater results for a given amount of energy expended, and in construction it is no more expensive than the open core. The present article will describe an open-core transformer of ½ kw. capacity, suitable for operating the high-frequency apparatus to its full output. Later articles will take up the construction of suitable sizes of closed-core transformers.

The distinctive features of the transformer to be described are found in its portability, freedom from oil or other fluid or semi-fluid insulating mediums, and the convenient form of primary winding, which renders possible, by the simple change of one or two connections, its use on either 52 or 110 volt circuits. By using a smaller size of wire as indicated in the specifications, the primary may be adapted for use on 220-volt circuits. For the sake of clearness, the various stages in the construction of the transformer will be placed under separate headings, and the complete specifications for coils of ¼ kw. and ½ kw. capacity are given below. While this article describes the ½ kw. size, the same general directions apply in the case of the ¼ kw. instrument.

SPECIFICATIONS FOR OPEN-CORE TRANSFORMERS

¼ kw.—Core 12 x 1½ in. Primary 560 turns No. 14 s.c.c. wire in four layers if for 52 or 110-volt circuits; if for 220 volt circuits use 1,000 turns No. 17 s.c.c. wire in five layers. Insulation over primary, 20 layers empire cloth, 8 mils thick. Secondary, 6 lbs. No. 34 s.c.c. wire, wound in two units of ten sections each. Each section to be not more than ¼ in. thick.

½ kw.—Core 18 x 2 in. Primary 660 turns No. 12 s.c.c. wire wound in four layers if for 52 or 110-volt circuits; if for 220 volts use five layers No. 15 s.c.c. wire. Insulation over primary, 24 layers empire cloth, 8 mils thick. Secondary, 9 lbs. No. 32 s.c.c. wire, wound in two units of fourteen sections each. Each section to be not more than ¼ in. thick.

The side elevation shown in Fig. 13 gives a good idea of the general construction of the transformer. The method of mounting, as well as the form of insulation used, is, of course, optional with the builder. However, the proportions here shown will be found to produce an efficient coil which combines with this desirable feature that of a pleasing appearance as well as mechanical strength. The first point to receive our consideration in the construction of this transformer is

The Core, which is composed of a bundle of very soft iron wire cut to 18 in. in length, and in sufficient quantity to make a compact cylinder 2 in. in diameter. This will require approximately 12 lbs. of wire. The gauge may be either No. 20 or No. 22 B. & S., preferably the latter.

A large core is usually a difficult proposition for the inexperienced builder to handle, although if he has access to machine-cut and straightened wire, he should experience but little difficulty in building up the core. This wire, as well as complete cores, may be purchased from advertisers in this magazine, if any builder should have undue difficulty in the construction. From time to time various methods of core-building have been described, but, in the author's experience, there are none to compare with the one described in the first of the recent series of articles on the "Construction of a Six-inch Coil," in this magazine. The method will be briefly reviewed here for the benefit of new readers.

A sufficient quantity of iron wire, having been obtained, cut to length and made perfectly straight, is to be grasped in both hands and given a twisting motion. This will cause the wires to lay naturally side by side and the bundle will assume a cylindrical form. Individual binding wires are placed at intervals of 2 in. along the bundle, and tightened carefully as the twisting process is continued. Within a surprisingly short time the bundle will be an extremely compact cylinder of iron wires held by means of binding wires at intervals along its length. If re-annealed wire has not been obtained, the core should be placed in an iron cylinder, closely packed with charcoal, and the ends closed up. This cylinder is then to be placed in a hot fire for several hours, or until it is bright red hot. The fire is then left to burn itself out and the cylinder left in place until cold. If this cooling process is made to last over a day or more, so much the better. When cool the core is removed from the cylinder and brushed clean, after which it is ready to be taped. The most suitable material for this is empire cloth cut diagonally across the weave into strips about ¾ in. wide. Silk ribbon is also very good for the purpose, but it is difficult to keep it tight while winding. A full turn of the tape is taken around one end of the core, first removing the binding wire at that point. The winding is then continued, overlapping each turn by half its width, and removing the binding wires as they are reached, until the entire surface of the core is covered with a neat and uniform double thickness of insulation. The finishing end of the tape may be coated with shellac and afterwards bound tightly with a single layer of strong thread. Having finished the insulation of the core we are ready to take up the winding of

The Primary.—This winding consists of 660 turns of No. 12 s.c.c. magnet wire in four layers. The winding is most conveniently done in a lathe, as the weight of the core is somewhat difficult to negotiate unless it is supported in some manner. If a lathe is not available, one of the usual and well-known forms of improvised winding machines may be brought into play.

If the lathe winding is selected, wooden caps may be made to fit over the ends of the core for a distance of about ¾ in. at either end. One wooden cap is to be centered and the other gripped in the chuck. The starting end of the wire is bent at right angles, and a piece of tape looped over it. Take one turn around the core, turning the lathe backwards, and let the first turn grip the ends of the piece of tape under it, so that the starting end of the wire will be firmly secured in position. After one or two more turns are laid on, pull the ends of the tape to still further tighten it and cut it off. The first layer of 168 turns may then be finished, care being taken to see that the turns are closely placed. A chisel-shaped instrument may be filed up from an old tooth-brush handle, and it will be found very useful in crowding up the turns. The winding occupies the entire space to within 1 in. of either end. The second layer is continued back over the first, winding, of course, in the same direction. The second layer will contain two less turns than the first. At the finish of the second layer the wire is to be cut and secured with a piece of tape. A couple of layers of heavy paper are then taken over the wire and secured with shellac. The third layer is to be started in a similar manner to the first, leaving a few inches for connections, and securing the end with tape. Wind the third and fourth layers as the first and second were wound and secure the finishing end as before.

While the primary is still in the lathe, draw a longitudinal line across it with a pencil held in the tool post, and by moving the carriage along the bed. Cut the empire cloth into strips 18 in. wide and carefully square one end. Run a line of shellac along the pencil mark on the primary and secure the end of the empire cloth in position, making sure that its edge exactly meets the pencil mark on the wire.

After the shellac has set sufficiently to secure the cloth, turn the lathe slowly, holding the cloth by the outer end so that it may be tightly and evenly wound over the primary. If the cloth sticks unduly, and some difficulty is experienced on account of wrinkles, wipe a cloth, saturated with linseed oil, over the surface. The oily rag is also useful in cleaning empire cloth from particles of dust and grit. Be most careful to see that no chips or filings of metal come in contact with the cloth as they are difficult to remove, and will surely cause trouble if left there. Approximately 24 layers should be wound over the primary to effectively insulate it from the secondary. The actual voltage developed by the transformer would not be sufficient to break down even two or three layers of empire cloth, but it is the high voltage surge from the oscillation circuit which opens a path for the leak. The thickness of cloth specified, in addition to the special protective device which will be described in a later paragraph, will afford ample insulation at this naturally weak place.

The cloth need not be in one continuous piece, and, indeed, it may be found necessary to use a succession of short strips in order to wind the cloth smoothly. The pieces should be as long as practicable, however, and the greatest care should be taken to see that no air spaces or wrinkles are left while the winding progresses.

For an oil-immersed transformer, good fiber tubing will be found very reliable, and when impregnated with oil, it acquires a high disruptive strength. Micanite is also very good, but it must be entirely sealed in to protect it from the action of the ozone generated by the spark. An oil-insulated transformer is not very well adapted to portable use, and if the solid insulation is chosen, the empire cloth tube will be found very satisfactory.

The primary with its empire cloth insulation is now slipped into a cardboard cylinder 3½ in. inside diameter, the ends of which have been fitted with the plugs *J* and *J*1, in Fig. 13. These may be of wood, but preferably of fiber. The tube which covers the primary would also be far stronger if made of fiber, but it is difficult to obtain one of this size. The end, *J*, is fitted with four terminal screws, which are conveniently located in the plug at equi-distant points from the center, rather than across the diameter as shown in drawing. The drawing was so made for the purpose of showing the method of connecting. The ends of the wire from the first and third layer are connected to terminals

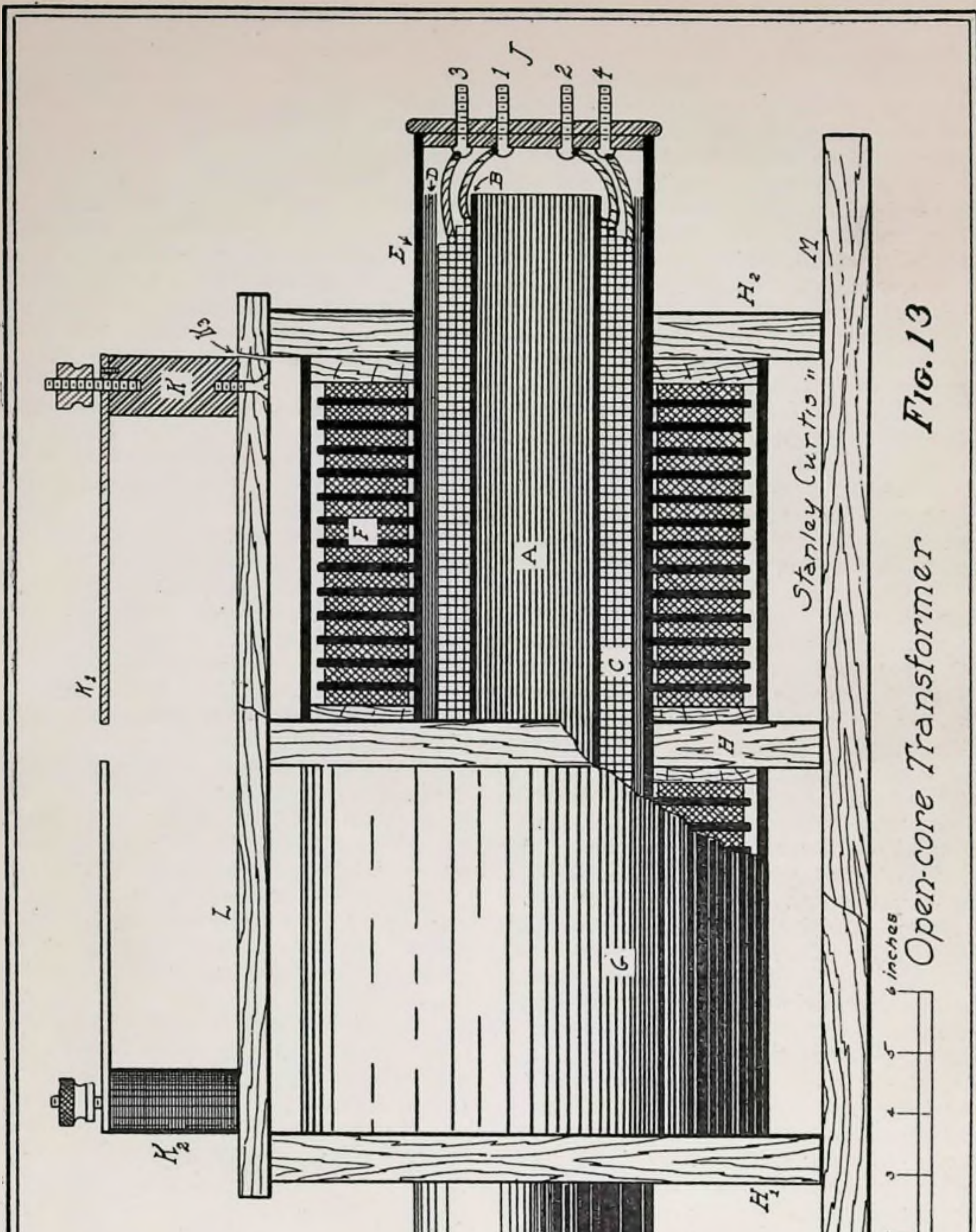


Fig. 13 Open-core Transformer

1 and 3 respectively, while those from the second and fourth layers go to 2 and 4. By connecting 2 and 3 together and applying the current to 1 and 4 the four layers are placed in series and the winding is suitable for use on 110-volt cir-

cuits. By connecting 3 and 1 and 4 and 2, the two sections are connected in multiple, and the 52-volt current may be used. Some impedance should be used in series with the transformer on either circuit to regulate the amount of current flowing, and an adjustable coil will be described in a later article.

After completing the primary and its containing cylinder, the plug *J*1, may be removed, and the whole placed in a trough containing melted paraffin. After boiling out for an hour or so, the cylinder is to be filled with the wax from the open end and allowed to cool.

The Secondary.—9 lbs. of No. 32 single cotton-covered wire will be required for the secondary. If the sectional winding is used, a section former will be required. The reader is referred to previous articles for a description of the former, if he is not at all familiar with its construction. Briefly described, it consists of two discs of wood or preferably of heavy brass, in the present case, 7 in. in diameter, and between these discs a smaller disc of ¼ in. thick brass. The whole is mounted in a polishing lathe or other means of support. The diameter of the smaller disc is 3⅞ in. for the sections of this transformer.

The wire should be thoroughly dried in an oven for several hours prior to the winding. Be careful not to char the insulation by having the oven too warm. The spools of wire should be immediately placed in melted paraffin as soon as removed from the oven, and after a thorough boiling out until no more air bubbles arise, they may be placed where they will keep hot until ready to be wound. A suitable support is arranged for the spools, and the section former firmly secured to the table. A small alcohol lamp placed between the spool and the former will keep the wax hot as the winding is done. Each section should be wound to a diameter of 6½ in., winding with moderate tension and taking care to see that the wire forms naturally into layers as it will if held at a considerable distance from the former. As each section is wound, allow sufficient time for the wax to set, and then remove former from the lathe. The center disc should have a slight taper to facilitate removal of the wire. Gently tap one side of the former and remove the disc. The annulus of wire will then be exposed. Tap the center disc gently, and it will be loosened enough to permit its dropping out from the center of the section. A final tapping on the edge of the remaining disc will enable the wire to be removed in the form of a solid ring. The exact number of turns placed in each section, and, therefore, the weight of wire, will vary considerably with different builders. For this reason, there may be a few ounces of wire left over when the 28 sections have been wound. In such an event, a few more sections may be added if there is sufficient wire. It is desirable to use an even number of sections on either side of the center piece, *H*, as this permits the use of two outside ends of the secondary winding for connection to the terminal pillars.

The sections are to be assembled in pairs with four thicknesses of filter paper or two thicknesses of heavy paraffined blotting paper between them, and the two inside wires joined and soldered. Be careful to see that the current flows in the same direction through both sections when they are so connected. This will be assured if the two outside ends are pointing in *opposite* directions when the pair is connected. Bind each pair of sections with strong thread and place them in two piles of seven pairs each, ready for assembling.

Four large washers of wood will be required for the ends of the secondary units. These washers may be turned of whitewood 7 in. in diameter, and with a 3¾ in. hole in the center. They should be a tight fit over the primary casing. For the secondary covering, two pieces of cardboard cylinder 7 in. inside diameter and about 6 in. in length will be required.

Lay off the center of the primary tube and place a wooden disc ⅜ in. from either side of the center. This will leave a ¾ in. space for the support *H*, which is made in two pieces. See that the wooden discs are a close fit into the ends of the cardboard cylinders, as these joints should be sufficiently tight to hold the hot wax which is poured into the cylinders. Stand the primary tube on end and place a pair of sections in position on the wooden disc. With a spoon made quite hot, ladle hot paraffin or beeswax into the space between the section and tube, allowing the wax to cool, and as it shrinks, add more until the entire space is filled with wax. If the builder has no vacuum impregnating chamber at his command, it is advisable to pack the space between section and tube with the "lint" produced by scraping a piece of clean blotting paper with a knife. If this is done the paper discs between sections will have to be made with a larger opening, so that the packing may be done from the upper side. This packing will absorb a large quantity of wax and there will be very little danger of air bubbles forming in the space between section and tube. The discs between pairs of sections are similar to those between individual sections, with the exception that they should be a close fit on the tube. After the seven pairs of sections have been placed in position, the outside ends of the wire of the adjacent pairs are to be carefully joined and soldered, using rosin as a flux. If the assembling of the pairs has been correctly done, it makes no difference which way the pairs go on the tube. To make doubly sure, however, it is well to see that all outside wires point in opposite directions when the sections are placed side by side. When all connections have been made, start at one end of the unit and see if the path of the current is in one directon around the core. If the direction is reversed by the mis-placing of a section, the mistake must be corrected. Finally, if the connections are found to be correct connect the two end wires of the unit in series with a battery and galvanometer, or other means of testing the winding for continuity, and see that there are no open circuits in the secondary. If this unit is found to be perfect the end disc of wood may be placed in position, and the cardboard cylinder forced over the secondary, bringing the fine wires out through small holes near the edges of the discs.

Invert the tube so that the second unit may be built up, and proceed as with the first. After the tube is placed over the second unit, carefully make a ½ in. hole at either end of each tube, through which the wax may be poured. The two ends of the wire from the units at the point where the piece *H* is placed are to be joined and soldered. Prepare a supply of paraffin wax and have a good pouring dipper ready. When the wax is good and hot, carefully pour into one of the holes in each tube, and continue to pour until the wax appears at the other hole. As the wax settles and shrinks on cooling, continue to refill the cylinders until both are entirely filled and the wax has hardened. When the wax is quite hard and cold remove any overflow around the holes and cover the cylinders to suit the taste of the builder. The very thin veneer which comes in rolls may be used to cover the cylinders, and it gives a rich and pleasing finish, especially if the veneer selected matches the rest of the wood used in mounting the coil. Very thin hard rubber is also used extensively for this purpose, but its appearance is not so agreeable unless the coil supports are also made of rubber, the cost of which would, in this case, be prohibitive.

The Mounting for the coil is best constructed of oak or whitewood, unless the builder wishes to use some other wood to match the furniture and other instrument cases in his laboratory. A wax finish is preferable to varnish in most cases, although this feature also rests with the individual. The dimensions of the transformer mounting may be taken from the drawing on which a scale of inches appears. The principal dimensions are as follows: supports, *H*, *H*1, *H*2, are of ¾ in. stock, 8½ x 8 in., with an aperture in the center to take the tube covering primary. The center piece *H*, is split in two pieces so that it may be placed in position between the secondary units. Base of ⅞ in. stock 20 in. long by 10 in. wide, finished to suit builder. Cross piece *L*, of ½ in. stock 8½ in. wide by 15 in. long. If a few extra sections are added to the secondary, the longer dimension of this piece will, of course, have to be modified accordingly, as will the length of the cardboard tubes covering secondary.

The mounting of the coil is held together with brass wood screws, those holding the cross-piece in position preferably having round heads, while those passing through the base should be flat-headed screws.

The Terminal pillars *K* and *K*2, are of fiber, and their construction should be clearly understood from the drawing. The pillars are 1 in. in diameter and 2 in. high. After drilling and tapping holes for the screws and studs which may be 8-32 brass ones, the cylinders are mounted in the lathe and the surface covered with a thin coat of shellac. Starting at the lower end, wind the entire surface of each cylinder with one layer of No. 32 s.c.c. wire, or if enameled wire is available, use it in preference, on account of the better appearance. The starting end of the winding on each cylinder is connected to one of the wires from secondary unit, while the top end of the winding on cylinder is connected to the stud or terminal. The safety gap electrodes $K1$, may be made of brass or aluminum, and the gap should be ⅝ in. in length. The purpose of external inductance on each pillar is to prevent the high voltage surge from striking back into the secondary of the transformer and breaking down the insulation.

Any one of several methods may be used to secure the terminal stud in the fiber pillar. If brass is used for the gap electrodes the studs may be sweat-soldered into the brass and finally, when screwed home, a small pin through the brass and into the fiber will insure permanency.

The safety gap must not be confused with the regular spark gap of the outfit, as its function is merely to afford a path for the back surge to discharge across, for it is placed beyond normal sparking distance of the coil. While the coil is in operation, a crashing white spark will appear at intervals in the safety gap.

This transformer is designed for use on alternating current lighting circuits with a frequency of 60 cycles. At higher frequencies the coil will operate satisfactorily, although the output will be somewhat less unless the impedance in series with transformer and line is cut down somewhat. The condenser capacity will also have to be changed for operation on higher frequencies.

With the resonator, condenser and transformer described, no difficulty should be experienced in obtaining streamers from the terminal of the resonator up to 18 in. in length. If the primary helix of the resonator is made slightly larger in diameter and with a few less turns (10 in all) the discharge may be lengthened as the insulation is increased. The sparking distance to a rod held in the hand is from 12 to 16 in., although, with very careful tuning and close adjustment of the amount of current flowing in the primary of the transformer, this distance may be considerably increased. The process of tuning includes adjustments of the condenser, plate by plate, almost infinitesimal variations of the length of spark gap, and a careful adjustment of the position of the clip from gap to helix. A quarter of a turn on the helix sometimes makes an astonishing amount of difference in the results obtained.

In the early high-frequency apparatus very little was done to bring the various parts of the outfit in resonance, and this probably accounts for the fact that it was thought necessary to expend from 3 to 4 kw. of energy in order to get a 12 or 15 in. spark. The spark produced by the apparatus described is by no means a thin one, and it compares favorably with that given by some of the highest-priced apparatus on the market. The efficiency of the air-insulated coil is, of course, lower than that of the high-grade commercial oil-insulated types on the market, but the advantages of portability, mechanical strength, light weight, and last, but not least, the truly startling display of "electrical fireworks" produced by the air-insulated Tesla or Oudin are not to be overlooked. For the traveling lecturer or for those who desire to use the apparatus for the purpose of entertaining the public, one of these coils will prove most useful. They are easily constructed by the average handy man, and for those who have not the facilities for doing the machine work on the coils, the finished sets of parts and wound secondary coils may be purchased from advertisers in this magazine at very reasonable prices. The secondaries usually present the most difficulty for the amateur worker, and it is in this part of the coil that the greatest liability of failure is present.

The primary helix of the resonator and the transformer with condenser constitute the chief essentials for a high-grade wireless telegraph installation, and by winding a second drum with 30 turns of narrow copper ribbon, this to replace the secondary of the resonator, the builder will have an oscillation transformer which will give good service in a wireless installation.

The outfit may also be used for X-ray work, and in this capacity, it is in many respects preferable to a large induction coil. With the resonator described, together with a $\frac{1}{4}$ kw. transformer using but 2 amperes in the primary, the author has obtained excellent radiographs of the bones in the hand and wrist in a very few seconds' exposure. The spark length was cut down to about 6 in., and the helix placed slightly out of tune so that the discharge would not injure the tube. For this purpose a special tube is necessary, as the ordinary form of induction coil tube blackens quickly when used with high-frequency current.

GAS ENGINE TROUBLES

Some of the troubles that the operator of a gas or gasoline engine is apt to encounter have been put in the form of a troubleman's report and printed in *Gas Review*. The following, which is an abstract of one of these articles, deals with troubles experienced in starting balky engines.

Engine stopped of its own accord while running. Owner cranked it but it would not go. He looked it over and over again but no fault could he find. His neighbors told him that such spells were natural with all gasoline engines. When we arrived, he and his family and the neighbors promptly gathered around the "brute" to learn what could have caused "her contrariness." Some of them remarked that they did not believe that anyone could start that engine. The owner was pretty sure that the trouble was due to leaky compression, because by holding the charge in a compressed position he could hear a slight escape of air.

We jerked the flywheel backwards and it promptly sprang back, showing that the engine had ample compression to start. We examined the intake valve; it was not stuck. We ascertained that the needle valve opening on the carburetor was not clogged, so the trouble was not with the engine's failing to get gasoline, or with the compression.

TESTING IGNITION

The trouble must be with the spark. We then put on the switch and tested for a spark with a metal wrench by holding it in contact with the insulated electrode on the igniter and the metal of the engine, and on breaking the contact it gave no spark. This indicated that there was no current or else that the sparker points were in contact all the time.

On moving the snapper tongue on the igniter we could hear the points come together, so the igniter points were not in constant contact and the movable electrode was not stuck. The trouble must be either with the battery or with the electrical contacts between the battery and the engine. On examination, all the connection nuts and the switch were found to be tight. One other contact needed to be looked to and that was the circuit breaker. To the eye the circuit breaker seemed to be O.K., but on springing or pushing the contacts together firmly and trying again with the metal wrench for a spark, a fine spark was obtained on breaking the contact.

Hence the cause of all this trouble was due to faulty contact at the circuit breaker. The remedy was to bend one of the circuit breaker brass contacts so that they went into firm contact when the exhaust valve was in a closed position.

In this engine the circuit breaker electrodes made a sliding contact. The constant sliding of one electrode on the other wore the metal away until they failed to touch. When examining for sparking troubles, don't overlook the connection at the circuit breakers. It is equally as important as any other connection.

As a result of this treatment and a fifteen minutes' lecture to the owner on "What makes a gasoline engine run," the engine is still going and will most likely keep going. What we need most for the good of the gas engine is better general knowledge of the elementary principles on which it operates.

BATTERY RUN DOWN

No spark. All connections good. Wired properly. Water oozing out of three of the dry cells. Snow on top of other two cells. Much snow in the battery box due to drifting under a loosely fitting battery box cover. Engine exposed to weather. Ammeter showed the cells to be dead.

The cause of the dead cells was due to the snow (a good electrical conductor) short-circuiting the cells; in other words, the snow connected the carbon battery post to the zinc cup edges, thereby running them down in a short time. The water oozing out of them was a sure sign that they had been short-circuited. When a dry battery is discharged quickly water runs down its sides and wets the paper cover and sometimes stands in little puddles on top of the cell. This water does not freeze, due to the chloride in it which makes it anti-freezing. On a freezing day this is a sure sign that the unfrozen water on the cells came from them and that it did not rain in or get there otherwise.

A new set of cells is the only remedy. A good spark and engine starting nicely was the result of putting in a new battery.

AIR SUPPLY

In another plant the engine was stationary, vertical, 4-cycle with a gasoline pump feed. No priming cock on the engine. Priming was done by lifting an air throttle damper, thereby making the engine suck in its priming charge through the carburetor.

By cranking very fast it would start and when started would run perfectly. It was notoriously hard to get the first explosion. When examining this engine, we tried the effect of placing one hand over the opening in the air intake pipe and found that when we did this the engine would start nicely with our hand excluding some of the air, but when the air damper only was lifted the engine would not go except after prolonged cranking. The trouble was thus proven to be in the air damper.

On taking out the air damper, four holes about ¼ in. in diameter were found to be bored through the circular disk that was intended practically to close the air pipe.

We plugged up these four holes with lead so as to exclude more of the air when the damper was raised in starting position. This was the nicest starting engine we ever saw after this treatment.

It is sometimes as necessary to look after the air supply as it is the gasoline supply. Excluding some of the air makes harder suction on the gasoline and makes the engine take a richer mixture, which sometimes aids in starting.

FLOODED CYLINDER

On another occasion every part of an engine was found to be in good running order on examination and we suggested to the operator the possibility of his engine's being flooded with gasoline. He said that he did not think so and proceeded to examine to satisfy hinself that it was not flooded. He caught hold of the flywheel and turned it over several times, holding his ear near the cylinder. He pronounced the engine not flooded.

We wondered what new method this was. It was certainly new to us and we promptly asked him how he knew the engine was not flooded. His answer was to the effect that he could not hear the gasoline "slosh." Is there a man who reads this magazine who thinks that it requires enough gasoline in the cylinder to hear it splash on moving the piston to cause a flooded condition of the engine?

That engine was flooded badly, but it did not have enough gasoline in it to hear it spash.

We shut off the feed by closing the needle valve, opened the air damper wide so as to supply air with which to burn the gasoline, and put on the battery switch and then cranked her over from twenty to thirty times, when it started to igniting and exhausting a cloud of black smoke. After eight or ten ignitions she began to miss fire, whereupon the needle valve was opened to give more gasoline. The engine then worked like a top.

We once visited a similar case in which the owner gave as his reason for knowing the engine was not flooded, "that gasoline did not run out of the igniter opening when he took out his igniter and introduced a paddle," and because gasoline did not wet the paddle he was sure the engine was not flooded. Who's to blame for such ignorance? Is there any wonder that all gasoline engines do not always run?

You can't tell by any of these methods

(*Concluded on page* 137)

DIMINUTIVE CENTRAL STATION AT LEWIS, IA.

Gasoline-Electric Equipment Supplying Energy to a Town of 650 Inhabitants

J. H. KUHNS

The problem of electric lighting and power service for villages and small towns seems to be finding satisfactory solution in the gasoline-electric generating sets designed originally for the United States government for the long continued and rigorous duty in seacoast fortifications. The successful use of these sets in a number of the forts has suggested their broader commercial utility. On January 6, the Lewis Electric Light & Power Company started to operate at Lewis, Ia., what is believed to be the first central-station plant exemplifying the applicability of these gasoline-electric sets for street and general commercial lighting and motor service. Already there are connected to the circuits eighty customers, twenty-five of whom are new users of electric energy. Over 800 lamps, or an average of over ten lamps per customer and nearly one and one-quarter per individual member of the town's population, are connected, with still a large reserve of undeveloped business to draw upon to build up a profitable station load.

Lewis is a small town of 650 population in a rich and fertile section of the best farming country in Iowa. Farm lands are valued here at about an average of $150 an acre. Much seed corn is raised and shipped from this center. One of the most prominent horse and cattle ranches, handling high-grade stock is located close by. As a town it has had a varied history, dating back over sixty years.

Lewis was at one time the county seat of Cass County, but was outrivaled for that honor by the more populous thriving little city of Atlantic, which has the good fortune to be situated on the main line of the Rock Island Railroad. With the building of the Atlantic & Griswold branch of the Chicago, Rock Island & Pacific Railroad a few years ago, now a connecting link between Atlantic and Red Oak, an important town on the main line of the Burlington route, Lewis spread out to the west, doubling its area and extending to meet the railway which crosses from north to south the extreme west end of the town. The railway station is at the foot of Main Street, a block west of the electric light plant. This newer portion comprises the principal business and newer residence part of the Lewis of today.

Five or six years ago there was installed an electric light plant in connection with a mill operated by water-power and later by steam. It met with but indifferent success in the hands of various parties. An unsuccessful effort was made to dispose of the old plant and system to the town at a considerable loss. It was then entirely dismantled and removed, a portion of the machinery being transferred to another town.

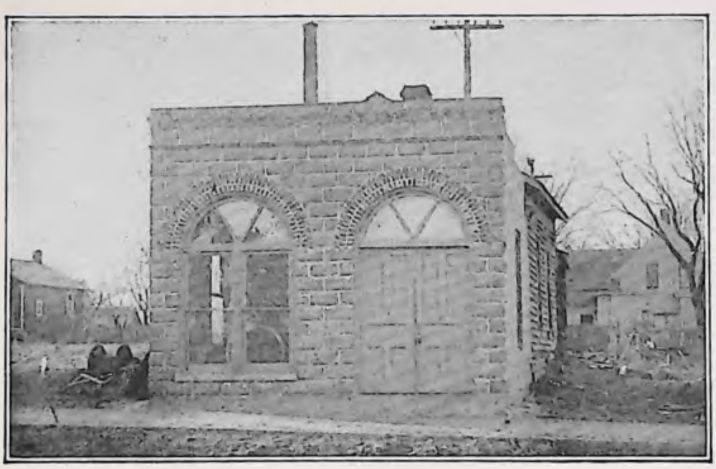


Fig. 1. Exterior of Central Station

For the erection of a new plant upon more modern and progressive lines a group of business men organized the Lewis Electric Light & Power Company with the following officers and board of directors: Prof. S. W. Rowley, president; Mr. David Hickman, vice-president; Mr. William B. Davis, secretary; Mr. Ivan H. Beardsley, manager and engineer, and Messrs. Daniel Stevens, Bert

Hardenberg, W. W. Albright, V. M. Elstin and M. H. Elliot, directors. The company is capitalized for $5,000, all stock being common and issued at a par value of $10 per share. No bonds have been issued. The primary purpose has been to install a thoroughly good plant and equipment, and to this end the actual cost has exceeded the capitalization, which is permissible by Iowa State law, the whole costing in round numbers, $6,000. In addition, $500 to $1,000 worth of supplies is carried for the convenience of consumers. The company is operating by agreement under a franchise granted other parties some years ago, as did its predecessors, no transfer of franchise rights ever having been made. After three years the town may acquire the plant, if desired, upon payment of a valuation determined by a committee of three appraisers, one appointed by the town, one by the company, and these two to select the third.

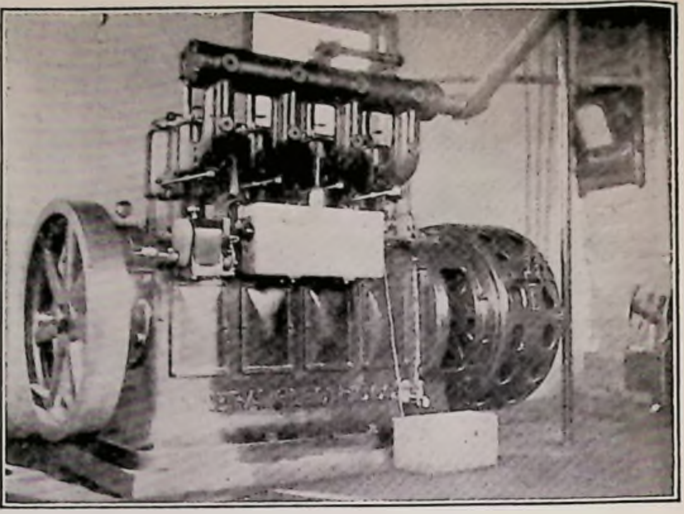


Fig. 2. Gasoline-Electric Generating Set

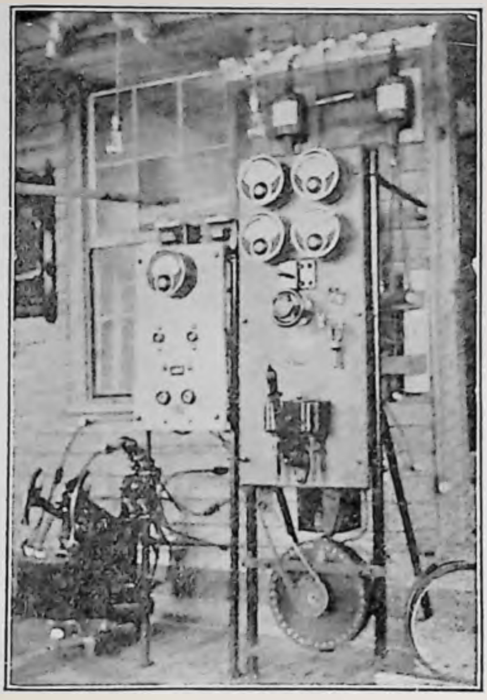


Fig. 3. Switchboard Panels

The central station is located on Main Street, which is the principal thoroughfare, and is installed in a low one-story building for which a mere nominal rental charge is paid, the company having the option to buy the property later at the value of the land plus the cost of the improvements and simple interest on the same. To the front of an old frame building about 16 ft. x 28 ft. has been built a neat, well-lighted concrete blockroom, about 16 ft. x 16 ft., carrying the building to the lot line and affording ample space for the generating set and switchboards, and such desk room as is needed for the ordinary office business of the company. In this room, which is finished in natural pine with plastered walls, has been installed a standard General Electric 25 kw. gasoline-electric generating set composed of a 4-cylinder, 4-stroke cycle, vertical water-cooled, 43-54 h.p. gasoline engine direct-conneetcd to a 3-phase, 2,300-volt, 600-r.p.m. alternator with a 125-volt exciter mounted on the same shaft and in the same frame. The whole is so constructed as to insure permanent alignment and prevent objectionable vibration.

The carburetor is of the constant-level type, and the gasoline is delivered by a pump connected to the engine through pipes direct from a 120 gal. tank set in the ground back of the station at a safe distance from surrounding

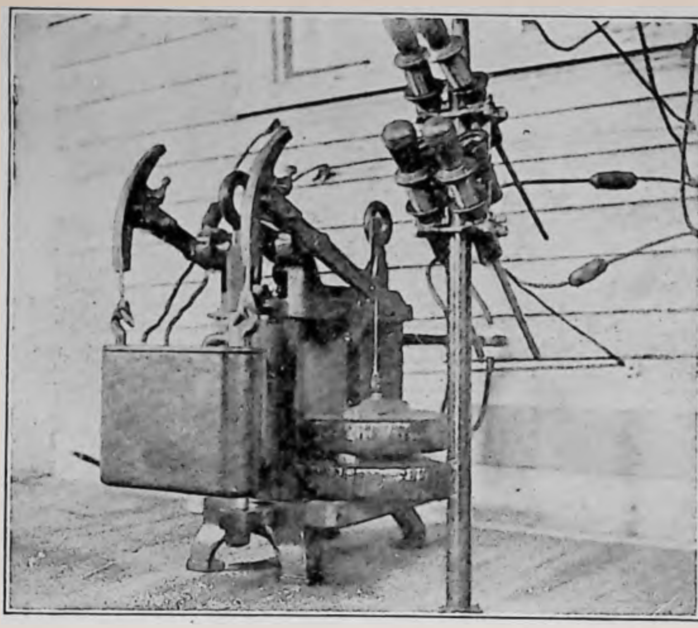


Fig. 4. Constant Current Transformer

buildings. Ignition is furnished by high-tension magneto with starting battery. Lubrication is effected by means of forced circulation through a pump connected with the engine.

With the generating set is a slate switchboard panel mounted on iron frames and with three ammeters, one voltmeter, an instrument plug switch for voltage indication, one single-pole carbon-break switch, one automatic oil circuit-breaker line switch and rheostats. Instrument transformers are mounted above and back of the board.

For street-lighting service a 4 kw. constant-current transformer has been installed, and with it a gray marble switchboard panel mounted on iron frames and carrying an ammeter and a 4-point plug switch. On a board near the generator set are mounted in convenient reach suitable wrenches, spanners and repair parts and tools.

To cool the engine cylinders a battery of five galvanized cylindrical steel tanks 6 ft. in diameter and 8 ft. high have been installed in the old part of the building adjoining the generating room and slightly above the level of the latter. By means of a pump connected with the engine the water with which these tanks are filled is kept in constant circulation during operation, thus dissipating the heat from the engine jackets. It was at first attempted to effect this water-cooling by using a single small tank and pumping cold water direct from a well at the rear of the building. This proved inadequate because of difficulty with the pump and frequent need of pump repairs. Hence the well and pump method was abandoned and the tank system substituted. The rest of the space in the old part of the building is utilized as a stockroom for wire and supplies.

Insufficient data have as yet been taken to ascertain the amount and cost of fuel per unit of energy. However, for a period of fifty-three days, from January 21 to March 15, there has been an average daily consumption of 21 gallons of gasoline at 11.7 cents per gallon.

Evening lighting service is furnished from dark until 11 o'clock daily except Saturday, when service is extended until 12 midnight; and morning service from 5.45 until daylight. Thirty-two 6.6 ampere, 32 c.p. series tungsten lamps at street crossings are lighted during the regular operating hours, modified by a moonlight schedule. For this service the town pays $1 per light per month. A few additional street lamps in the residence portion will be added soon. For commercial lighting a combination

Fig. 5. Modern Cottage at Lewis, Pa.

schedule of flat rate and meter rate has been arranged. For a small number of lamps the charge for energy per month is 75 cents for a 16 c.p. lamp, $1 for two, $1.50 for three. When there are more than three lamps the circuit is metered. Consumers may own their meters or the company will furnish them on a rental charge of 25 cents per month. The company now has $260 in rented meters in service and about as many more are owned by consumers. The meter rate is 15 cents per kw.-hour up to 20 kw.-hours and 10 cents per kw.-hour for all energy in excess of that amount.

Consumers furnish their own wiring, fixtures and lamps, the company furnishing service connection to the house entrance. The company has adopted the policy of wiring houses at an advance of 10 per cent. on the cost of materials, with a charge of 30 cents an hour for labor. Lamps are sold at 25 cents for a 16 c.p. carbon, 80 cents for a 40-watt and $1.10 for a 60-watt tungsten lamp.

Probably the best lighted house is a very pretty modern cottage at the corner of Main and Washington Streets, where twenty-three 40-watt tungsten lamps are used. The attractiveness of this well-lighted house sets a commendable example for others there and elsewhere. Liberal use of light goes a long way toward solving the problem of lighting villages and small towns, and promotes a spirit of progress that soon puts the town out of the rural village class, increases business and enhances property values.

Negotiations are under way for operating the town pumping plant by means of a 3-phase motor. The town has already bought and installed a 5 h.p. Fairbanks 3-phase, 60-cycle, 220-volt motor belted to a countershaft, and the company has run a special set of primary feed wires from the station to the pumping plant on Market Square to provide for this service. The water is lifted by a Deming pump from a 65 ft. well to a water tower on the Public Square six blocks distant on higher ground in the old part of the town. A 6 h.p. gasoline engine is now used for pumping, but it is estimated that not over 3 h.p. is required.

Fig. 6. Pole and Transformer in Pole-Line Distribution System

It is thought that by slight additional running time, or by operating a few hours in the day once or twice a week, the pumping can be done at a saving to the town and a profit to the company. The gasoline engine at the pumping station will be retained for auxiliary or emergency pumping service and probably operated by the company for the town at about actual cost of fuel and labor. A two months' trial will be given before closing negotiations.

There seems little demand in a place of this size for a day load. A possibility spoken of by the management is that in case of doing the water-works pumping it may be arranged to run the electric service on Tuesdays to care for washing machines and laundry irons, that being a convenient time for most housewives.

An electrical exhibit, perhaps with some of the practical domestic apparatus for heating and cooking, is contemplated in connection with the annual school exhibit about commencement time. It would be strange, indeed, if the intelligent demonstration by these bright young people of the utility, simplicity

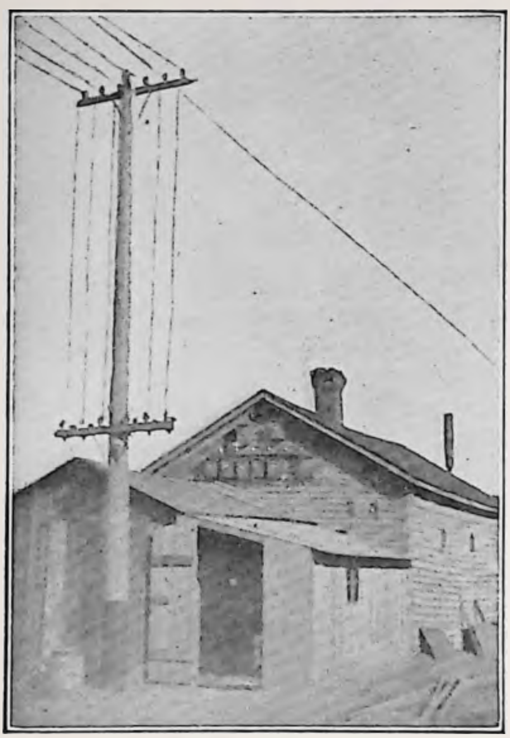


Fig. 7. Rear of the Central Station

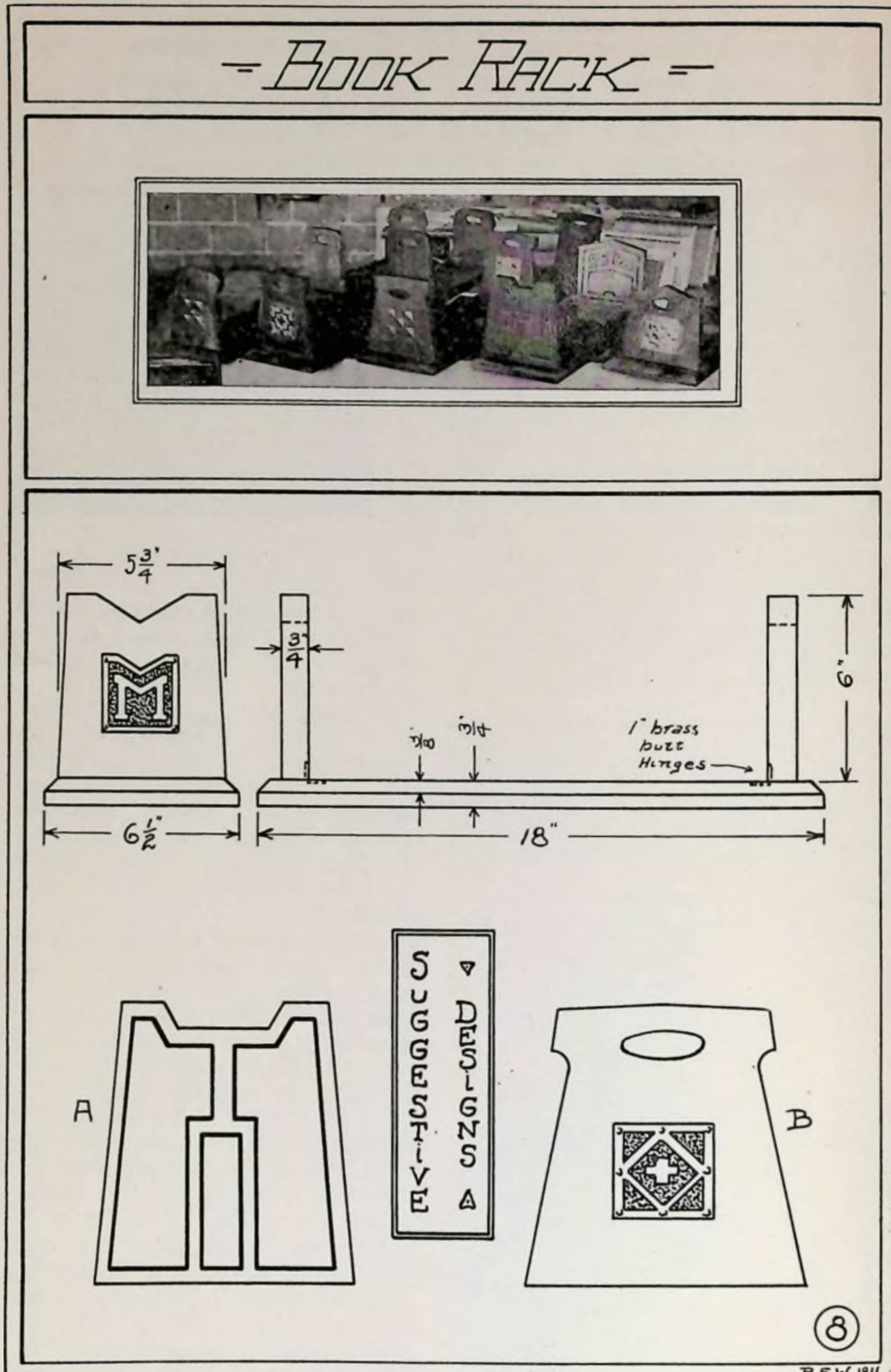
Fig. 8. Water Tower

and convenience of such appliances did not influence their parents and friends to put some of these appliances into their homes.

Leaving the generating room all primary mains and feeders are carried from the back of the station to the pole line in the alley at the rear. The station equipment and circuits are protected by lightning arresters, inserted where the lines leave the building. Additional lightning arresters will be placed upon the lines.

All primary and street-lighting circuits are of No. 10 weatherproof copper wire and the secondaries are of No. 6. The pole line exemplifies good regular engineering practice, though heavier poles would be an advantage. Much credit is due to the company's electrician, Mr. Ivan H. Beardsley, for his skilful construction. White cedar poles of 25 ft., 30 ft. and 35 ft. lengths, supplied by local dealers, are set from 110 ft. to 125 ft. apart.

The entire equipment was supplied by the General Electric Company and installed under the supervision of an engineer from its Chicago offices. The service is said to be unsurpassed by that of any other town of similar size.—*Electrical World*.


BOOK RACK
5 3/4"
3/4"
6"
3/8
3/4
1" brass butt Hinges
6 1/2"
18"
SUGGESTIVE DESIGNS
A
B
8
R.F.W. 1911

THE HOME CRAFTSMAN

RALPH F. WINDOES

BOOK RACK

The book rack offers an excellent opportunity for the amateur craftsman to exercise his ability as a designer. The ends of the same can be shaped and decorated in a great variety of ways, some suggestions of which are here illustrated. The material to purchase for one of these racks is given below. Oak is an excellent wood to use, but it is very hard for the beginner to utilize, so it is advisable for him to purchase whitewood.

1 piece ¾ x 6¾ x 31 in., smooth two sides; four 1 in. brass butt hinges, with screws; 30-gauge brass; small brass escutcheon pins; fine steel wool; banana oil; stain and prepared wax.

Begin by scraping and sanding one surface of the board perfectly smooth. Saw off a piece about 18¼ in. long for the bottom. Plane one edge and one end of this. Set the gauge at 6½ in. and mark the other edge. Plane this down to the mark. Measure the length, 18 in., and square across. Plane the end. Bevel the edges on the smooth face with a ⅜ in. bevel as seen in the drawing.

Next decide on the shape of the ends you are going to use. Make a full size drawing of an end on paper. Cut the remaining piece of wood in two and place the ends of each piece together. Nail them with two nails leaving the heads above the wood so that they may be withdrawn. Trace the design on the wood and cut the ends out together. Be sure that the grain will run perpendicular to the bottom piece. Smooth them up and separate them.

You are now ready for the design on the ends. The photograph shows a number of different ways in which this can be accomplished. Two of these are decorated with carving, three with brass panels, two with fancy headed tacks, and the remaining two are undecorated. If carving is the choice we will suppose that the design at *A* has been selected. This must be drawn out full size and then transferred to each end with carbon paper. Next, a veining tool needs to be secured at a hardware store and these lines cut out with it.

B shows a brass panel with a pierced design. From some 30-gauge brass cut a piece 2½ in. square. Draw an appropriate design and transfer it to this piece. Lay the metal on a piece of soft wood and pierce around the outline and inside the spaces as shown in the drawing. This can be accomplished with a nail slightly pointed. This piercing makes the parts unpierced stand out, and they can be polished highly with steel wool, after which a coat of banana oil must be given the piece to prevent its tarnishing. A panel for the other end must be made in the same way.

Next set the hinges, two on an end, flush with the surface of the wood. To do this, place the ends and the hinges into position and mark around the latter with a knife. Chisel places out so that they are flush with the boards and screw them in place.

Now you are ready to finish the piece. If oak has been used the wood will require a filler, as has already been described. If a close-grained wood has been employed it will first need a coat of stain, then a coat of shellac, and, lastly, a coat or two of wax. The stain may be purchased ready for use, also the wax, which should be applied according to directions found upon the can.

If the carving decoration was used the rack will require nothing more, but if the brass panels were chosen they need to be mounted with escutcheon pins.

Desk Set

The desk set here illustrated consists of two pieces and comprises three articles, a paper knife, an ink bottle holder and a pen tray. It is made entirely of copper or brass with a square glass ink bottle. It is not difficult to make, and it is advisable that every craftsman attempt it.

The new materials needed are: 20 gauge copper or brass; 1¼ in. square glass bottle; a few rivets.

First, make the tray. It will probably not come out to the exact dimensions given on the drawing, but the craftsman should try to make it come so.

A piece of metal 4¼ x 11¾ in. will be needed. First draw a rectangle 2½ in. x 8 in., as shown. These lines should be scratched over so they will be permanent. Inside of these draw another rectangle in pencil, making the lines about ¼ in. from the larger one. The metal between the two needs to be stretched to form the hollow part of the tray. This is done, with the ball-pein of the hammer, by pounding this space evenly on a flat metal surface like the face of a flat-iron. The hammering has hardened this metal so it needs to be annealed. Annealing is accomplished by heating it red hot and allowing it to cool naturally, or by dipping it into cold water. This softens the metal again. A very good way to heat it is to place it in a stove on the hot coals or place it over a gas plate. It will probably be necessary to anneal it two or three times during the making. Next, take a piece of hardwood about ⅞ in. thick and place it in the vise so that the grain runs vertically. The edges need to be square. Tip the piece at an angle and place it so that the edge of the block comes exactly below one of the scratched lines. Now drive the metal inside of these lines back to form the bottom of the tray, using the hammer as before. When this is completed turn the tray over and lay it flat on the block. Then go around the edge with the rounded end and turn the edge as seen in the illustration. Smooth it up as well as you can and pound the bottom and edges until they lie flat.

Next lay the ink bottle holder out full size on a piece of paper. Transfer it to the metal with carbon paper and cut it out with the snips. Fold it up and bend the sides as illustrated, and rivet it to the tray, using about three rivets.

The paper knife is very easily constructed. Cut out a piece of metal the exact shape that you want the knife, and lay it on the end grain of the wood. Pound it to shape with the ball-pein as seen in the photograph.

The rough edge is given both pieces by pounding the extreme edge with the ball-pein of the hammer, holding the piece on the flat metal surface during the operation.

Perhaps the best finish for these pieces is a high polish. This can be accomplished with steel wool or pumice stone, after which a coat of banana oil should be given them.

(*To be continued*)

Soldering Aluminum

Among solders most commonly used for this work with more or less success are:

5 parts zinc, 2 parts tin, 1 part lead.

9 parts zinc, 100 parts tin, 165 parts lead.

46 parts zinc, 2 parts tin, 52 parts copper.

10 parts zinc, 100 parts tin, 20 parts silver, 1 to 6 parts aluminum.

70 parts aluminum, 20 parts tin, 10 parts copper or silver.

30 parts aluminum, 20 parts copper, 50 parts zinc.

12 parts aluminum, 8 parts copper, 80 parts zinc.

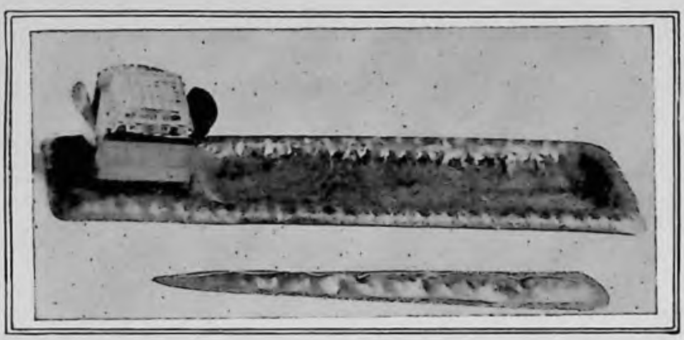
6 parts aluminum, 4 parts copper, 90 parts zinc.

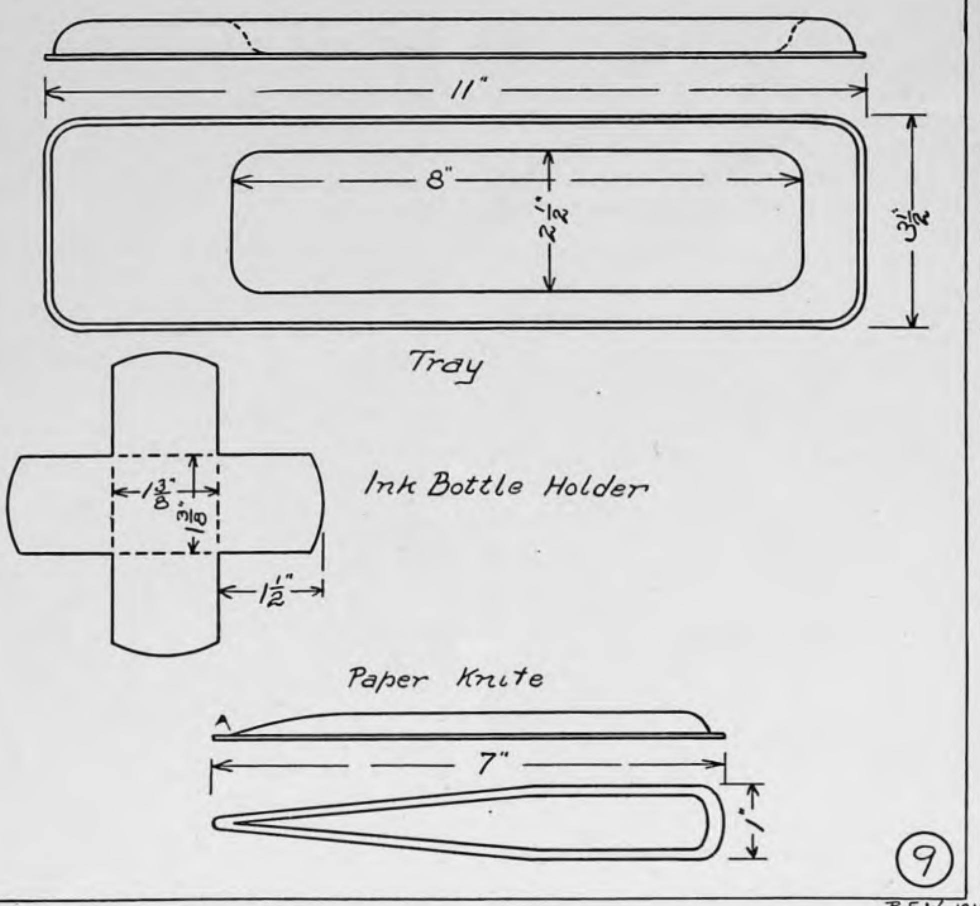
5 parts zinc, 95 parts tin.

With the last five the surfaces should be first tinned. The use of good flux, such as borax, is generally desirable. Quite a number of solders and processes that are trade secrets are now being exploited in the market, some of these being quite satisfactory.

Many authorities recommend that the parts be first tinned with an alloy 1 part aluminum to 5 parts tin, to prevent the film of aluminum oxide that forms on the surface of pure aluminum, and which is the cause of the difficulty in soldering this metal.—*Practical Engineer.*

— Desk Set —




11"
8"
2 1/2"
3 1/2"
Tray
1 3/8"
1 3/8"
Ink Bottle Holder
1 1/2"
Paper Knife
7"
1"
9
RFW 1911

MAKING AN ACCUMULATOR—Part II

WM. C. HOUGHTON

PASTING THE PLATES

Procure a supply of oxide of lead, red lead, known as minium, for the, positive plates, and yellow lead, litharge, for the negatives. Great care should be used to get pure oxides for this purpose. If grids are of the size given in the article in the July issue, about 1 lb. of oxide will be required for each plate.

A supply of pure sulphuric acid should also be obtained. The chemically pure acid is good, but rather expensive. What is known as pure brimstone acid, guaranteed free of iron and arsenic, is equally good for this purpose and can be had for about three cents per lb. in moderate quantities. Make a dilute solution of the acid, five parts water to one of acid. It may be unnecessary to repeat the warning to pour the acid slowly into the water, not the water into the acid. Mix in a glass or earthen vessel, stirring with a glass rod or strip. Use no metal of any kind in mixing the acid or the paste. In short, great care should be used to avoid contamination of the paste or electrolyte in all accumulators.

Take a sufficient quantity of oxide to paste two or three plates, and moisten with the dilute acid and mix thoroughly to a rather stiff mortar or paste. Do not get it too wet. It should be almost mealy. All the positive plates or all the negatives should be pasted first; then everything cleaned thoroughly, to avoid mixing the two oxides. Lay one of the grids on a flat surface, perferably a large plate of glass. Make a wooden paddle, or a strip of heavy glass with corners and edges ground smooth, if possible. Using the paddle like a mason's trowel, fill the holes on one side of the grid, pressing the paste in as compactly as possible and smoothing it off flush with the surface of the grid. Slide the grid off the edge of the glass and turn it over and paste the other side in the same way. Next, hold the plate on edge and smooth up both sides alternately with the end of the paddle. Set away in a warm place and allow to dry 24 hours or longer. No attempt should be made to get a water-smooth surface on the paste. If the paste works at all watery on the surface, too much liquid has been used in mixing, and a little dry oxide should be worked in. When thoroughly dry, the positive plates may be soaked 24 hours in a strong solution of chloride of lime (bleaching powder). They should then be washed and again dried. This partly "forms" the plates and increases the initial capacity.

ASSEMBLING

The grids are cast with two lugs with hooks on them, and are intended to be hung from the edge of the battery jar. If to be used for stationary purposes, no insulation need be used between them if placed about ½ in. apart. If they are to be portable, hard rubber or grooved wooden separators should be put between plates, and the whole held in position by strong rubber bands slipped around them. In any case, they should hang clear of the bottom of the jar ½ in. or more.

For each cell three, five, seven or more plates may be used, according to the ampere capacity desired. There should be one more negative than positive plates. They are to be sandwiched in, negative and positive alternately, with negatives outside.

CONNECTIONS

A sufficient number of connecting lugs should be prepared to join all the positives and negatives, respectively, in each cell. They may be cut from heavy sheet lead ⅛ in. or thicker. Heavy lead pipe may be split and used for the purpose, if no sheet lead is to be had. A suitable extension should be provided on each lug for connection to the next cell. The lugs should have holes cut in them to fit the top lugs of the battery plates. When fitted in place they may be thoroughly "sweated" on with a soldering copper. The solder used should be two parts lead and one part tin. The copper must be well tinned, large and fairly hot, but care must be used not to melt down the lugs entirely.

FORMING AND CHARGING

When everything is ready for the first charge, the jars may be filled with electrolyte. A solution of about one part acid to four parts water should be used. Distilled water or rain water is best. Some city water is all right, but it often contains enough iron or other chemical impurities to make it unfit for the purpose. The electrolyte should have a specific gravity of about 1.150 to 1.200. A hydrometer is almost a necessity if one is to do much work with accumulators. A suitable one may be had for about 75 cents.

The electrolyte must be allowed to cool after mixing before being put in the jars. Charging should begin at once when the electrolyte is put in. A long charge at a very low rate is to be given for the first few times. For a 60 ampere-hour cell the charge may begin at 3 or 4 amperes, dropping slowly to 2 or even 1 ampere. When the voltage of each cell reaches 2.6 or 1 or 2 ampere current, the cell is completely charged. In no case should the charge be continued when the electrolyte begins to boil or gas violently. In such case reduce the rate or stop altogether. If possible, discharge battery at a low rate and immediately recharge. The capacity will steadily increase to a maximum under this process. Do not discharge below 1.8 volts per cell. When down to this point the accumulator is practically exhausted. After wholly or partly discharging, a fresh charge should be put in at once. If to be left unused for some time, a short charge should be put in every two weeks or so.

If it is desired to put a battery out of commission for some time, it should be discharged down to 1.8 volts per cell. The acid is then to be drawn out and replaced with clean water. The discharge is then to be continued until no voltage shows, finally short-circuiting the battery. Draw off the water, put in a second filling and repeat the discharge, if any pressure shows, as it may. Finally, drain the water and the dry plates will keep without damage any length of time.

When put in commission, the battery must be again formed much as when new.

THE RATIONALE OF SCREW-CUTTING

The aspect of this subject which we propose to consider here is the relation between the lead-screw and the numerous pitches which are cut under its control, says *English Mechanic*. Rules are rather numerous and sometimes confusing to a student. Let us get behind the rules and discuss the basis of them all.

The basis is the lead-screw, the pitch of which is ¼ in., ½ in., or ⅜ in.—the last, happily, having fallen into disuse in present practice, is only retained in some old lathes which survive in turneries. Continental lathes, and a few English and American, have screws of metric pitches which simplify calculations much. But the first point to note is that the pitch of a lead-screw, which is unalterable, is the dominating controlling factor in the cutting of threads of all pitches, of whole and fractional dimensions and numbers, and of pitches coarser or finer than the lead-screw. The problem, therefore, is always one of proportion or ratio, and this can only be varied by toothed change-gears, which make a formidable-looking show, puzzling to many beginners.

The most elementary case which can arise is that in which a screw has to be cut having the same number of threads per inch as the lead-screw—say 2 and 2, or 4 and 4. To produce this result, any two equal gears can be used that will connect up between the lead-screw and the lathe-mandrel. The result will be that the mandrel will rotate at the same speed as the lead-screw. Consequently, a tool held in the slide-rest and presented suitably to a bar rotated by the mandrel will trace a thread of the same pitch as that of the lead-screw. If the latter has four threads per inch, or ¼ in. pitch, the thread cut will also be of ¼ in. pitch (Fig. 1).

Next, imagine that a thread has to be cut of a finer pitch than that of the lead-screw—say of eight per inch, or ⅛ in.

pitch. The lathe-spindle will obviously have to rotate at a more rapid rate than the lead-screw, in the proportion of 8 threads to 4 threads, or at just twice the speed; and the smaller change-gear wheel must be placed on the mandrel, and the larger one on the lead-screw (Fig. 2). But, on the other hand, suppose a thread of coarser pitch to be required—say of 2 threads per inch. Then the mandrel must be rotated at a slower rate than the lead-screw, or at just half the rate. Then the larger gear-wheel must be placed on the mandrel (Fig. 3).

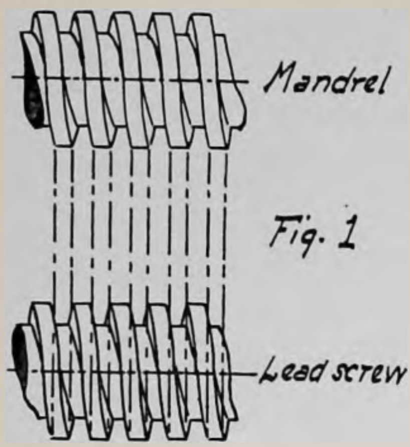


Fig. 1

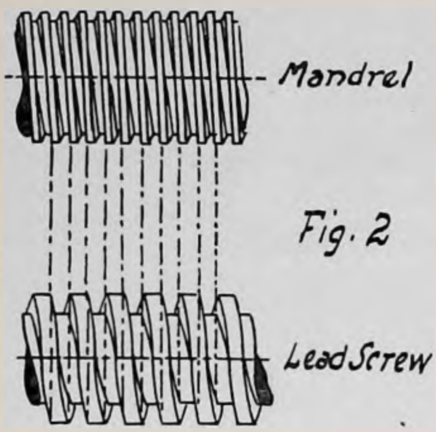


Fig. 2

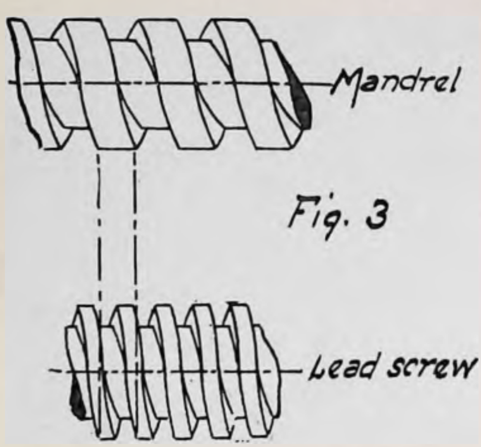


Fig. 3

We may now formulate a mental rule —namely, that to cut any threads of finer pitch than that of the lead-screw, the rate of revolution of the mandrel must be accelerated; and to cut any threads of coarser pitch than that of the lead-screw, the rate of revolution of the mandrel must be retarded. To produce the first result, the smaller gear goes on the mandrel; to produce the second, the location is reversed, the larger going on the mandrel. We also see that a fundamental rule is evolved, which must be committed to memory. It is: "The pitch of the lead-screw is to that of the screw to be cut as the number of teeth on the mandrel gear is to the number of teeth on the lead-screw gear." This rule is applicable to all pitches whatsoever, and shows the relative positions of the larger and smaller gears just noted, for the acceleration, or retardation, of the movement of the tool. Obviously, too, this fundamental rule may be stated in terms of the number of threads per inch in lead-screw and screw to be cut, equally well with the pitch. Therefore one may say $\frac{1}{4}$ in. pitch, or 4 to the inch, $\frac{1}{2}$ in. pitch, or 2 to the inch. The ratio, which is the essential, is unchanged.

Having arrived at these fundamental facts, let us now learn the meaning of the trains of gears which are set up at the left of the head-stock. The simple pair of gears just evolved does not appear there, but three gears, and often four or more. If the wheels on lead-screw and mandrel were geared together, what would happen would be that the mandrel and lead-screw would be rotated in contrary directions, and a left-hand screw would be cut (Fig. 4.) To rotate the two elements in the same direction, an idle wheel must be inserted, and then we have the simple train for a right-hand thread (Fig. 5.) The size of the idle wheel is of no importance. It does not affect the ratios. It is selected of a size suitable for gearing up between the other two. The positions of these are unalterably fixed by the mandrel and lead-screw. But the swing plate permits of a large amount of latitude in the diameter of the idle wheel.

Soon, however, one learns that the limits between which a single combination or simple train are available are very small, though most of the threads in common use are included. Whether pitches are fine or coarse, the same limitations exist, because the differences in the ratios of the gears exceed the number of teeth in the gears which are available or practicable. A gear of 120 teeth is the largest in a set, and one of 20 or 15 teeth the smallest, which limits the proportion available in a single train to 6 to 1, or 8 to 1. When such ratios are exceeded, a process of splitting up is adopted. The number of gears is increased, and the train is compounded of numbers the products of which yield the ratio required (Fig. 5).

Suppose that with a lead-screw of 4 threads per inch, a screw of 32 threads per inch is required to be cut. Proceeding mentally step by step, we find that the speed of rotation of the mandrel will have to be accelerated over that of the lead-screw in the proportion of 32 to 4 = 8 times, and, therefore, supposing a simple train were practicable, a gear would have to be placed on the mandrel having ⅛ the number of teeth of that on the lead-screw. If a 25-tooth gear were on the mandrel, one of 200 would be required on the lead-screw, and this is not available. But if the products of four gears are obtained as 8 to 1, they will do equally well. Now 5 times 5 makes 25, and 10 times 20 makes 200, and 5, 5, and 10, 20, though not actual gears, are factors from which suitable gears can be selected. Sometimes ciphers are added, equivalent to multiplying by 10. Sometimes factors are multiplied by other numbers. Often two factors are multiplied by one number, and two by another, only the numbers so treated must go in pairs, one number in each ratio. Here cancellation affords a simple and ready method, because one can see the evolution of the numbers at a glance.

Thus, factors $\frac{5 \times 5}{10 \times 20}$ may be made $\frac{50 \times 50}{100 \times 200}$. But we get back to 200 again, which is not available. Then, say, $\frac{5 \times 5}{10 \times 20} \times 4 = \frac{20 \times 20}{40 \times 80}$. These would be correct, but two 20-toothed gears might not be available, so say $\frac{5 \times 5}{10 \times 20} = \frac{25 \times 20}{50 \times 80}$, in which two factors—one above and one below—have been multiplied by 5, and two by 4. When in doubt, the proof is

$$\frac{25 \times 20}{50 \times 80} = \frac{500}{4{,}000}, \text{ and } \frac{4{,}000}{500}$$

= 8 to 1, or 32 to 4, the ratio required. When the ratio is obtained, if that is multiplied by the number of threads per inch in the guide-screw, the quotient will give the number of threads per inch which the wheels will cut. Thus 8 = ratio x 4 threads = 32 threads.

As to the disposition of these gears in a train so compounded, since there are now two drivers and two driven, one of each must be placed on the stud. So long as the smaller gears (in this example) are the drivers, either one may go on the mandrel, or the stud. The swing plate allows of a good deal of latitude in such arrangements. The stud for a compound train is twice the length of that for a single train.

If we pass now beyond the limit in the other direction, and have to select gears for a screw of long pitch or lead which is much greater than the pitch of the lead-screw, again a compounded set of gears is required. Say a screw of 3 in. pitch has to be cut with a lead-screw of ¼ in. pitch, the ratio is 4 times 3, or the two screws are as 1 to 12. In this case the mandrel would require a gear with 12 times the number of teeth present in the lead-screw gear, supposing the train were a single one, in order to retard the rate of revolution in that proportion. For the simple train, if we assume a gear of, say, 20 teeth on the lead-screw, the proportion 1 to 12 would require a 240 -toothed gear on the mandrel. So we break up into compound factors thus:

We may start either with assumed single gears, 20 and 240, or with the ratio 1 to 12. Then we might put down $\frac{240}{20}$, and break up $\frac{12 \times 20}{2 \times 10}$, and multiply two factors by 10 and two by 4, $\frac{120 \times 80}{20 \times 40}$. Or put down $\frac{12}{1}$, and multiply each, say, by 4, $\frac{12}{1} \times 4 = \frac{48}{4}$, and then break up $\frac{4 \times 12}{4 \times 1}$, and multiply, say, two factors by 20 and two by $10 = \frac{80 \times 120}{40 \times 20}$. In each case the proof is

$$\frac{120 \times 80}{20 \times 40} = \frac{9{,}600}{800} = 12, \text{ or } 12 \text{ to } 1.$$

Our ratios have hitherto been those of whole numbers; we have not been bothered with fractional parts. But we might have to deal with these, such as a pitch or lead of $3\frac{3}{8}$ in., or of $6\frac{5}{8}$ in. Or, on the other side, one of $6\frac{1}{8}$ threads to the inch, or $9\frac{7}{8}$ threads to the inch. The first kind are much more frequent than the second, and some pitches are very much larger, as in cutting spiral gears on milling machines, which is, after all, only screw-cutting.

All one has to do in these fractional pitches is to make the fraction the basis of the ratio, and turn fraction and whole number into a whole number, stated in terms of the fraction. The two cases just mentioned, in which, respectively, the number of threads is given as in 1 in. of length, and in which a thread exceeds 1 in. in length, must be taken separately.

Taking the case of a number of threads per inch of length, if the fraction is $\frac{1}{8}$, the whole number is multiplied by 8; if $\frac{1}{4}$, the whole number by 4. Thus, for $3\frac{3}{8}$ threads per inch, say $3\frac{3}{8} \times 8 = 24 + 3 = 27$ eighths. For $6\frac{5}{8}$ threads per inch, say $6\frac{5}{8} \times 8 = 48 + 5 = 53$ eighths. For $6\frac{1}{4}$ threads per inch, say $6\frac{1}{4} \times 4 = 24 + 1 = 25$ fourths. The denominator of the fraction, therefore, is used to multiply the whole number by, and the number representing the numerator is added. But the number which stands for the number of threads per inch of the lead-screw must also be multiplied by the denominator of the fraction in order to divide up the lead-screw into the same terms or ratio. Thus, since $6\frac{5}{8}$ has been divided into 53 eighth parts, if the lead-screw which has to cut it has 4 threads to the inch, then we must say $4 \times 8 = 32$ eighth parts, and the ratio will stand

$$\frac{53 \text{ screw to be cut}}{32 \text{ lead-screw}}$$

That is, if the length of 1 in. of the screw to be cut is divided into eighths, there will be 53 eighth parts in that inch (Fig. 7) And if the length of 1 in. of lead-screw is divided into eighths, it will have 32 eighths in that part. And a complete number of threads first coincides with an exact number of inches at 53 turns, corresponding with 32 threads on the lead-screw, both occurring at a length of 8 in.—8 being the denominator.

Or, taking $6\frac{1}{4}$ threads per inch, which is 25 fourth parts, the ratios will be, since $4 \times 4 = 16$

$$\frac{25 \text{ screw to be cut}}{16 \text{ lead-screw}}$$

Here there will be 25 fourth parts in 1 in. of the screw to be cut, and 1 in. of the lead-screw will have 16 fourths (Fig. 8). Gears will be selected in these proportions. In both of these cases the screw to be cut is of finer pitch than the lead-screw, and, therefore, the small gear, or gears, will be drivers. A complete number of threads first coincides with an exact number of inches at 25 turns, corresponding with 16 threads on the lead-screw, both occurring on a length of 4 in., 4 being the denominator.

Taking now, this second example, in which the ratios $\frac{16}{25}$ correspond with drivers and driven, say, $\frac{16}{25} = \frac{4 \times 4}{5 \times 5}$. For practical gears without duplicates, multiply two factors above and below by 10 and two by 5. $\frac{4 \times 4}{5 \times 5} = \frac{20 \times 40}{25 \times 50}$, and 40 and 20 are the drivers, and 25 and 50 are the driven. And the proof is

$$\frac{25 \times 50}{20 \times 40} = 1.5625, \text{ and } \frac{25}{16} = 1.5625,$$

showing equal ratios between the change-gears selected and the screw to be cut and the lead-screw.

The other case of fractional pitches, or those in which a single lead or complete turn exceeds 1 in. in length, is dealt with in a different manner, though on the same principle. Thus, to cut a thread with a lead of 3⅜ in., find the number of threads in the same length of a lead-screw, say of 4 pitch. In 3 in. of lead-screw there will be $3 \times 4 = 12$ threads, to which add 1½ threads = 13½ threads in a length of lead-screw corresponding with one thread of the screw to be cut (Fig. 9). So the ratio will be as 1 to 13½, or as 2 to 27, either being employed as most convenient. As the speed of the mandrel has to be retarded, the largest gear or gears will be drivers, and the ratio is put as $\frac{13\frac{1}{2}}{1}$, or more conveniently $\frac{27}{2}$. Say $\frac{27}{2} = \frac{3 \times 9}{2 \times 1}$. Multiplying two factors above and below the line by 40 and two by 10 will give suitable gears $= \frac{120 \times 90}{20 \times 40}$, and the proof is $\frac{120 \times 90}{20 \times 40} = 13.5$, the ratio required.

When, as in the foregoing, the number of threads in 1 in. is not an even number, or when the pitch is greater than 1 in., the general rule applies: Find the number of inches which contains a complete number of threads to be cut. Find also the number of threads contained in the same distance on the lead-screw. These numbers correspond with the ratio which exists between the drivers and driven wheels. The number of complete threads to be cut in the distance ascertained, divided by the number of threads in the lead-screw in the same distance, give the ratio.

Sometimes, instead of one thread being stated in a length of over 1 in., several threads are given in a length of several inches. This is a case allied to the one just considered, if it involves fractional parts. Supposing 9 threads are wanted cut in a length of 24¾ in. Then, using a lead-screw of 4 pitch, $24 \times 4 = 96 + 3 = 99$ quarter inches or threads in lead-screw in a length of 9 in. to be cut. As the threads are coarser than those in the lead-screw, the revolution of the mandrel must be retarded, and the ratio, to stand like the gears, will be $\frac{99 \text{ drivers}}{9 \text{ driven}} = \frac{9 \times 11}{3 \times 3}$. Then multiplying by 5, and by 10, either of the following combinations can be obtained:

$$\frac{45 \times 110}{30 \times 15}, \text{ or } \frac{90 \times 110}{30 \times 30}, \text{ or } \frac{90 \times 55}{15 \times 30},$$

and either will give the ratio of $\frac{99}{9} = 11$.

Another way of putting the ratio is: Having the pitch of the screw required to be cut, place it as one fraction, and then, inverting the pitch of the lead-screw, multiply the numerators together, and the denominators together, which will give the ratio of the change-gears. If the pitch of one is expressed in inches, the pitch of the other must be in like terms. If the pitch of one is expressed in threads per inch, that of the other must be similar. First, to cut a screw of ⅝ in. pitch with a lead-screw of ¼ in. pitch, say:

$$\frac{5}{8} \times \frac{4}{1} = \frac{20}{8}, \text{ or } \frac{10}{4} \text{ ratio,}$$

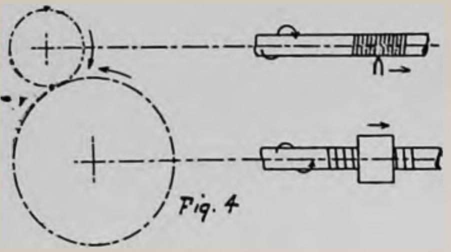
$$\text{and } \frac{100}{40}, \text{ or } \frac{50}{20}, \text{ or } \frac{75 \text{ driver}}{30 \text{ driven}}.$$

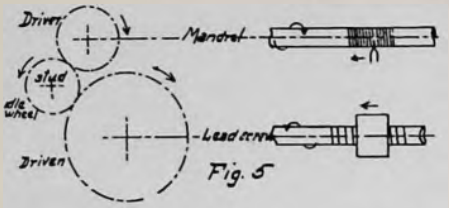
In this case, and others like it, as ⅜, ⅞ in. pitches, etc., the numerator indicates the least number of inches which the saddle must travel to complete an even number of threads, and the denominator indicates the number of threads. Thus for the ⅝ in. pitch screw, the travel will be 5 in. when the complete number of threads is 8. Again, to cut a screw of 14 threads per inch, say

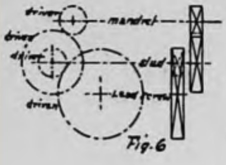
$$\frac{1}{14} \times \frac{4}{1} = \frac{4}{14} \text{ or } \frac{2}{7},$$

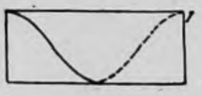
and breaking up

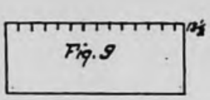
$$= \frac{2 \times 2}{2 \times 7} = \frac{20 \times 20}{20 \times 70} = \frac{20 \times 40}{40 \times 70} = \frac{30 \times 40 \text{ drivers}}{60 \times 70 \text{ driven}}$$

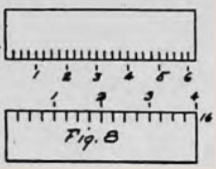












The common rule, "Place the pitch of the lead-screw as numerator and that of the screw to be cut as the denominator," is simplicity itself, and holds good whether the screw to be cut is finer or coarser than that of the lead-screw. Associating this with the rule already given, the wheel deduced from the pitch of the lead-screw or the numerator goes on the mandrel. That deduced from the pitch of the screw to be cut, or the denominator, goes on the lead-screw. And the same rule holds whether the trains be simple or compound. The relative positions cannot be mistaken, since the numerator gear above goes on the spindle, the denominator gear below on the lead-screw. Thus, to cut a coarse pitch of 1¼ in. threads per inch with a lead-screw of 4 threads per inch: Multiply by the denominator of the fraction to get the ratio

$$\frac{4}{1\frac{1}{4}} \times 4 = \frac{16}{5} = \text{ratio}.$$

Multiply, say, by 5

$$= \frac{80 \text{ driver}}{25 \text{ driven}}$$

Decimals might be used:

$$\frac{4}{1.25} \times 20 = \frac{80 \text{ driver}}{25 \text{ driven}}$$

Or to cut a fine pitch of 13 threads, say

$$\frac{4}{13} \times 5 = \frac{20 \text{ driver}}{65 \text{ driven}}$$

To cut 36 threads:

$$\frac{4}{36} = \frac{2 \times 2}{4 \times 9} = \frac{20 \times \overset{40}{20^*} \text{ drivers}}{{}^*\underset{80}{40} \times 90 \text{ driven}}$$

(*Cancelled figures.)

The method of cancellation previously referred to is a rapid method of getting change-gears by the inspection of the figures, and it can be made to include the relative location of the gears for threads of finer or coarser pitch than that on the lead-screw. Thus, place the number of threads in the lead-screw for a numerator and the number of threads in the screw to be cut for a denominator, and add ciphers. Having a lead-screw of 4 threads, to cut a screw of 20 threads per inch:

$$\frac{4}{20} \times 10 = \frac{40}{200}. \quad \text{Breaking up} = \frac{\begin{array}{c}\times 6 \times 10 \\ {}^*5 \times 8^*\end{array}}{\begin{array}{c}{}^*10 \times 20^* \\ \times 10 \times 6\end{array}}$$

$$= \frac{30 \times 80}{100 \times 120}.$$

(*Cancelled figures.)

30 and 80 will drive and 100 and 120 be driven.

Hitherto we have taken a free hand in placing gears on the mandrel. But very often a gear is left on the mandrel for an indefinite period to save the trouble of changing it. In such a case it becomes a practically permanent fitting, and the first element in the calculation. Here we call our rule to mind: "The pitch of the lead-screw is to the pitch of the screw to be cut as the number of teeth on the mandrel-wheel is to the number of teeth on the lead-screw wheel."

Put in a proportion sum: Pitch of lead-screw : pitch of screw to be cut : number of teeth on the mandrel-wheel : number of teeth on the lead-screw wheel. We know the first three terms, and want the fourth. Hence, multiply the pitch or the number of threads of the screw to be cut by the number of teeth on the mandrel-wheel, and divide the product by the pitch or the number of threads per inch of the lead-screw. Assume a lead-screw of 4 threads per inch, a screw of 11 threads per inch to be cut, and a gear of 20 teeth on the mandrel. Then: 4 : 11 : 20 : 55 = number of teeth on the lead-screw wheel, because

$$\frac{11 \times 20}{4} = 55.$$

To prove the rule, say

$$\frac{11}{4} = 2.75, \text{ and } \frac{55}{20} = 2.75,$$

showing equal ratios.

SOLDERING AND BRAZING—Part III

H. W. H. STILLWELL

CLEANING AND HOLDING THE WORK

Perhaps the best method of preparing a metal surface for soldering is with the scraper or file. An old hand or pillar file should be bent at the end. This may be accomplished with a forge fire or blow-pipe, and an anvil or block of iron and hammer; the corners should be slightly flared or rounded (see cut). If a scraper is to be made, the cut of the file should be ground away, and a chisel edge made. This edge should be quite blunt and as sharp on the cutting edge as possible (see cut). If too much taper be given to this edge, it will not stand up in rough use and will require frequent sharpening and the general results will not be satisfactory. When file or scraper has been shaped to suit the needs of the workman, it must be hardened by heating to a good cherry red and plunged into water. The degree of hardness may be determined by testing with another file; if the file will not "touch" the hard end of the scraper, it is as it should be, with the exception of re-grinding, which must be done to remove the old edge which is somewhat "burnt" by the process of hardening. Another useful scraper can be constructed from a piece of sheet tool-sheet about ⅛ in. in thickness. This should be shaped to a triangle with hack-saw and files, and a chisel edge made on all three of the edges. A hole should then be drilled in the center slightly smaller than the diameter of the rod which is to serve as a handle. The end of the rod should then be turned down, or may be filed carefully to fit the hole, leaving a shoulder for the triangular scraper to rest against. Rivet carefully in place and drive a stout wooden handle on the opposite end. This scraper must be hardened the same as the one made with the file, and may be done in the same manner, after which it must be re-ground on the edges and may be polished with fine emery cloth or paper to add to the neatness of the finished tool. In pattern-making a variety of files and tools are used, but for ordinary work, these will not be required.

In cleaning copper work a dilute solution of sulphuric acid is best. Articles made from lead or zinc can be cleaned with a potash solution; but care must be exercised as the alkalies attack these metals. Articles of zinc can be cleaned with a solution of dilute sulphuric or muriatic acid.

Much difficulty is sometimes experienced in "filling" a joint or hole in a piece of work. This trouble may be remedied by a piece of moist clay (do not use putty) pressed into shape to allow the solder to flow into the right place. Clay is used to imbed the parts in, to hold them in position for soldering. Plaster of Paris is also much used for this purpose, but difficulty is sometimes found in getting it out of a piece of work, especially in hollow places. A dilute solution of muriatic acid will help to remove it, however.

Castings containing aluminum are always harder to solder than other alloys. In some instances where the percentage of this metal is high, it is necessary to copperplate the parts to be joined before a satisfactory joint can be made. In nearly every instance the work can be "stuck" together, but not actually soldered. Other information upon the subject of soldering aluminum will be given later.

A very good job of soldering can be done on work that will permit of it by carefully fitting the parts to be joined, laying a piece of tin-foil, covered on both sides with a flux, between the parts and pressing them tightly together. Heat until the foil is melted. This is a very good method of joining broken parts of brass and bronze work. In this method, the broken parts must fit perfectly and when they are in this condition, the resulting job will be highly satisfactory and the joint almost imperceptible.

CAST IRON SOLDERING

There are many methods of accomplishing this result; some are regarded as secret. One method, perhaps the oldest, is to brush the surface thoroughly with a brass-scratch brush; this should be continued until the surface is coated with brass; then tin the surface, and solder as usual. A better method is to copperplate the parts and solder together. If plating facilities are not at hand, a good substitute can be had in the following solution of sulphate of copper: about 1 oz. of sulphate of copper, ½ pt. of water and ½ oz. of sulphuric acid. Brush this solution upon the surface or dip into the solution; rinse off and dry it well before soldering.

The iron may be tinned; all scale must be removed and the surface made bright, and this may be accomplished by filing or scraping, or with an emery wheel. The article should be dipped in a lye to remove any grease, then rinse the lye off; dip into muriatic acid of the usual strength, then go over the surface with rosin and a half-and-half solder. It is sometimes necessary to dip into the acid several times to get the piece thoroughly tinned. Rubbing the surface of the iron with a piece of zinc while the acid is still on it will greatly facilitate the tinning.

Soldering cast iron may be accomplished in still another manner. Clean the surface until bright as before, and brush over with the chloride of zinc solution; sprinkle powdered sal ammoniac on it; then heat until the sal ammoniac smokes. Dip into melted tin and remove the surplus; this should be repeated if not thoroughly tinned. Half tin and half lead solder will give good results for this class of work.

SOLDERING WITHOUT SEPARATE FLUX

Solder which can be used without a special flux contains the flux-rosin enclosed inside of it. This can be melted with a match or soldering copper. It is much used by electrical workers for the small joints in wires and is called solderine. It consists of a very soft solder tube filled with rosin.

TINNING ARTICLES OF IRON

It is sometimes desirable to tin small articles of iron for various reasons. This may easily be done as follows: the articles should be pickeled in warm sulphuric acid or hydro chloric acid until all the scale is removed and then rinsed, in clear water. Should there still be any little black spots showing on the metal, they must be removed by further pickling, or by scrubbing them with a hard brush and a little fine sand until the surface presents a clean, gray, uniform space. The articles are then immersed in the chloride of zinc solution, and on removal from this are dusted over with powdered sal ammoniac. They are then ready for immersion in the molten tin. If the articles are required to be highly polished, the surplus tin should not be wiped off, but should drain off alone. A brilliant polish is then given by working over the surface with a rag mop attached to a polishing lathe, the mop being dusted with polishing lime.

REPAIRING CORRUGATED IRON

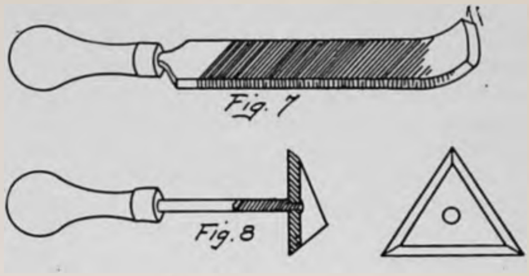
Corrugated iron may be repaired in the following manner: we will consider a large hole in the iron. Such a hole when covered with a piece of the same material should be well fitted to the hole, and soldered in position. The iron must be thoroughly cleaned by scraping, or by other suitable means, where the soldering is to be done, and raw spirit (hydrochloric acid) used as a flux; the iron then may be soldered with ordinary solder and soldering copper in the usual manner.

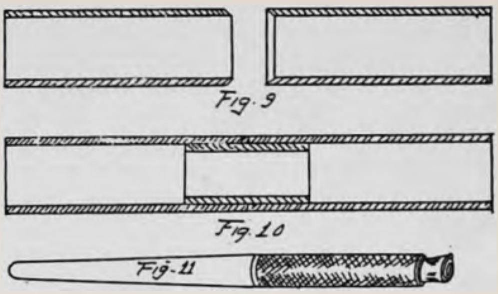
BRONZING SOLDERED JOINTS

It is often desirable to finish a brass fitting by bronzing to give it the same finish as the rest of the article or to match some other part of the work. Soldered joints may be finished in this manner by a superficial coating of gold size, and while the latter is still wet, dust over the moist parts with bronze powder until the whole of the solder is hidden. When the gold size has set hard, the bronze powder will be found to have firmly adhered to it. The surface may then be rendered smooth by very lightly rubbing with a burnishing tool, giving a good finish.

TO BRAZE BRASS TUBING

To join two brass tubes, reduce the diameter of the end that is to be brazed till the other section will just go over it (Fig. 9). When ready, place some of the best soft brazing solder, say No. 4 or No. 5, which is usually in grains about the size of small pin heads; mix with some fine dry powdered borax with just enough water added to make the mixture hold to the tube. If the brazing solder is not at hand, a strip of soft brass or the usual brazing brass will answer equally as well and may be held by the end with a pair of pliers or tongs and moved wherever desired, and at the will of the operator. The brazing brass, when heated, will melt and run between the two tubes till quite flushed. It is very difficult to finish a joint smooth while hot; this may be done, however, when cold, and all unnecessary metal dressed off level. This operation will leave the tubes sufficiently soft to enable the end, after placing in the tube plate, to be drifted in. A much stronger joint can be made as shown in Fig. 10, and one, if properly handled, will be invisible. Insert a liner, say 1 in. long and of a size to telescope in the tubes to be joined (see cut), placing about ½ in. on each side of the joint; bring the ends of the tubes flush and braze. If tubing to telescope is not available,





use a piece of that to be joined, cutting sufficient out and closing up, until it will fit the inside of tube. Soft solder should be used, 1 part copper and 1 part zinc, so that the solder will run freely, when heated, about the joint.

SOLDERING COMPOSITION PIPE

Much difficulty is experienced, especially by the amateur, in soldering joints in composition pipes, when the composition of the pipe is of a low melting point. It is sometimes necessary to have the pipe in an upright position, although better results can be obtained if in the horizontal. The solder used in this class of work is the usual lead and tin alloy in about equal proportions by weight. The joints are made by the aid of a mouth blow-pipe and an alcohol lamp, if the pipe is not large. If a small gas blow-pipe is at hand, this may be used; but great care must be taken not to heat too much, as much of this pipe will melt at a slightly higher temperature than that of the solder. In preparing the joint for soldering, the end of one pipe is enlarged so as to receive the end of the other (Fig. 9). The pipe should enter from 1/16 in. to 1/4 in., according to the diameter of the pipe. The parts to be soldered are then scraped bright, and a little tallow and powdered rosin placed in the bright parts. The ends are properly fitted together, either in an upright or horizontal position, preferably the horizontal, and held in place by any suitable arrangement. The solder is melted into the socket end of the pipe by a thin flame from the blow-pipe. The flame is continued until the solder is melted and "tins" to the pipes. When brass unions are used, the ends of the brass linings should be first carefully tinned, or the solder will not alloy to them.

TO SOLDER ALUMINUM

Much has been said and written upon this subject, and a great amount of it is not worth the paper upon which it is written or printed. There are many solders in use, but a really perfect one, is yet to be found. Joints which have been carefully soldered will corrode after a few months' exposure to the atmosphere. Zinc and Venetian turpentine have been used with success upon small articles. The solder should be placed upon the metal together with the turpentine, and the heat should be applied very gently with the blow-pipe until the solder is entirely melted. The trouble with this method is much the same as with other solders, it will not flow gently on the metal; large surfaces cannot be easily soldered.

As a flux, paraffin, benzine, vaseline, stearine, copaiva balsam, etc., will give good results. Each of the above will be found to work better with certain classes of work than with others, according to the solder used.

Alloys for this work are many and varied. A good solder for work of low grade is the following: tin, 95 parts; bismuth, 5 parts. Another consists of 14 lbs. zinc, 1¾ lbs. lead, 3½ lbs. spelter and 7 lbs. phosphor-tin. The phosphor-tin should contain about 10 per cent. phosphorus. With this method, all dirt must be removed from the surface of the metal with benzine; the solder is applied with a copper, and when the molten solder covers the metal, scratch through the solder with a wire brush.

In the operation of soldering aluminum, the tools used should be made of aluminum for most of the work, as copper or brass will often form alloys with the aluminum and solder. There are cases, however, in which a copper bit, may be used to advantage, as stated above, but even with this method, great care must be used not to overheat the metals to be united. The small aluminum tools will facilitate the fusion of the solder and its adhesion to the previously prepared surfaces.

Another method which has been patented is as follows: Clean the aluminum surface by scraping and then cover with a layer of paraffin wax as a flux. The surface should then be coated by fusion with an alloy of 5 parts zinc, 2 parts tin, 1 part lead. The metal surfaces thus prepared can be soldered together either by means of zinc or cadmium, or the alloys of aluminum with these metals. In fact, any good soldering preparation will answer the purpose.

Still another method is as follows: Coat the aluminum surface to be soldered with a layer of zinc. On top of the zinc is melted a layer of an alloy of 1 part aluminum to 2½ parts of zinc. The surfaces are placed together and heated until the alloy between them is liquified.

A very satisfactory method of soldering aluminum and one requiring very few and simple tools, is as follows: First, procure a small piece of thin sheet aluminum about 1½ in. square, roll it into a little coil; next, procure a wooden penholder and place the roll of aluminum in the hollow end of the penholder (Fig. 11), leaving about one-half out; the exposed portion may be flattened by a slight blow of a hammer. Clean the aluminum article at the place of the joint by rubbing with fine emery cloth or scraping with a knife. Heat the article to be soldered to the melting point of the solder, in any convenient way, say, on the top plate of a kitchen range, or over a bunsen burner, with a piece of sheet iron placed thereon. Then place it on the table or work-bench on a sheet of asbestos to prevent burning the table; and when hot sprinkle on the flux and rub with the little aluminum tool before described, which will tin the surface very easily. While the article is still hot apply the solder and guide the flow with the narrow edge of the tool; then remove the article and allow it to cool to make a good strong joint. This method may be used to good advantage as no special apparatus is required, no soldering copper, blow-pipe nor blow-torch will be needed as with some other methods. The following alloy is excellent when a hard solder is desired, as, for cycle, automobile or special work; aluminum, 70 per cent.; tin, 20 per cent. and silver, 10 per cent. This solder can be worked with the same process as described above, but will require a slightly higher temperature.

PHOSPHOR SOLDER FOR ALUMINUM

With this solder no separate flux is needed as it is contained in the solder. The proportions for one solder are zinc, 50.03 parts; tin, 47.99 parts; aluminum, 1.76 parts; and phosphorus, .22 parts. When adding the phosphorus, first mix it as follows: Take a length of 1 in. gas barrel which has a screwed cap at one end, the opposite end being closed with a tin plug. Remove the screw cap, and, having carefully dried between blotting paper the proper proportions of phosphorus, insert the latter in the tube and replace the cap. Now place the plugged end of the tube into the molten tin; this will melt the plug of tin and so allow the phosphorus to come in contact with the molten metal. The ingot of phosphor-tin formed could be alloyed with the zinc and aluminum, or, preferably, with the zinc alone, leaving out the aluminum altogether. In this solder the phosphorus acts as a flux and no other is necessary. Use an ordinary copper bit forged to a wedge shape and bent to form a quarter circle. With such a bit, its wide edge is used at right angles to the surface of the aluminum, and by lightly moving it backward and forward when charged with solder, a clean aluminum surface is exposed, and to this the solder adheres.

Aluminum is a peculiar metal to solder, at one time a good job may be made, and at another and under apparently the same conditions, the result will be far from satisfactory. Care and experience will overcome these difficulties and the old saying will fit well here, "If at first you don't succeed, try again."

(To be continued)

THE "GNOME" AVIATION ENGINE—Part II*

AUSTIN C. LESCARBOURA

In the March edition, an article appeared under the above title. The writer has lately had the good fortune to secure further data on the "Gnome" motor, and will give below, more details in connection with those already set forth in Part I.

In Fig. 1, we have a diagram of the inside working parts of the rotary motor. The shaft, being hollow, aside from its primary duty of forming the axle for the revolving cylinders, also serves to feed the explosive gas to the cylinders and the castor oil for the lubrication. There are two separate tubes from the oil pump, one which is for lubricating the cylinders, while the other is for lubricating the piston rods and joints. The entire lubrication system is under the control of the aviator at the point marked *u*.

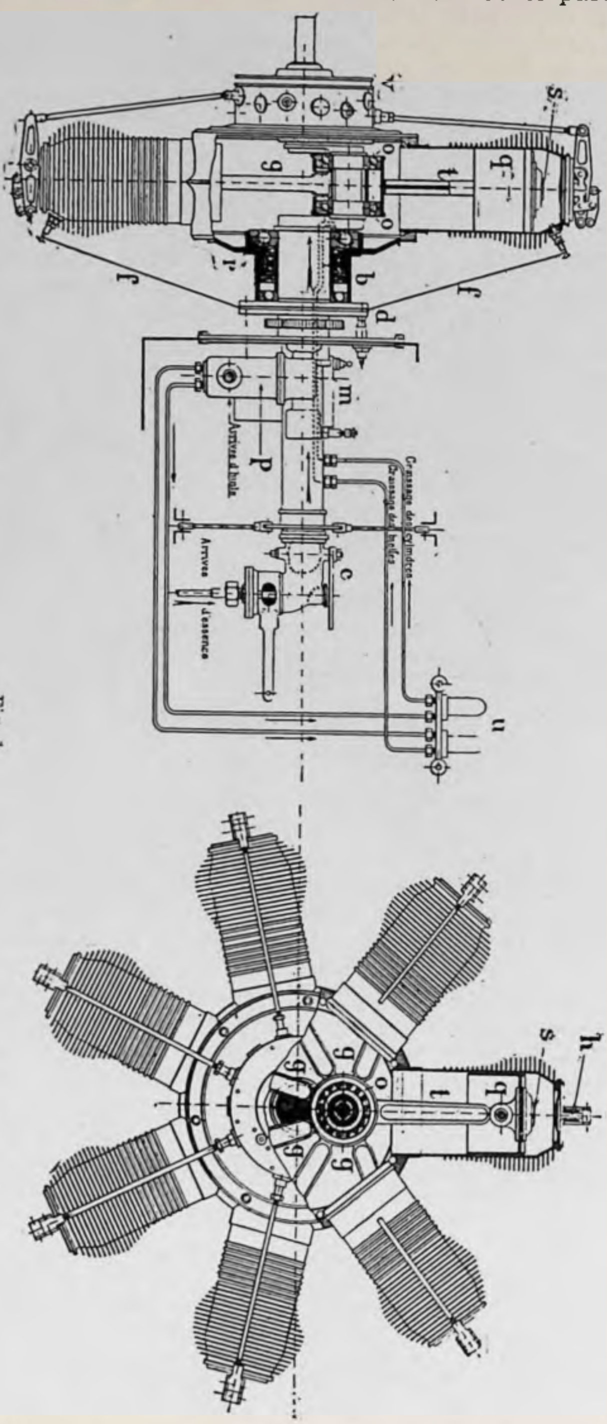
It will be noticed that at the point where the revolving cylinder piston rods are connected to the shaft, the shaft is shaped so as to give the rods an eccentric motion. The rods are all connected to the shaft, through the medium of a double ball-bearing sleeve *o*. However, six of these rods are jointed to the ball-bearing sleeve through free joints *g*, while the seventh, or master rod *t*, is solidly connected. This will be noticed by examining both diagrams. At the end of each piston rod, is a pivoted foot *q*, which in turn fits into a heavy piston head. At the top of the piston head is the valve *s*, which, as described in Part I, is equipped with the counterweights to offset the effects of the centrifugal force. These piston valves may readily be reached by removing the heads of the cylinders. All the mechan-

* Continued from March issue.

ism of the valves and counterweights is lubricated by the excessive oil from the piston rods and cylinders.

The large end flange *v* contains the seven cams and the ball-bearing for that end of the motor. To this flange the propeller or other transmission device may be attached if desired. The exhaust valves *h* are controlled from this part.

The main center body of the motor, to which the cylinders are attached, is also of nickel steel, as characteristic of the other parts. There are seven holes around this body, which are made so that the cylinders will fit into the holes tight, making a perfect connection. The cylinders are held in such a manner as to be easily removed, yet secure from accident while the motor is in operation.



c—carburetor
d—ignition commutator
s—automatic valves

p—oil pump
b—ball-bearing support
h—exhaust valve
o—ball-bearing joint

Fig. 1

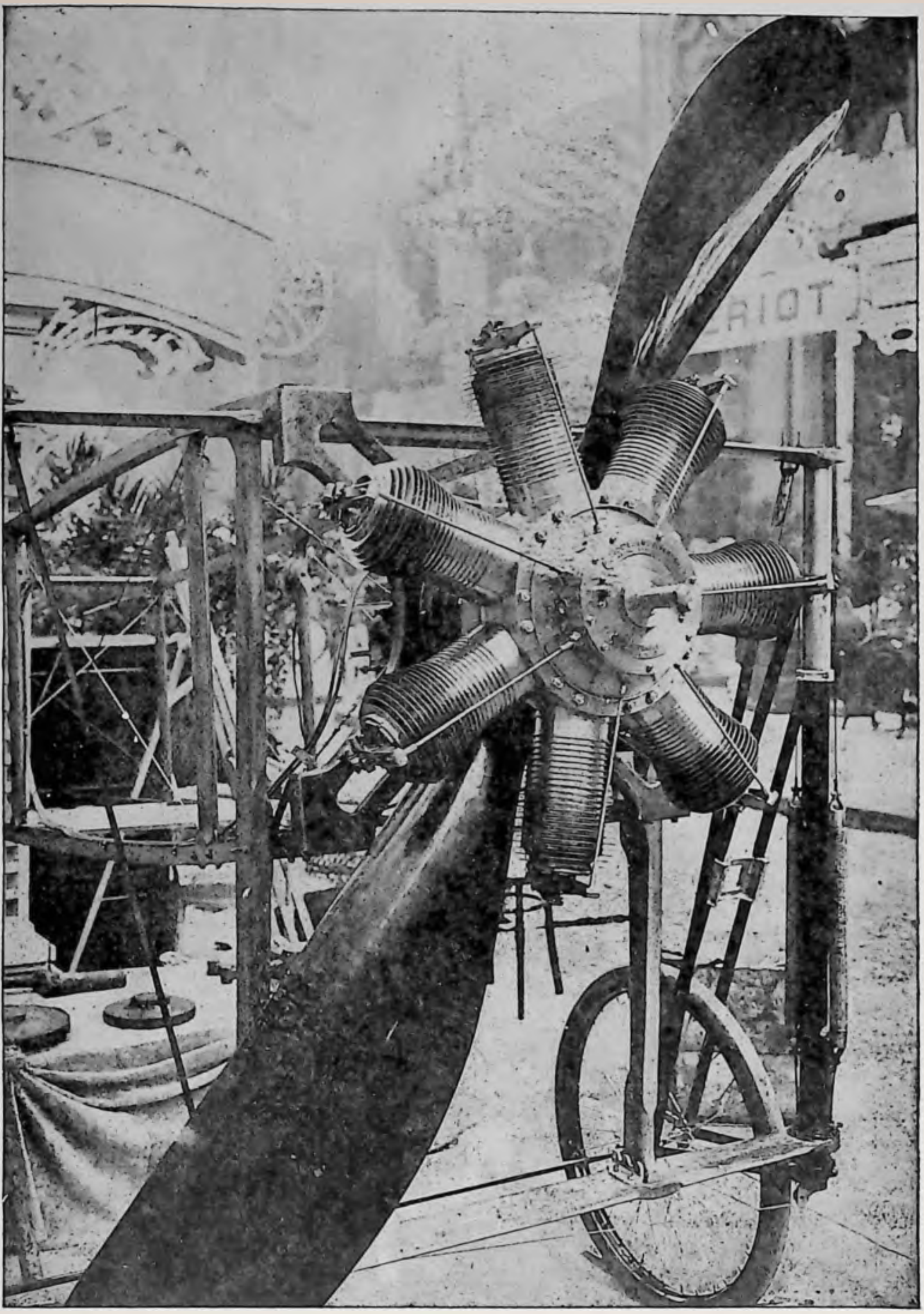
m—magneto
v—distribution box
t—master piston rod
u—oil control

f—ignition wires
q—piston
g—jointed piston rods

The cylinders, as we all know, are turned from solid steel bars and equipped with cooling flanges. After the approximate size of the bore has been attained, a machinist, with a flexible drive grindstone, grinds the inner walls until a perfect fit is obtained with the piston. Towards the top of the cylinder and a little to one side, the spark plug is screwed into place, and connected by the bare wire *f*, to the commutator *d*.

Many of the parts and their construction may be noticed by studying the drawings, and the table below them will give the name of each part lettered. The reader should take note of the great number of ball-bearings, which causes the motor to have smooth running qualities.

There are various methods used to mount the "Gnome" motor. In Fig. 2, we have the mounting for the 100 h.p. motor, which consists of two 50 h.p. units bolted together on the



(From "Vehicles of the Air," by Victor Lougheed)

Gnome Revolving-Cylinder Motor

This remarkable engine, which is one of the lightest and most powerful yet built, develops 50 h.p. at 1,200 revolutions a minute. The seven cylinders and the crank-case ring are one piece of metal, being machined down from a heavy casting. The advantage of the revolving-cylinder design is its immunity from vibration, due to the absence of reciprocating parts (the cylinders travel in a circle around the crankshaft and the pistons in a circle around the crankpin) and the elimination of the flywheel. This motor at present holds the distance and duration record of 118 miles in three hours. The above picture also affords an excellent view of the Bleriot alighting gear.

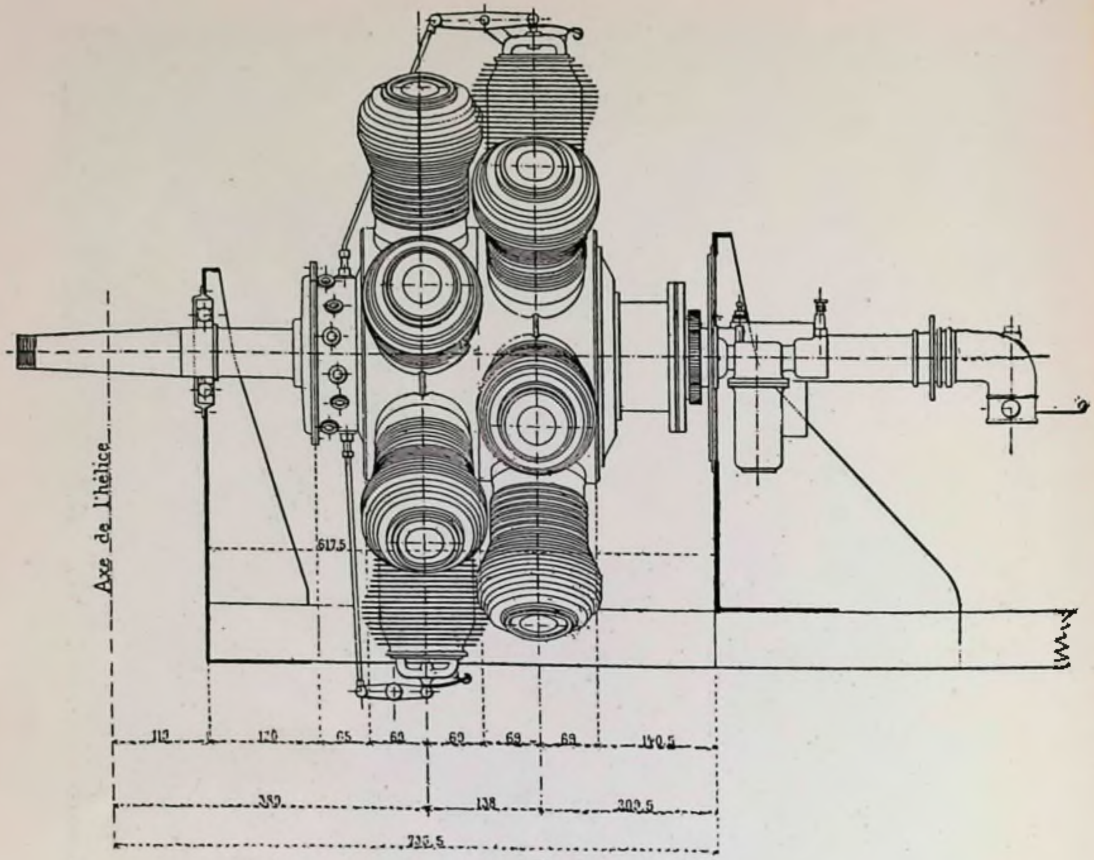


Fig. 2.

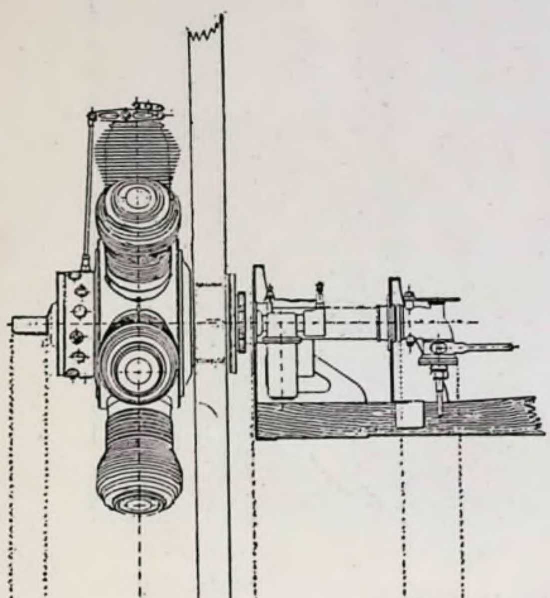


Fig. 3

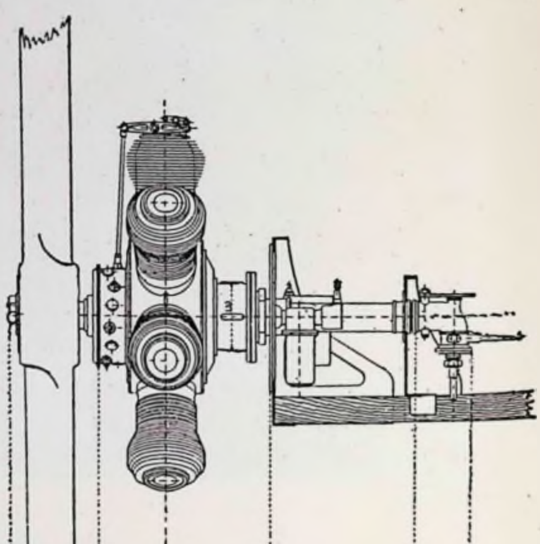


Fig. 4

same shaft. This motor is supported at both ends, owing to its great weight. In Fig. 3, we have a 50 h.p. unit with the propeller in back of the motor. This is one of the most used methods, characteristic of the Henri Farman biplanes, and many of the Bleriot monoplanes. In Fig. 4, we have the opposite instance, where the propeller is in back of the support and in front of the engine. Both methods have their enthusiastic supporters who claim advantages for their respective choice. In many of the 50 h.p. Bleriot racers, the motor is mounted on two supports and the propeller connected to the protruding shaft.

Different aviators have their individual methods of controlling the revolving engine. Some aviators throttle the mixture, and leave the engine working, while others cut down the spark and leave the throttle wide open. It is evidently a matter of choice, for both systems are used by the world's greatest aviators.

The "Gnome" motor made its debut at the Betheny meet in France, during 1909. It was a revelation to the aviators as well as to the scientific world. By leaps and bounds, it advanced to first place among aviation engines, which it undisputedly occupies at present. There is little need of calling the reader's attention to the latest achievements of this engine. We might just recall the most important ones, as, for instance, the flight of Pierre Prier, from London to Paris in a non-stop flight; that of Capt. Bellenger, from Paris to Pau in two days; that of Lieut. Bague, from Nice to a small island off Italy's coast, a flight of 125 miles over water without any escorting boats; of Henri Farman's attempt to win the 1910 Michelin flight prize, with a duration record of 8 hours and 23 minutes. He states that he had sufficient gasoline to remain aloft for 12 hours. No one has debated his statement, or argued as to the impossibility of such a flight. The "Gnome" engine, thus far, is the great milestone in the progress of aviation, and will go down in history as the first successful and reliable aviation motor.

ELECTRICITY AND RIFLE SHOOTING

J. A. S.

A good deal of interest has been aroused by the introduction to the British market of Rose's self-recording target, manufactured by a limited company bearing the same name, the demonstration of which has recently been given which was attended not only by the British military experts, but by the

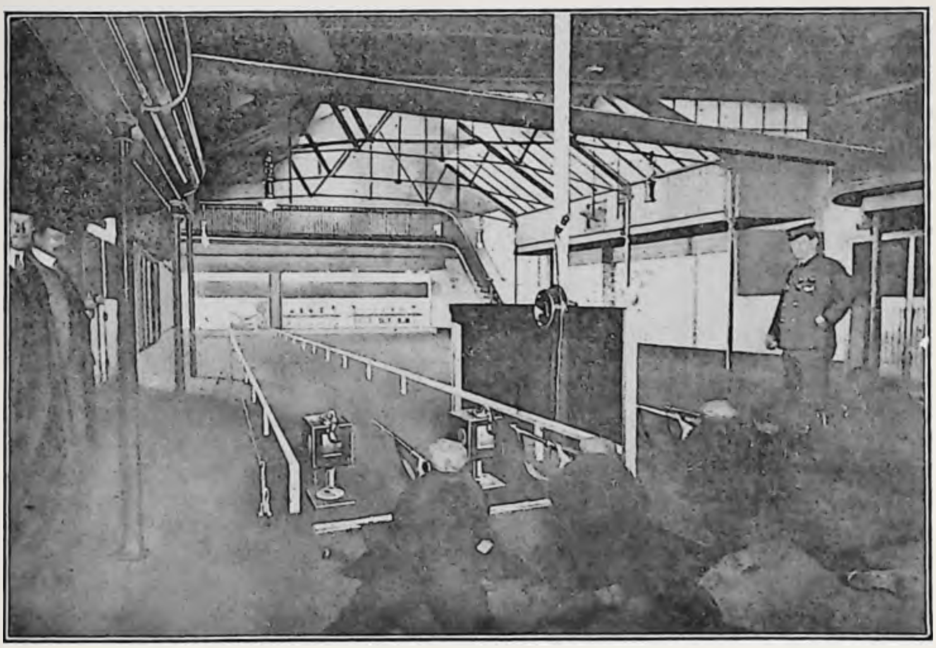


Fig. 1

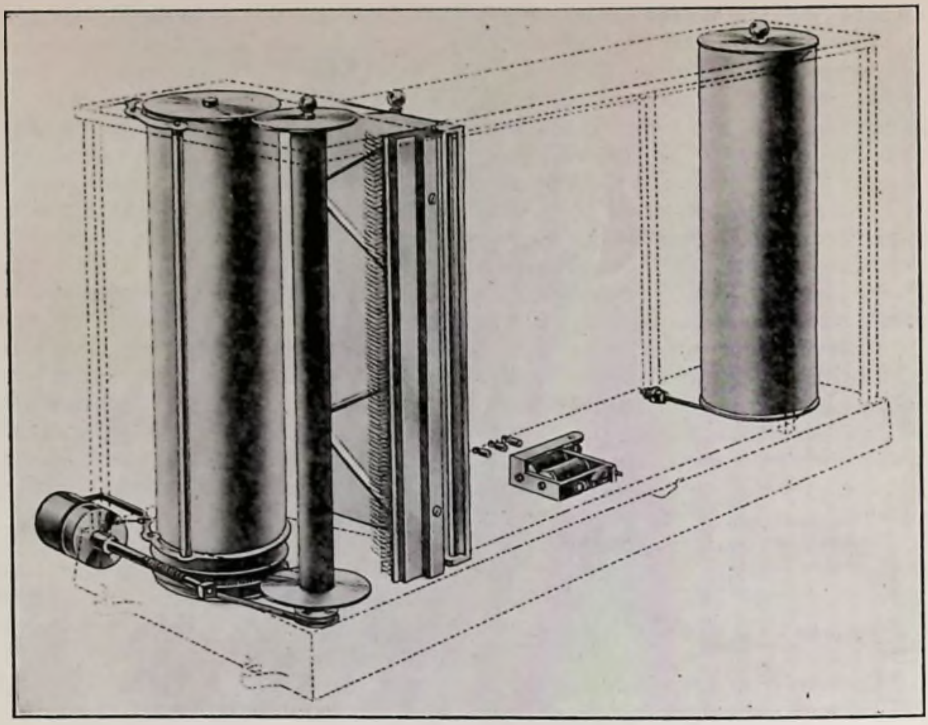


Fig. 2

military attachés of France, Russia and Japan. Fig. 1 gives the whole appearance of a miniature rifle range with this apparatus, and the advantages which this device has, comprise amongst others the fact that it is not a sectional target, and hence the use of the numerous connecting wires is avoided (the number of which is actually limited to three), but also secures greater accuracy in registering the hits, as it shows not merely the section, but the actual position. Another advantage over previous systems is that it cannot only be used as a fixed target, but also as a recording target for moving objects, and, in this case, it shows the position, not only of the hits on the running objects, but also that of the misses; this being the unique feature which tends to improve marksmanship. This facility for showing the track of the bullets which miss, when firing at the moving object, is a most important point, in view of the fact that present methods offer no means whatever of doing so, which obviously entails considerable amount of expenditure of ammunition without result. The *Territorial Service Gazette*, which is the organ of the territorial and reserve forces of Great Britain, characterizes Mr. S. A. Rose's target as one of the most wonderful inventions of the age, and says that, although it will probably be some time before its possibilities are recognized, there is no doubt that it will revolutionize the present systems of marking. For this reason some details of the apparatus may be of interest to American readers.

It consists of an object target (Fig. 2), which is composed of a roll of paper wound from one roller onto the other, so that a square of the paper is exposed through the hole in the armor plate so as to be shot and perforated and wound up after each shot. Fig. 5 shows diagrammatically the arrangement of the target apparatus and the perforation caused by the shot passing under a row of contact fingers F, one or more of which drop into the hole and make contact, immediately disconnecting a clutch C, which stops the mechanism and indicates on the reproducer the exact position of the bullet. This reproducer (Fig. 3) is a transparent facsimile of the object target; behind it is a permanent magnet miliampere-meter D, Fig. 5, the pointer of which E has on its tip G a small white disc representing the bullet hole. This tip comes to rest in a position exactly representing that of the hit on the target. The movement of the paper on the object target is accomplished by a small motor (Fig. 3), and on miniature ranges this movement is mechanically transmitted on a reduced scale to the carriage of the pointer in the indicator target (Fig. 4), the pointer moving horizontally across the face of the latter a distance corresponding to that of the paper with the bullet hole in it. At the bullet hole the contact fingers on the object target complete the circuit to the miliampere-meter through a small resistance, which varies according to the position of the contact finger, and the pointer moves vertically to the position, giving the correct elevation of the bullet hole. The combination of mechanical horizontal movement with vertical electrical movement gives 200 position indications per square inch of target. Normally, the apparatus is at rest, owing to one of the fingers making contact through a perforation or gauge hole. The gauge holes are punched at regular intervals a little larger than the width of the target, and so placed that the pointer returns to zero at each one. In the diagram (Fig. 5), the pointer is in the gauge hole, and the current is flowing from the main through the reproducer illuminating lamp L and the adjustable po-

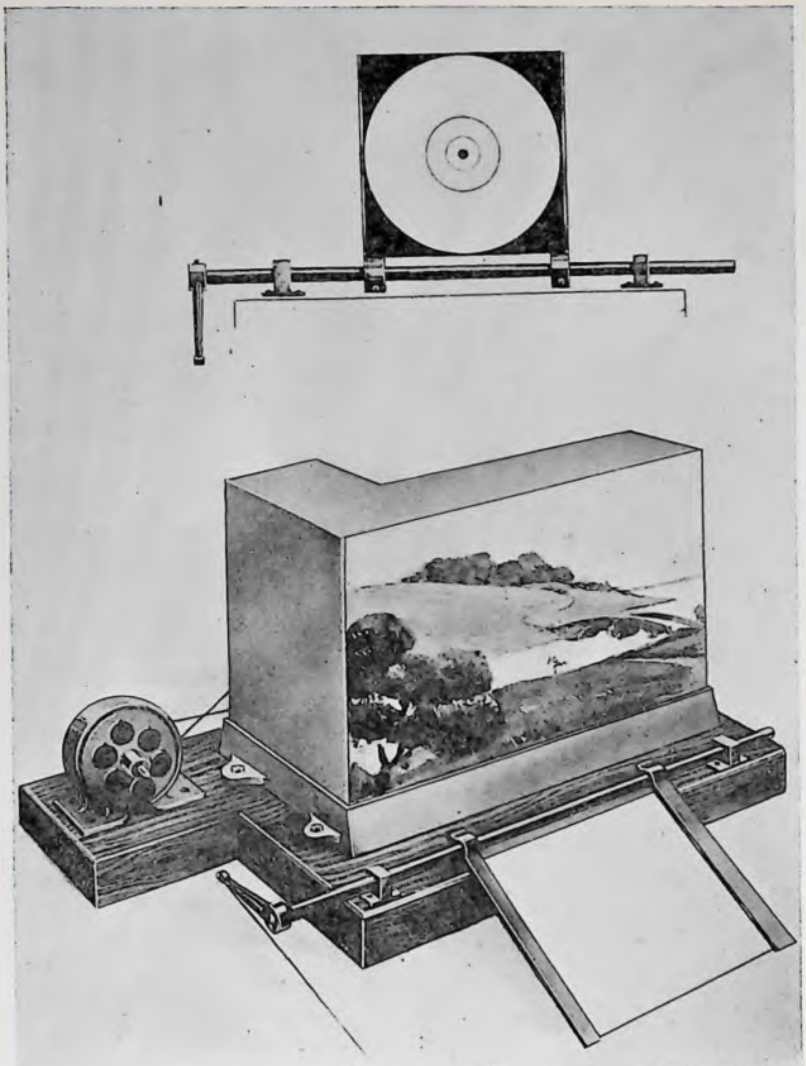


Fig. 3

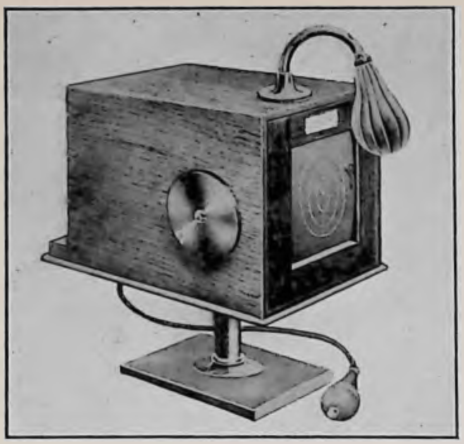


Fig. 4

tentiometer M to earth, and in parallel with this to earth, through the contact finger, by way of the reproducer D, and the cut-out N, which cuts off the current from the magnetic driving clutch C. If the short-circuiting key is pressed, the current is cut off from the cut-out, and the armature returning establishes the clutch circuit, starting the mechanism, and removing the perforation from under the contact finger, after which the key may be released, and the machine runs (if no shot has been fired) until the next gauge hole is reached, by which time the reproducer pointer has travelled across its screen, released itself and returned automatically to zero. A shot may now be fired, the key depressed momentarily, and the sheet travels on to the bullet-hole, which is indicated as explained. Another depression of the key starts the machine, which runs to the next gauge-hole, the indicator returning to zero ready for the next shot. It will be seen that actually the horizontal position is given by the distance of the bullet perforation from the gauge-hole, regardless of whether the perforation was made whilst the paper was at rest or traveling. To start the apparatus it is only necessary to put a plug in a lamp socket and switch on. In the diagram P is a shunt across the clutch coil, R the target lamp, S the motor, H the reserve roll of paper, I the speed roller from which the speed of the paper and reproducer pointer is controlled, K the receiving roller for used paper, E, L', L', connecting wires, U the reproducer driving belt, and V a sliding contact maker to adjust the voltage of the reproducer circuit.

It will be seen that this apparatus is suitable for all ranges from 25 to 2,000 yds. It is possible to utilize the fixed or running target; the former is used for beginner's practice, while the more advanced marksmen utilize the running object which can be operated at varying speeds and in conjunction with backgrounds of any variety of color or surroundings while the lighting can be varied to represent all conditions of practical shooting. In a moving target the running man or deer is printed on the moving roll of paper and a suitable picture or screen is used in conjunction with it so that the moving object appears to be emerging from one piece of cover to the shelter of another. A replica of the man is provided on the reproducer screen and the position of the white disc (Fig. 3), with relation to this figure, shows accurately where the shot went, showing not merely whether the moving object was hit or missed, but actually where the shot went. It would, therefore, appear that this apparatus will prove a prime necessity to all ranges, whether miniature or out-of-doors, where accuracy in firing is sought, and the matter is therefore of considerable interest.

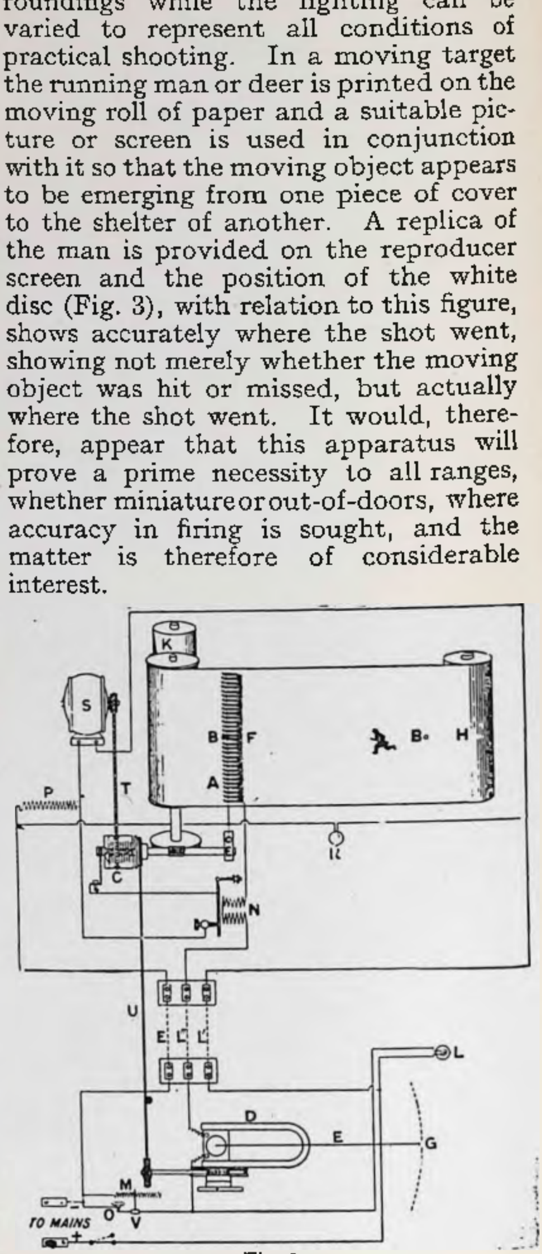


Fig. 5.

WIRELESS TELEGRAPHY

In this department will be published original, practical articles pertaining to Wireless Telegraphy and Wireless Telephony

CONSTRUCTION OF RECEIVING APPARATUS FOR A MODERN WIRELESS STATION—*Concluded*

W. C. GETZ

THE CONDENSERS

In the article that appeared in the April and May issues of this magazine, on the construction of a wavemeter, considerable space was given to the description of an adjustable rotary condenser, and the construction of the same, and so the reader is requested to obtain these copies and refer to same, if he desires to make this type of condenser. However, a brief description of several of the commercial makes of rotary condensers will be given in this issue.

In Fig. 7 is shown the type of adjustable condenser made by the Wireless Specialty Apparatus Co. This has a very large range of capacity, and is used in many of the government stations.

Fig. 8 shows the latest type of rotary condenser brought out by the Clapp-Eastham Co. This has a range of variation from .00003 m.f. to .001 m.f., which is all that is practically desired with the inductive tuner.

In Fig. 9 is shown another type of adjustable condenser made by the Wm. J. Murdock Co. This is of the telescoping horizontal plate variety that many experimenters favor. The capacity range of this is from .00005 m.f. to .003 m.f.

In Fig. 10 I have drawn a view of a tubular type of fixed condenser made by me, when in business in Baltimore several years ago. This condenser proved exceptionally good for use with the silicon and perikon detectors.

The plates consist of two sheets of tin-foil, each 1¾ in. x 4½ in. Between them and on the outside of each is placed a sheet of paraffined paper, .003 in. thick and 2 in. x 5½ in. in area. As shown in the drawing, the sheets of foil overlap each other for 4 in., so that the active area is 4 in. x 1¾ in. = 7 sq. in. To one end of each sheet a wire is soldered, on the end of which is fastened a ½ in. copper washer having a ⅛ in. center. Assembled, the washer projects ¼ in. beyond the edge of the paper, making the total width of the unit 2½ in.

After placing the tin-foil and paper in position, a hot iron should be held on the sheets for a few seconds until the paraffined paper sticks to the tin-foil.

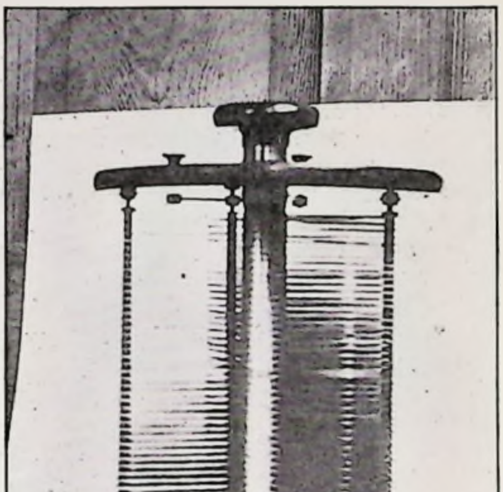


Fig. 7. W.S.A. Co. Adjustable Condenser

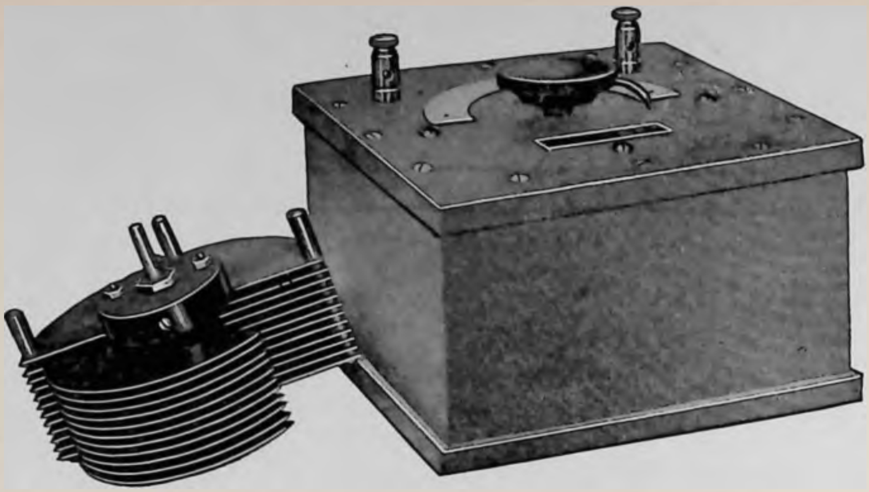


Fig. 8. Clapp-Eastham Rotary Condenser

When cool, the sheets are rolled up into a compact cylinder, having an outside diameter a little less than ½ in.

A fiber tube, ½ in. inside diameter, 1/16 in. wall, and 3¼ in. long is now procured. As shown in the sectional view, the rolled condenser is slipped into this tube after a 1 in., 8-32 round head brass machine screw is made fast to each washer with a nut. The space between the washer and the edges of the tube is then filled with sealing wax.

Another copper washer must then be placed on the end of the screw, and then a battery thumb nut on each end completes the job. Before using the fiber tube it should be immersed in boiling paraffin wax until all moisture has been driven from it, as the writer has in several instances traced trouble to moisture in fiber fittings.

To now figure the capacity of this condenser, we use the formula:

$$C = \frac{2248\,KA}{D \times 10^{10}}$$

In which

C = capacity in microfarads
K = specific inductive capacity of the dielectric
A = area of effective surface of the plates
D = diameter of the dielectric in mils.

For our dielectric, paraffined bond paper, the value of K will be between 3.65 and 3.68. We will take 3.66 as the average value. We already have A as 7 sq. in. D is .003 in. This gives us

$$C = \frac{2248 \times 3.66 \times 7}{.003 \times 10^{10}} = .001919 \text{ or } .002 \text{ m.f.}$$

DETECTORS

There has been so much written about detectors in the past issues of this magazine, that I will devote but small space to them in this article. The use of the crystal rectifying type of detector is now almost universal. Of this type, the best known are the carborundum, the silicon, the ferron and pyron, and the perikon detectors.

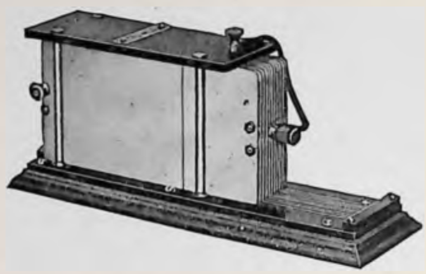
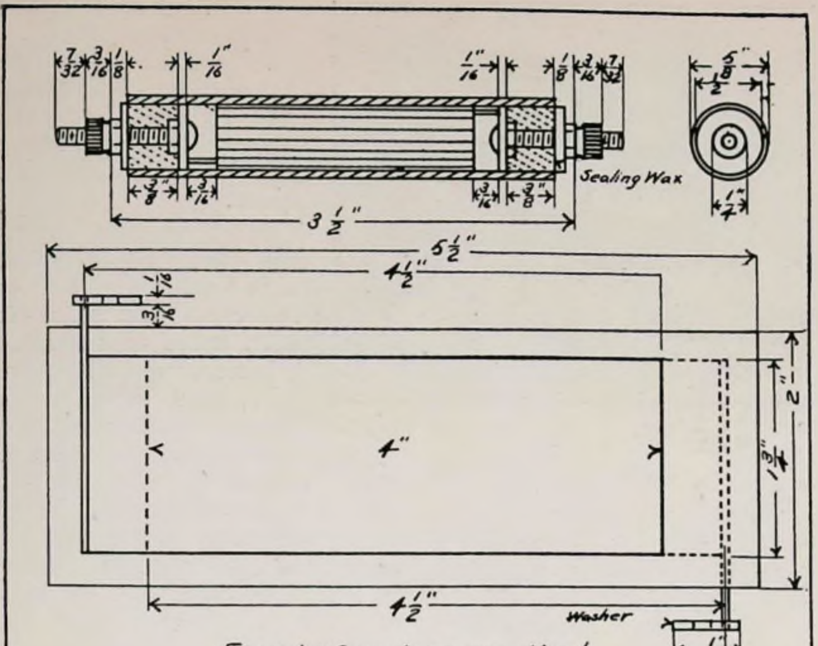


Fig. 9. Murdock Adjustable Condenser

The carborundum detector consists of a carborundum crystal held between metallic springs. For the best results, it requires about two cells of dry battery to operate it. While not as sensitive as some of the others, it is very reliable, and holds its adjustment well.

The silicon detector consists of a silicon "button," or crystal, held under an adjustable metal point. Fig. 11



Fixed Condenser Unit.
Fig No. 10.

shows the latest type of experimental silicon detector. This is sold by the Wm. J. Murdock Co., and is manufactured under the license of the Wireless Specialty Apparatus Co., owners of the patents covering the crystal rectifying detectors.

The ferron detector, as shown in Fig. 12, has been highly developed by the Clapp-Eastham Co., and has an excellent reputation for efficient operation.

In Fig. 13 is shown a view of the perikon detector, made by the Wireless Specialty Apparatus Co., and sold to the leading government and commercial stations. In Fig. 14 I have given a working drawing of this detector. It consists of a "turret," in which are fastened a number of zincite crystals, and which is supported by a square standard. Opposite this is an eccentric cup containing the bornite or chalcopyrite crystal, also supported by a standard. These crystals are fastened in with Wood's metal, which was fully described in my article in the June issue of this magazine. The cup terminates in a shaft which enters a barrel, and runs back to the rubber adjusting knob. This barrel contains a coiled spring which produces sufficient pressure to hold the crystals against each other. The detector is mounted on a hard rubber base.

The sensitiveness of this detector can be increased practically 30 per cent. by applying about .1 volt battery

Fig. 11. Silicon Detector

current to it, the positive side going to the bornite. As this requires a potentiometer, many experimenters do not care to take advantage of this increase in sensitiveness.

The pyron detector is made of the same element as the ferron—iron pyrites,—and is about of the same degree of sensitiveness.

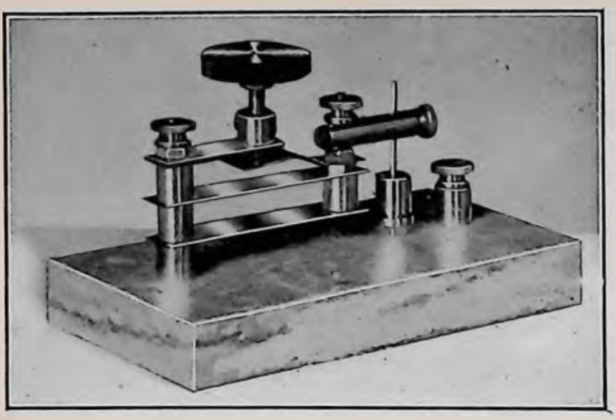


Fig. 12. Ferron Detector

THE TELEPHONE RECEIVER

On the telephone receiver depends the ultimate success or failure of a wireless telegraph receiving set. For that reason the experimenter should not be satisfied with a poor set of receivers—and he should be sure that when he buys a set he gets them from a reliable concern.

There has been considerable argument as to the use of enameled wire on receiver windings. The writer, who was among the first to adopt the enameled insulated wire for wireless receivers, believes the enameled wire winding far superior to any fiber insulated wire, such as silk or cotton—if it is wound on properly.

For instance, the following windings were made by me on a special magnet bobbin. Using No. 40 single silk-insulated wire, it would only contain 2,070 turns, with a resistance of 283 ohms. With No. 40 enameled wire, 10,020 turns with a resistance of 1,583 ohms were wound in the same space.

Most of this antagonism to the use of enameled wire originated with a cheap concern in the east, that was stocked up with a lot of foreign-made receivers wound with silk or cotton wire, and who began a systematic campaign of misinformation on the subject because they wanted to get rid of the receivers. Incidentally, it might be mentioned that it was this firm which originated the use of German silver wire in receivers, to save a few cents in winding.

The average beginner is easily hoodwinked by irresponsible people, who make a grand display of low prices in their advertisements, but who are out to get the experimenter's money, and give as little as possible in return. I have frequently pointed out that it is not the high resistance which counts, but it is the ampere turns for a given resistance. Of course, with detectors of the crystal rectifying type a resistance of from 800 to 1,600 ohms per receiver is desirable; but to get that

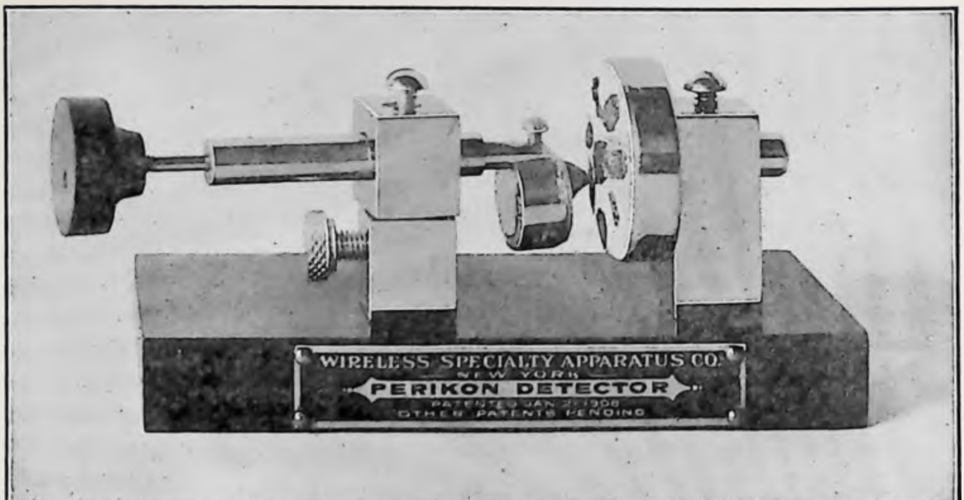


Fig. 13. Perikon Detector

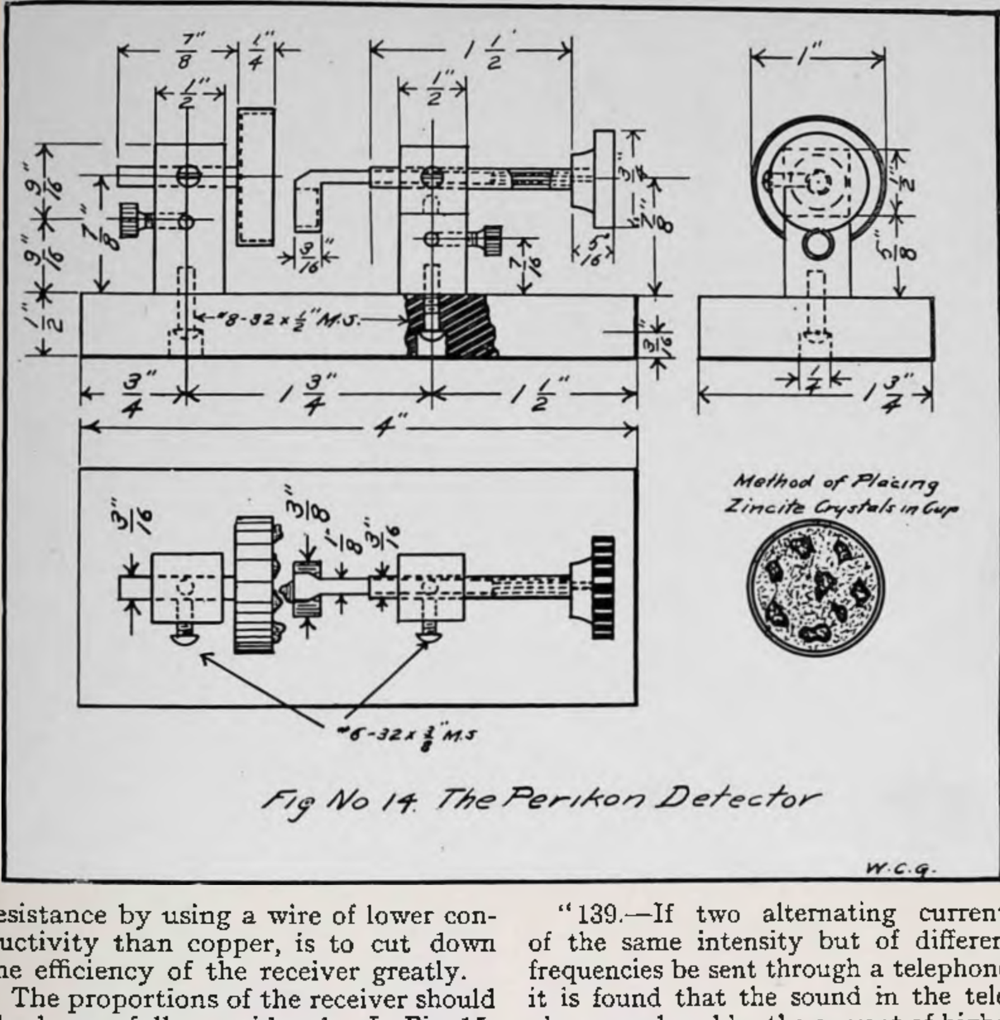


Fig No 14 The Perikon Detector

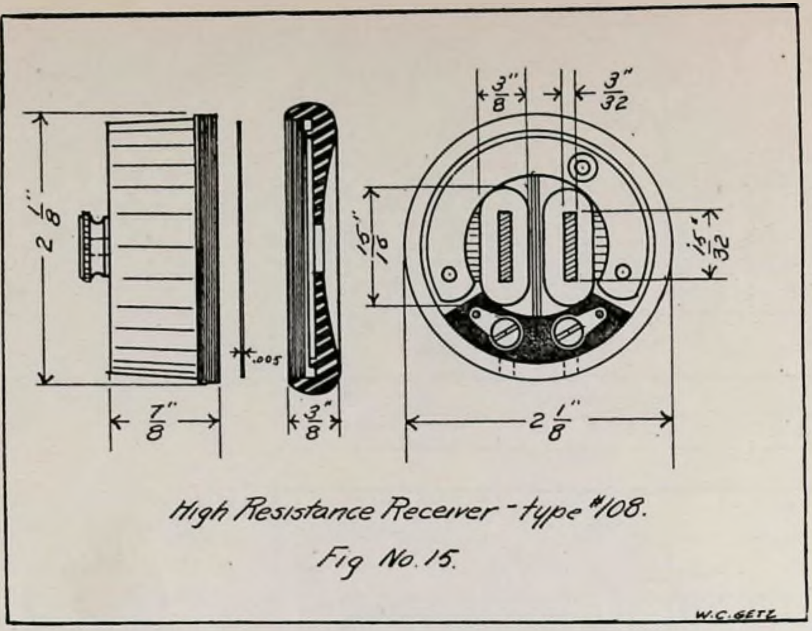
resistance by using a wire of lower conductivity than copper, is to cut down the efficiency of the receiver greatly.

The proportions of the receiver should also be carefully considered. In Fig. 15, I have given a drawing of the type No. 107–108 receiver wound by me. This receiver had a 2 in. x .005 in. diaphragm, and the tone value was superior to the smaller types. The general features and dimensions of this receiver are given in the drawing. The receiver was wound with 10,000 turns of No. 40 wire having a resistance of about 1,500 ohms.

In Fig. 16 is shown a pair of 6,000 ohm Sullivan receivers used by the government. This receiver is an English make, the American agents being the Wireless Specialty Apparatus Co.

The following extract from the Navy Wireless *Manual* shows how the increase of spark frequency in the transmitting station effects the efficiency of the telephones.

"139.—If two alternating currents of the same intensity but of different frequencies be sent through a telephone, it is found that the sound in the telephone produced by the current of higher frequency is louder than that produced by the lower. This fact is due in part to the peculiarities of the human ear, which is more sensitive to high pitch sounds than low, also in part to the diaphragm of the telephone which is usually of such weight and size as to vibrate more readily to a sound of a rather high pitch. This fact has an important bearing on wireless telegraphy, for the pitch of the sound produced in the telephone connected to the detector at the receiving station depends simply on the number of sparks per second at the sending station. In order to determine exactly what is the relation between the strength of the current required to produce an audible sound in the telephone, and the frequency, a series of experiments has



been recently carried out on a pair of head telephones of the type ordinarily used in wireless telegraphy, the results of which are shown in the table.

Sparks per Second	Volts to Produce Audible Sound
60	$6{,}200 \times 10^{-7}$
120	2,900 "
180	1,700 "
300	600 "
420	170 "
540	80 "
660	30 "
780	11 "
900	6 "

"In the first column are given the frequencies or the number of sparks per second, and in the second the number of volts alternating current which it would be necessary to apply to the terminals of the telephone to produce audible sound. From this it is seen that it requires about a thousand times as much voltage at a frequency of 60 to produce a sound as is required at a frequency of 900. We may assume, therefore, that if the number of sparks at the sending station be increased from 60 to 900 per second, and the spark length be kept the same, the effect on the receiving station would be increased one thousand times. If the number of sparks be increased in this way without reducing the spark length, it is evident that the energy made use of at the sending station must be greatly increased. It will be more interesting, therefore, to calculate what the increase in sending efficiency of the station will be with the increasing spark frequency, if the total energy be kept constant. So, if we assume that the energy is proportional to the number of sparks, and divide the relative increase in loudness of sound in the telephone at the receiving station for any frequency by the relative increase in the number of sparks per second, we will have a fair comparison of the efficiencies at the two frequencies.

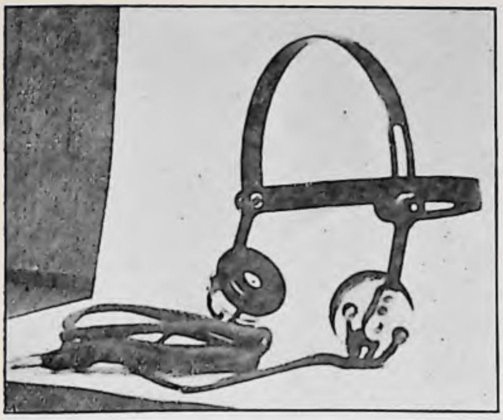


Fig. 16. Sullivan Receivers

Sparks per Second	Strength of Signal	Sparks per Second	Strength of Signal
120	1	540	13
240	1.5	900	64

"The results of such calculations are seen in the table, which shows that there would be a very slight advantage in replacing a 60 cycle alternator for a 120 cycle alternator, the former giving 120 and the latter 240 sparks per second, but the advantage increases rapidly as the frequency increases. The maximum sensitiveness of the telephone appears to lie in the neighborhood of 900.

"140.—In addition to the increase in sensitiveness of the telephone at high frequencies, there are other quite independent advantages in the use of a high-pitched spark. First, it is found in practice that a high-pitched musical signal is much more readily distinguished at the receiving station in the midst of atmospheric disturbances and ordinary interference; and second, at the sending station, a shorter spark gap, which would generally be used with a high frequency spark, puts less strain on the insulation of the condensers and other parts of the circuit, and reduces the losses due to brush discharges, which in many stations amount to a considerable share of the total amount of the power employed.

"A third advantage is that with a high spark frequency, larger amounts of energy can be radiated from a moderate sized antenna, without subjecting it to excessively high potentials.—The advantages of ease in reading, the lessening of the strain on condensers and insulators, and the increase in effective energy capacity of the antenna, especially when the latter is small, are very marked, so that it has been found possible to use small wireless sets of 2 k.w. where formerly from 5 to 10 k.w. were employed.

"The only difficulty involved in using very high spark frequencies lies in cooling the spark gap. For this purpose a rotary gap or some special refrigerating device must be used."

THE WIRING DIAGRAM

There are a number of ways of connecting up the receiving instruments, but in this article only one diagram will be given. It employs the inductive tuner, variable and fixed condensers, the crystal rectifying detector, and the telephone receivers.

In Fig. 17 we have the wiring diagram of this set. The oscillations coming down the antenna pass to the binding post *B*3 of the sliding contact, thence to the primary and through the rotary condenser (or direct) to ground.

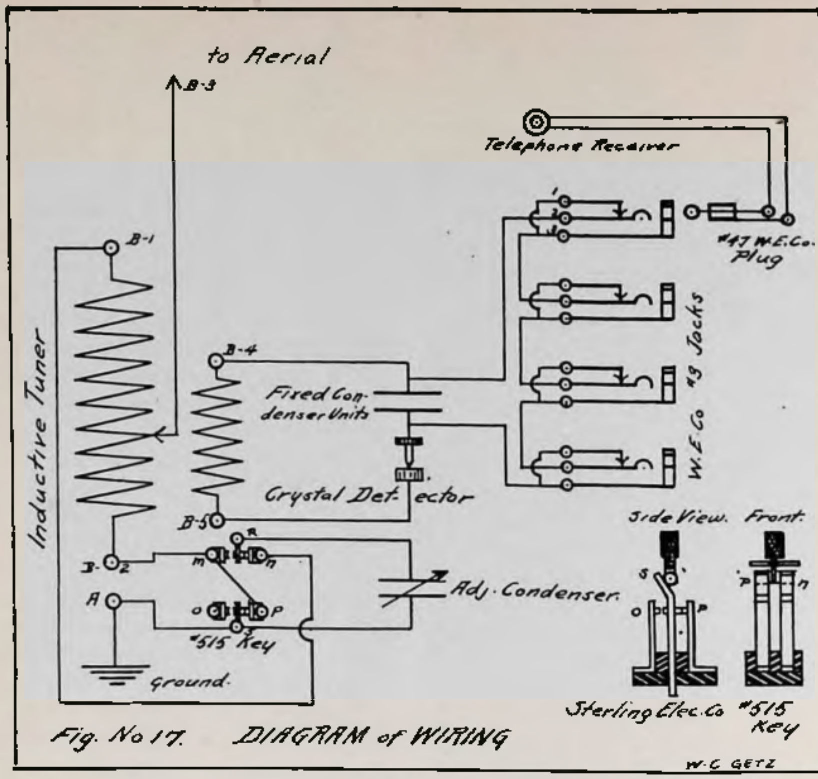
It will be noticed that a key switch is inserted between the ends of the primary and the ground. This is to allow the adjustable condenser to be placed in series or in multiple with the primary. To shorten the wave length, the condenser should be placed in series with the primary winding; to lengthen the wave length, place it in multiple, or bridged across the primary.

The type of key selected is the No. 515 key made by the Sterling Electric Co. The sketch in the lower right-hand corner gives an approximate appearance of the side and front views.

When the key is thrown to the left (looking at side view and wiring diagram) the center contact springs *s* and *r* connect with the left contact springs *o* and *m*. This places the adjustable condenser which is connected to *s* and *r* across *o* and *m*. The point *o* is not connected to anything as the side *s* of the condenser is permanently connected to ground. Thus, when to the left, the adjustable condenser is in series between the ground and the primary of the tuner.

When thrown to the right the contacts *s* and *r* engage the contacts *p* and *n* respectively. The point *p* is permanently connected to the point *m*, and, as stated, the side *s* of the condenser goes to ground. As *n* connects to the primary terminal, *B*1, at the other end of the winding, by throwing the switch to the right, connects the terminal *B*2 direct with the ground terminal *A*, and bridges the condenser to *B*2 and *B*1, in parallel with the primary. This makes an exceedingly convenient and easy device to change from a low to a high wave length.

The secondary of the tuner connects from its terminal *B*4 to one side of the fixed condenser unit. The other side of the fixed condenser unit goes to the



detector, and from the detector, back to the terminal $B5$ of the secondary.

Across the fixed condenser unit is connected a set of four telephone jacks. These are the Western Electric Co.'s No. 3 jacks, which correspond with the same company's No. 47 plug. In many stations the experimenter has more than one set of telephone receivers, and when his friends are present he likes to cut in additional telephones so that they can "listen in." This is a great nuisance, if the telephone cords have to be connected together with old binding posts or short pieces of wire, and even when connected, frequently in the midst of a message someone moves and breaks the connection, leaving all the instruments dead.

With this jack, the spring 1 is normally in contact with the spring 2. When the plug is inserted in the jack the "tip" of the plug engages spring 2 and forces it away from spring 1, thus opening the connection previously existing here. But at the same time the "sleeve" side of the plug makes connection with the collar of spring 3, thus placing the telephone receiver connected to the plug in series with spring 1 and 3. When several of these jacks are used as shown, spring 1 is connected to spring 3 in each jack, and spring 3 connects to spring 2 of the following jack. Thus, when only the first plug is inserted, the circuit is closed through the following jacks. Inserting a plug in any of the other jacks places the second receiver in series with the first one instantly, and without interfering in any way with the operating of the first one. In a like manner, a receiver may be removed from the circuit, and the instant the plug leaves contact 2, the spring makes contact with 1, and the circuit is closed through.

This will be found a great convenience in not only experimental but also in all commercial stations, as it eliminates the interruption to business that is bound to occur when it is necessary for a second operator to cut in.

These jacks, while they come mounted singly, can also be had in a strip of four, on what is known as the W. E. Co. No. 99–30 mounting strips. It will be this style of strip that I shall designate for the assembly drawing, to be given later. The list price of these jacks is 17 cents, and with the No. 99–30 (special) would probably be about 45 cents, so that the set of four would cost $1.80. The No. 47 plugs also list at 45 cents, thus making $3.60 for the complete set of plugs, jacks and mounting. As this is the list price, there may be some reduction from same.

THE ASSEMBLING OF THE RECEIVING INSTRUMENTS

Many experimenters like to assemble their receiving instruments on a board or in a case, as it makes a much more compact and neater appearance than having them lying loosely all over the operating table.

In Fig. 18 is a receiving set made by Clapp-Eastham Co., the apparatus being assembled in a compact case. In Fig. 19, is a set of the Murdock instruments mounted on a board. Both of these sets have many features to commend them to the experimenter.

In Fig. 20 I have given the design of a containing case on which the perikon detector in Fig. 14, two of the fixed condenser units in Fig. 10 and the rotary condenser described in the April and May issues of this magazine may be mounted, together with the No. 515 Sterling Electric Co.'s key, and the Western Electric jack strip.

This case is 6 in. wide, 3½ in. deep, and 7¹⁄₁₆ in. long, inside dimensions. The case is of ⅜ in. wood, making the outside dimensions 6¾ in. x 3⅞ in. x 8³⁄₁₆ in. The base is of ½ in. wood, 7¼ in. x 9¼ in., with the bevel and reduction to the size of the case as shown.

The position of the rotary condenser, perikon detector, key and jack set and fixed condenser units is plainly shown on the drawing. To support the condenser units, brass angles of ¹⁄₁₆ in. metal are attached as shown. The units slip into them in the slots, and the thumb nuts are then tightened, placing the two units in multiple. If desired, only one unit need be used.

Six binding posts are placed on the case, these being of the type shown at *B* in Fig. 5. The set is wired in accordance with the diagram in Fig. 17, and the terminals *B*4 and *B*5 connect to the respective terminals on the secondary of the inductive tuner. To the terminal *Z*, a short piece of wire is connected under the case, and twisted around the ground wire. This post is for the buzzer test set described in the June issue to be connected to. The posts *B*2 and *B*1 connect to the primary terminals of that marking, and the terminal *A* connects to the ground wire.

In wiring a receiving set it is recommended that stranded electric lamp cord be used. On the connections in the case, everything should be soldered or firmly held under lock-nuts. In fact, it is

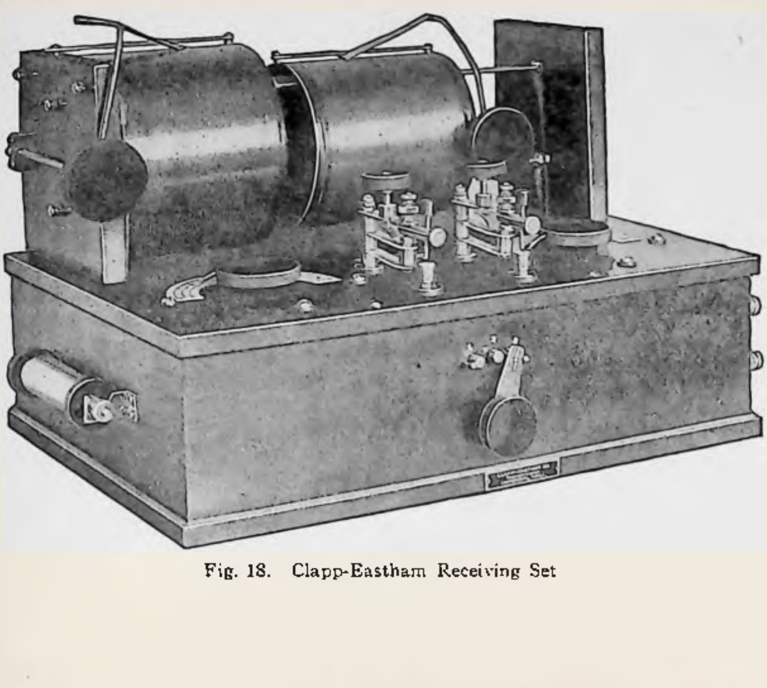


Fig. 18. Clapp-Eastham Receiving Set

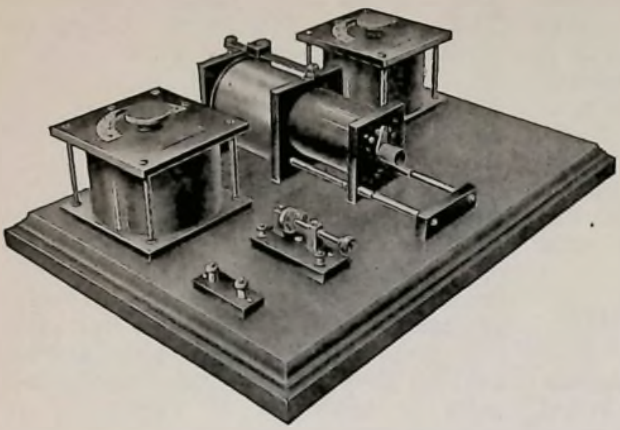


Fig. 19. Murdock Receiving Set

advisable to solder U-lugs on all conductors to be fastened under lock-nuts, as this will save much trouble due to loose wires.

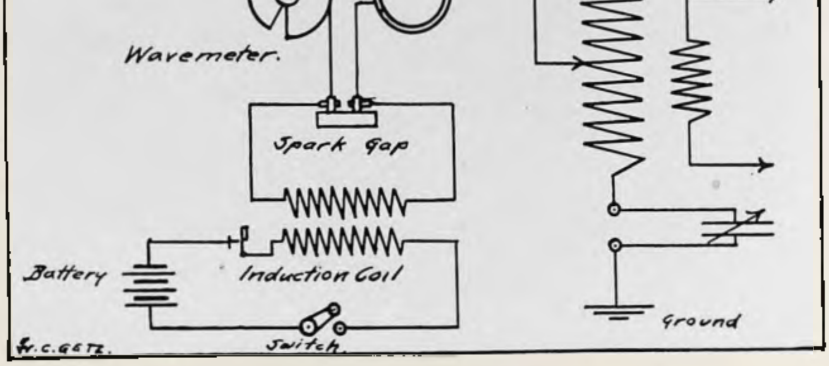
For wires on the outside of the case that are frequently changed, the Frankel Testing Clips, offer an excellent means for making rapid and perfect connections. Several 2 or 3 ft. pieces of lamp cord, with one of these test clips on each end should always be had at hand, as they will be invaluable for making the quick changes necessary when testing or trying out some new hook-up.

CALIBRATING THE RECEIVING INSTRUMENTS

Having completed the wiring and assembly of the receiving instruments and connected same to the antenna, the next thing will be to calibrate our receiving instruments so that we can determine what wave length the station we are receiving from is using. First, it will be necessary to fix a suitable scale to the slide contact of the primary; to the secondary—from the end of the primary winding; and on the rotary condenser.

Now we take the wavemeter described in the April and May issues, and disconnect the detector and telephone receivers from it. In their place we put a small spark gap as shown in Fig. 21. This gap should not be much more than 1/32 in. between points. A small induction coil run by a dry battery will now be placed across it. A suitable switch should be in the primary circuit of the induction coil.

We will graduate our set in steps of 25 meters, starting at 150 meters. Now, referring to the table given in the April issue, with the wavemeter article, we find that with No. 1 coil in, and the condenser scale at 100, the wave length is 150 meters; and with No. 2 coil in and the condenser at 1, we also obtain 150 meters. Set the wavemeter for one of these readings.



Place the wavemeter near the antenna and start the spark coil. Adjust the primary of the tuner until we pick up the buzz in the receiver. Then adjust the receiving rotary condenser and the secondary coil until we get it strongest.

Take a sheet of paper and make up a form like the following in Table A.

TABLE A

Wavelength in Meters	Tuner Slide	Secondary Point	Distance	Rotary Condenser Series	Multiple
150	8	3	2 in.	30	
175	11	3	2 in.	16	

Say our scale on the tuner slide is divided into 40 parts; the secondary into inches from the end of the primary; and the rotary condenser into 100 parts.

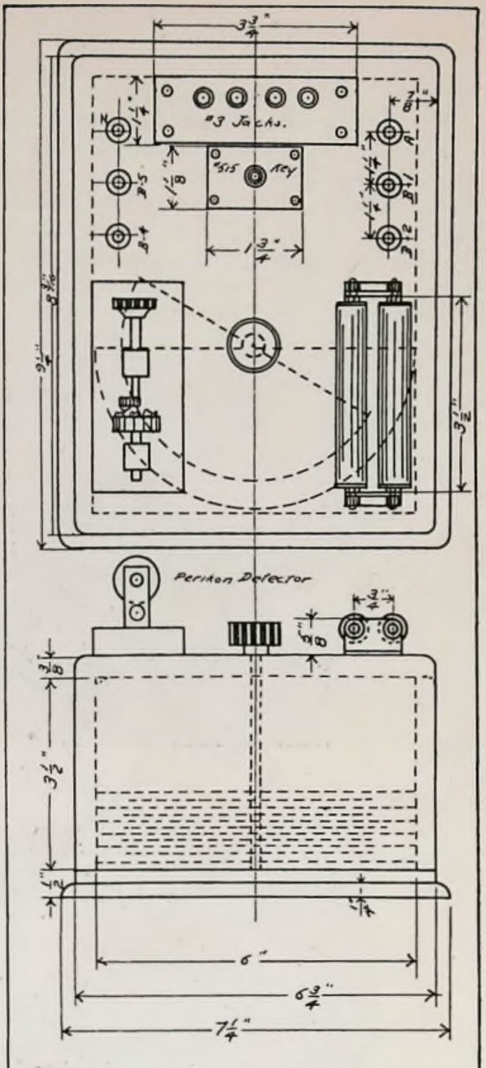
Now we find that we can tune in 150 meters sharpest when the tuner is at 8, the secondary on point 3 (3 sections in) and 2 in. from the end; and the rotary condenser in series and at 30. Set this down in the table as shown.

Let us now try for 175 meters. Referring to the wavemeter table again, we find that with coil No. 2 in, the range of the wavemeter condenser is from 150 to 250 meters. Also, the chart in Fig. 10 in the April issue shows us that 175 meters will be about 20 points on the wavemeter condenser. Set the condenser to this point and again start the spark going, and try as before for the buzz.

Say this time we get it at 11 on the tuner primary; the same points on the secondary; and the rotary condenser at 16. Set this down on the list. In this manner the receiving set may be calibrated for the entire range of the wavemeter. In fact, it becomes a wavemeter in itself.

It must be remembered, however, if at any time any of the instruments, the diagram of wiring, or the aerial is changed, the figures obtained are not correct, and a new set of readings must be taken.

The advantage in having a set calibrated is as follows: suppose you desire to listen in to a certain station that you have never caught before with the hook-up you are using. You would perhaps finally catch it by luck in aimlessly adjusting your instruments continuously. Now, if you know the wave-length of the station, set your instruments to the



Containing Case for Receiving Apparatus. Fig. No 21.

required wave-length, and beyond occasionally moving your secondary in or out to get a more efficient coupling, you will be in the proper adjustment to catch the station when he starts to send.

The government list of wireless stations, which appeared in this magazine several months ago, gives a complete list of wave-lengths and call letters for all government and commercial stations, which, when studied in connection with the calibrating of your apparatus, will enable you to pick up stations at greater distances than you have received heretofore.

AN IMPROVED SILICON DETECTOR

E. H. WILLIAMSON, JR.

There is one peculiarity in regard to the use of the silicon detector in wireless telegraphy which has been doubtless noticed by users of that device. This peculiarity is, that when the detector has been adjusted for receiving, it is apt to be thrown out of adjustment when a message is sent from a near-by induction coil or transformer, and the more powerful the discharge used in sending, the greater is the effect on the detector.

This trouble is probably due to a slight fusing of the silicon surface at the point of contact of the brass rod or gold point, whichever may be used. The trouble can only be obviated by an actual separation of the contacts; the mere cutting of the connections, or bridging the detector, with a shunt, having no effect. In the ordinary form of detector it is necessary to run up the contact screw to separate the brass and silicon, and this necessitates a new adjustment and test when it is desired to receive again. To obviate this trouble I have devised the novel form of detector shown in Figs. 1 and 2, which practically explain themselves. As will be seen, the detector consists of the usual bent arm supporting a long brass screw with a fine thread, a 4-40 in this case. This screw bears upon a slender flexible piece of spring brass provided with a brass point which forms the contact with the silicon.

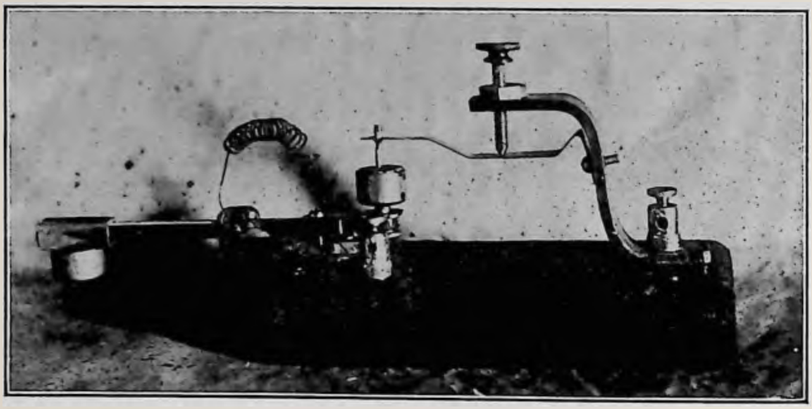


Fig. 1. Arm in Position for Receiving

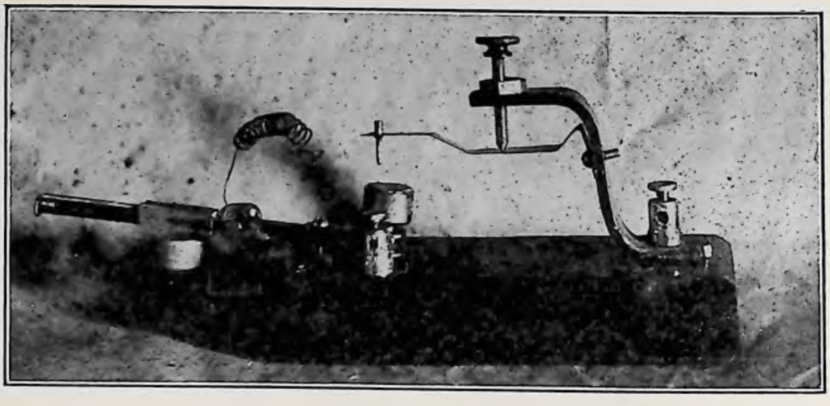


Fig. 2. Contact Broken When Sending

The latter, as usual, is soldered in a metal cup, and this cup is screwed to a short piece of spring brass which is pivoted to the balanced arm of 3/16 in. square brass rod, so that it can be swung from side to side horizontally.

The balanced arm, which is about 4 in. long, is pivoted, so as to swing freely, to an upright support, in such a position that the excess of weight will be at the end to which the silicon is attached. The base of the support is screwed to the wooden base of the detector, the screw holes being filed lengthwise to allow of a movement back and forth. This, with the swinging movement of the cup spring, allows every part of the silicon surface to be reached by the brass point, a great advantage when hunting for a sensitive spot. The free end of the balanced arm supports a short piece of the square tubing such as is used for the sliding contacts of tuning coils, and is provided with a weight which, when slid out to the end of the rod, is sufficient to hold the cup end up firmly against a stop-pin with a fixed pressure. To adjust for receiving, the long screw is moved up or down as usual, forcing the contact pin with more or less pressure against the silicon. When sending, the weight is slid forward toward the center until the cup end drops of its own weight. To receive again, the weight is pushed back to the end and the cup comes up again to exactly the same position and tension as before. I have tested this detector thoroughly in my own station and found it perfectly reliable and needing no adjustment after the first setting, though my 1½ in. spark coil operates within 8 in. of it.

To avoid poor contact at the pivot screw of the balanced rod, the latter is connected with the binding-post by a flexible spiral of No. 24 wire soldered to the rod.

Repairing a Commutator

Putting new mica segments in the commutator of armatures is not so difficult, but to keep the copper segments from becoming loose and projecting, causing the brushes to rattle, is the most perplexing problem that I have had for a long time. I would tighten the screws that pull up the mica ring as tight as I could with a wrench and screw-driver. The commutator was turned in a lathe and was all right, but when put in the frame and let run for one-half hour, the bars would be loose.

It went along this way for about nine months, making about 15 to 20 armatures. I finally learned and have a scheme now that makes this trouble a thing of the past. I tighten the screws with a screw-driver as tight as I can by hand, take two blow torches, one on each side of the commutator, put a strip of asbestos paper around the commutator leads, when it is an enclosed commutator; and a strip of asbestos paper around the commutator leads and asbestos wool packing between the bars on an open commutator. Then I heat the commutator with the two blow torches until the alcohol burns.

The mica segments and ring are shellacked before being put into place. The heat of the commutator causes the shellac and alcohol to run, consequently a blue flame will be seen all around the commutator if it is heated enough. Then tighten with a wrench or the special apparatus shown in the illustration and you will not be bothered with loose bars. The tool is flattened to a screw-driver on one end and the other end is a round point.—*Practical Engineer.*

Gas Engine Troubles

(Concluded from page 95)

if an engine is flooded. A tablespoonful of gasoline may be sufficient to prevent ignition. If you suspect too much gasoline, the quickest remedy is to work it out through the exhaust by opening the air pipe and closing the gasoline needle valve. In very cold weather a very good remedy is to take out the igniter, hold open the exhaust valve, and set the gasoline in the cylinder on fire with a match.

Be careful not to get in front of the opening when the match is applied, for a blaze of fire 3 ft. long is very apt to come out, after which the surplus gasoline will burn slowly like so much kerosene until it is all burned out of the cylinder. The reason for holding open the exhaust valve is to give a circulation of air through the cylinder so that the flame will not smother. This method has the advantage of warming the cylinder. When the surplus fuel burns, put the igniter back in place and start the engine in the usual way.

EDITORIAL

The recent proposal by the postmaster-general that postage on the advertising portions of magazines should be materially raised, and the resulting discussion of the matter in the newspapers and in Congress, has served to focus public attention again on some of the problems of magazine publication. The proposed increase in postage was defeated in the last Congress, but will presumably be brought up again next winter for solution, and undoubtedly the periodical press faces the necessity for changing its methods of doing business. In making any change in rates, however, Congress should not be unmindful of the fact that all publishers' contracts with both subscribers and advertisers are made for long periods of time in advance, and that any change in rates should be so made as to allow existing contracts to be carried out without serious loss.

It has no doubt again been brought to the attention of our readers, that owing to the conditions which have existed for a generation in the matter of low magazine postage, there has been built up, in the United States, an enormous industry, which is constituted on false economic lines. We have a great volume of periodical literature which is furnished to the purchaser at a price materially below the cost of production. Every magazine of any importance gives the subscriber for his money far more than he could buy in the form of books, and in consequence thereof, the publisher is forced to obtain for his advertising an amount sufficient to meet the deficit involved in producing the magazine, and also the profit which he may be fortunate enough to secure. Therefore, every subscriber should feel that the advertisers are largely responsible for the excellence of the magazine that he reads, and that he could not have anywhere near as good a magazine if it were not for their support. He should feel that, other things being equal, he should buy his goods from the firms who advertise in his favorite magazine, rather than from others who are not willing to proclaim the merits of their goods through this medium. He should write to these advertisers for information which they will gladly furnish, and should show them, as far as possible, that he appreciates the help in the way of literature which they are only too glad to furnish him. It is well also to remember that only goods which possess real merit can stand the test of advertising, that many a manufacturer produces for a certain time goods which may be apparently cheaper than advertised brands, but that he cannot afford not to advertise if his goods have real merit, for the man who does not advertise in this age is bound to fail. Remember also, that every reputable publisher takes care that his advertisers live up to their published statements, and only allows those firms to use his columns whose reputation and goods are such as to render them worthy of confidence.

One of our young New England readers, a high school pupil, advises us that he is the winner of a silver loving cup in a recent model flying machine competition in which were entered a large number of model aeroplanes. He further states that the monoplane which brought the prize to him was made from directions and specifications given in *Electrician and Mechanic*, and that our publication has proved to be of great assistance to him in his study of aeronautics.

We desire to call the attention of readers who are interested in model flying machines to the excellent design offered in Mr. Twining's article in the present issue, and venture to suggest that amateur builders will find the specifications worthy of their consideration.

He who criticizes is your friend; treat him as such. He who flatters is to be regarded with caution. What is his motive? But flattery and honest praise are not the same.

Do not shake off or avoid your work; do not go around obstacles—go through them.—Marden.

HERE AND THERE

Why Willie lost his Job

Carpenter (to his apprentice): "Well, Willie, have you sharpened the tools?"

Willie: "Yes, all but the 'and-saw, and I haven't quite got all the gaps out of it."

Seizing His Opportunity

It happened in Topeka. Three clothing stores are on the same block. One morning the middle proprietor saw to the right of him a big sign "Bankrupt Sale," and to the left, "Closing Out at Cost." Twenty minutes later there appeared over his own door, in larger letters, "MAIN ENTRANCE."—*Everybody's Magazine.*

In an Illinois town that you can't find on the map, the fire department has an unexcelled record for conscientiousness and devotion to duty. One night the church bell clanged out an alarm with the code taps that indicated "fire north of square."

In instant response the fire department jumped on his horse and galloped to the rescue. He had not gone far when a second alarm announced a second fire, this time to the south. An anxious citizen, speeding toward his southside property, called out to the passing marshal:

"Hi, Jake! you're headed the wrong way! There's a big blaze to Greening's."

The fireman was no shirk. "Keep it a-goin', Ed!" he shouted. "I'll be over in less 'en ten minutes!"—*Everybody's.*

Gentle Reminder

It was midnight. The man had entered the house as quietly as possible. His shoes made some noise. He had just reached the door of the bedroom when he heard some one moving in the bed as if about to get up, and he paused. The sound of a woman's voice floated to his ears.

"If you don't take your boots off when you come into this house," it said, "there's going to be trouble, and a whole lot of it. Here it's been raining for three hours, and you dare to tramp over my carpets with your muddy boots on. Go downstairs and take them off this minute!"

He went downstairs without a word, but he didn't take off his boots. Instead he went straight out into the night again, and the "pal" who was waiting for him saw a tear glisten in his eye.

"I can't rob that house!" he said. "It reminds me of home."—*Blue Bull.*

In Search of His Home

A peaceable resident of West Sixty-Fifth Street was rudely awakened from sleep last week, at about two-thirty a.m., by a loud ring at his doorbell.

Throwing open the window, he stuck his head out and in no very pleasant manner demanded to know what was wanted.

"Scuse me, sir," answered a muddled voice. "Does Jones—hic—hic—live here?"

"Jones?" said the party addressed angrily. "Of course not. What the devil do you mean by ringing people's bells at this time of morning? Who are you, anyway?"

"Who'm I?" asked the disturber apparently surprised at not being recognized. "Why, I'm Jones!"—*Lippincott's.*

A Gloomy Prospect

"When I grow up and marry, mother, will I have a husband like papa?" asked Mary.

"I hope so, dear," said mother.

"And if I don't marry, will I be like Aunt Sue?"

"I hope so."

"Dracious!" said Mary, as she turned away, "what a fix I'm in!"

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage, and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1639. **Apprenticeship to Learn Wireless.** E. M. D., South Bend, Ind., desires to know where he can apply for an apprenticeship in order to thoroughly learn wireless? Ans.—Owing to the very large number of amateurs who have thoroughly grounded themselves in wireless telegraphy, the wireless companies do not find it necessary to themselves train their operators. We would advise you to either attend a school of telegraphy or study up by yourself, and when you feel yourself competent, apply to one of the commercial companies for a position.

1640. **Wireless Work.** L. R. J., Lynn, Mass., asks: (1) Can the same formula be used for calculating the capacity of a sending condenser for wireless work and for telephone condensers? (2) Give formula for calculating impedance? (3) Can you give the capacity in microfarads and the inductance in microhenrys of an inductively coupled 2 kw. government station, using any wave length between 425 and 700 meters,—and also of 1,200 or 1,500 meters? Ans.—(1) Yes, if allowance is made for the material used in the dielectric. (2) If impedance is meant in its strict sense, it may be found by the following formulæ:

$$\text{Impedance} = \sqrt{R^2 + \left(2\pi \sim L - \frac{1}{2\pi \sim C}\right)^2}$$

and, if no capacity is present, this may be simplified to:

$$\text{Impedance} = \sqrt{R^2 + (2\pi \sim L)^2}$$

where
- R = resistance in ohms
- L = inductance in henrys
- C = capacity in farads.
- $\sim$ = cycles per second (frequency of current).

Impedance is that quantity which, when multiplied by the current, gives the electromotive force: in other words, impedance in the case of alternating currents, corresponds to resistance in the case of direct currents. (3) If the capacity is expressed in microfarads and the inductance in microhenrys, the wave-length may be found by this simple formula:

$$\text{Wave-Length (meter)} = 1897 \sqrt{C\,L}$$

It will be seen from this that we may have a great variety of different values of C and L and yet get the same wave-length. In general practice, the capacity (C) of sending condensers is between .0001 and .05 microfarads and the inductance which is used may be found immediately from the formula. It is not possible to give any more details, for they vary greatly from station to station.

1641. **Portable Outfit.** P. S. M., Jamaica, N.Y., asks: (1) Kindly give a diagram of the wiring for the portable outfit in the October, 1910, *Electrician and Mechanic*. (2) Are these dimensions right for a 9 in. spark coil? Core 16 x 1⅜ in., primary 2 lbs. No. 10 d.c.c., secondary 8½ lbs. No. 36 s.c.c. wound in 30 sections, run on 12 volts 12 amperes; condenser for same is 100 sheets of 5 x 10 foil. (3) What instruments are needed to go with the above coil; also dimensions of same? Ans.—(1) Diagram forwarded direct to you. (2) The dimensions given should give you at least a 6 in. spark. (3) If you mean for wireless work, the above coil is not suited for same. Instead of No. 36 wire, use No. 28 enameled wire. For the dimensions of the remaining apparatus to go with this to make an up-to-date wireless outfit, see article in February and March, 1911, issues of this magazine, by W. C. Getz, on construction of transmitting equipment.

1642. **Measuring Waves.** J. B., West Chester, Pa., asks: Can you inform me whether there is any instrument sufficiently sensitive to measure the waves coming in from an aerial? Ans.—You do not say whether you want to measure radiation or wave-lengths. In the April and May issues of this magazine, Mr. W. C. Getz gave a complete description of the construction of a wavemeter and a hot wire meter. The former will measure wave-lengths from 150 to 1,100 meters, and the latter indicate the radiation.

1643. **Telephone Interferences.** E. W. F., Cleveland, O., asks: (1) Is there any way in which I can stop the neighboring telephones from making a very loud noise when I am sending? (2) Can the telephone company stop me from sending and who must stand the expense of remedying this trouble? (3) Is a four-wire aerial 40 ft. high better than a six-wire 25 ft. high? (4) What would you rate a coil that has four layers of No. 16 wire on primary and 2 lbs. of No. 26 on secondary? Ans.—(1) See article by Mr. J. B. Taylor, in June, 1911, issue of this magazine. You do not say whether you are using a tuned transmitting set or not. You should have given a better description of this. If practicable move your aerial as far as possible from the telephone wires. Use a carefully tuned transmitting circuit. Be sure you have a good ground, not near the telephone ground wires. (2) As the telephone service is a necessity, while your outfit is only for your own amusement, you will be held responsible for the correction of the trouble, and the telephone company can enjoin you from interfering. (3) The four-wire aerial 40 ft. high will be more efficient. (4) With the meager data furnished, would approximate the rating about 100 watts.

1644. **Private Lighting Plant.** T. F. J., Scranton, Pa., asks: (1) For the address of a firm where he can obtain 20-volt Tungsten lamps? (2) How many turns of No. 34 d.c.c. wire is wound in each section of the armature of the "recording wattmeter?" (3) What speed is the dynamo run at? Ans.—(1) We would suggest that you write to any of the electrical supply houses whose announcements appear on our advertising pages or to the author of the articles you mention. (2) Each section of the armature of the "recording wattmeter" will require about 50 turns of No. 34 d.c.c. wire. (3) At 1,800 revolutions per minute the dynamo described generates 40 volts. The field winding is purposely made of somewhat heavier wire than is necessary, and the machine builds up readily while running at a speed of 1,000 to 1,200 revolutions; and at this speed it generates a sufficiently high voltage to charge 11 cells of storage battery.

1645. **Indoor Aerial.** D. D., Brooklyn, N.Y., writes us that he lives in a tenement house and that the landlord will not permit him to put an aerial on the roof. He wishes to know what he can do so that he may use his wireless receiving instruments. Ans.—We should advise you to experiment with an indoor aerial which may be strung across the rooms inside the house, care being taken to insulate the wires from contact with all metal articles in the room, and particularly from contact with the gas pipe. Ordinary porcelain knobs will answer the purpose here. While such an aerial will not give you the results that a large one on a roof would, you will probably find it well worth the trouble it took to put it up.

1646. **Coil Data.** L. R. C., Beverly, Mass., asks: (1) For dimensions for 1 in. coil, secondary to be wound with No. 28 B. & S. enameled wire. (2) Same as above for 2 in. coil, secondary No. 28 B. & S. Also which is the better insulator for above coils, beeswax or linseed oil? (3) He understands that wireless transformers are generally wound to 10,000 volts, as, in order to secure a higher voltage, more wire must be used; therefore, the secondary will have more resistance. This will make the available current smaller and the coil will not send so far. If this true of transformers, why is it not true of spark coils? Ans.—(1) For 1 in. coil use a core 1 x 8 in.; primary two layers No. 16 d.c.c. wire; insulating tube eight layers empire cloth; secondary, 3 lbs. No. 28 B. & S. gauge enameled wire; secondary to be wound in sections not larger in diameter than 3 in., and in thickness not greater than ¼ in. Length of secondary as short as possible with good insulation. (2) For 2 in. coil use core 1⅛ x 9 in.; primary two layers No. 14 d.c.c. wire; insulating tube twelve layers empire cloth; secondary 6 lbs. No. 28 B. & S. gauge enameled wire wound in sections not more than 3¼ in. diameter and having thickness of not more than ¼ in. Insulating discs between sections three thicknesses of empire cloth or two of waxed paper. If coils are to be used continuously, linseed oil will be the more efficient insulator, but care must be taken to expel a greater portion of the moisture from it by thoroughly boiling before pouring into the coil case. Linseed oil is sometimes poured through strainers which have been used for straining lead paint. This renders the oil totally unfit for use as an insulator for high voltages, and care should be taken to procure oil free of lead or other impurities. Transformer oil can sometimes be obtained from central station managers, and, if such oil is available it should certainly be used. (3) The function of the transformer in wireless telegraph stations is to charge a condenser. For this, a voltage of from 5,000 to 15,000 is required. In the smaller sizes of transformers it would not be possible to secure a higher voltage unless very fine wire was used in order to increase the number of turns in the secondary to the requisite amount. For this reason small transformers are built to deliver secondary potentials of about 6,000 or 7,000 volts. In practice the same is actually true of spark coils. Experiments with coils, containing a comparatively large and powerful primary and core, together with the secondary wound with heavy wire placed as close to the core as possible, have proved that such a winding is preferable for the purpose of charging condensers to the now almost obsolete form, using very fine secondary wire and having an enormous number of turns. In induction coil designing for this purpose, the following hints may be put to good use: Core length not to be over 12 times its diameter; for very rapid interrupter use 2 or even 1 layer of primary wire just sufficiently large to carry the current without overheating; secondary to be not greater in diameter than 3 times the diameter of core, and in length to be as short as possible; size of secondary wire to be determined by the number of turns necessary and the allowable space for secondary bobbin.

1647. **Telephone over Fence Wire.** A. C. J., Lewiston, Oriente, Cuba, asks: Would it be possible or practical to operate a telephone line for a distance of three miles by utilizing the wire on a fence; Ans.—A fence wire might be used as a conductor for a telephone line, providing it was carefully insulated from the ground on each post. Some difficulty might be experienced, however, in rainy or damp weather, as there will probably be considerable leakage between the wire and the ground. The experiment would not be expensive, and we would advise you to try it

1648. **Chemistry.** R. B. T., Jamestown, N.Y., asks: (1) What chemical change takes place when tin is dissolved in copper sulphate? (2) When the copper is precipitated is the tin taken into solution? (3) What gas is given off when copper is dissolved in nitric and what is its symbols? Ans.—(1) When iron, zinc, cobalt, nickel, lead, cadmium, bismuth or tin is placed in contact with a copper sulphate solution, the copper is deposited and the other metal goes into the solution in the form of a sulphate. Exactly what salt of tin would be formed depends somewhat on conditions of temperature and concentration of solution. (2) The gas given off when copper is dissolved in nitric acid is nitric dioxide N_2O_2, which, on contact with air, unites with it, forming reddish brown fumes of nitrogen tetroxide N_2O^4

1649. **Wireless.** W. G. K., Cleveland, Ohio, asks: (1) Why won't the following set work? Double 75 ohm receivers, electrolytic and silicon detectors, single slide tuning coil with secondary, glass plate condenser, E. I. Co.'s potentiometer, and arial 30 to 50 ft. high (not higher than trees and house) and about 75 ft. long. (2) How much, and what size wire would be necessary to change above receivers to 1,000 ohms each? Ans.—(1) You cannot expect to obtain any results whatever, with a set of 75 ohm telephone receivers, as they are not sensitive enough. To rewind them, you will require about 2 oz. of No. 40 enameled magnet wire. Your potentiometer may also be unsatisfactory.

1650. **Wireless Trouble.** J. L. F., Ft. Wm. N. Harmon, Mont., writes us that he has experienced considerable difficulty in the operation of his wireless set, and asks for advice which we give as follows: Ans.—You have made several serious mistakes in your connections as shown on the diagram you have enclosed. First, if you use battery with your detector, the telephone receivers should be in series with the battery and the detector. Preferably, they should be placed in the circuit where the + end of the potentiometer connects to the point of the detector. This allows the direct current to flow through the receiver and detector back to the potentiometer-battery set, but, as the telephone receivers are in series with the battery circuit, they have sufficient impedance to choke out the high-frequency oscillations, and force them through the detector. As you have your set wired, the telephones bridge the detector, allowing the majority of the direct current to constantly flow through the receiver, regardless of incoming signals. In addition, a fixed condenser bridged around the detector and receivers allows the H. F. oscillations to pass through to ground without touching the detector. And to still complicate matters, the potentiometer is bridged across the detector, allowing a proportion of the energy to escape via this path without actuating the detector. It is surprising that you even picked up buzzer signals with your set. To sum it up, put your telephones in series with battery feed; disconnect fixed condenser from around phones. It would also improve conditions to cut out one of the condensers you have in series in the aerial and ground, and fix the other so that it may be thrown in either series or multiple with the primary of the L.C. tuner. (2) With respect to the telephone wire aerial, your set evidently throws crosstalk on the respective circuits. It would be better if you put up a 30 or 40 ft. aerial, say to one of the telephone poles, separate from the telephone system. (3) You should get all the western and Great Lakes stations without difficulty, as well as Fort Omaha and Fort Riley, Kan.

1651. **Wireless.** J. H. J., Owensboro, Ky., asks our opinion on an instrument he has devised and writes as follows: As I understand it, a relay can only be operated by the use of a coherer or auto-coherer. Do you think an instrument that will operate a relay when electrolytic, silicon or other such sensitive detector is in use would be of any value? Of course, the polarized relay would be of 1,000 ohms or better owing to circumstances. The instrument would be connected in exactly the same manner as the telephone receivers, the relay being connected in series with the contacts of the instrument and the batteries of the relay circuit. Ans.—If the instrument that you mention is as sensitive as a 1,500 ohm telephone receiver, and will operate a suitable relay, it should be of considerable value in wireless work. Of course, the advantage of a telephone is that the operator can easily distinguish between static, high and low pitch signals, etc., even when he cannot tune them out. Your instrument could not make this distinction. But then, if your appliance could be used to actuate a suitable tape recording device, and did not require much attention, it would be very useful.

1652. **Airships.** S. W. U., Ludlowville, N.Y., asks: (1) Which is the safer and easier to operate, a biplane or monoplane? (2) What is the salary and opportunities for advancement for a wireless operator, automobile repairman and chauffeurs? Ans.—(1) There is practically no difference in regard to safety between biplanes and monoplanes. It is usually understood that a biplane has somewhat more stability than a monoplane, but there is very little difference in regard to operation between the two types. (2) We can give you no fixed figures in regard to salaries for the various class of operators which you mention. They may vary anywhere from a few dollars per week to $25.00 or $30.00 per week, or even more in the case of skilled mechanicians, varying with the experience of the man and the section of the country.

TRADE NOTES

We take pleasure in acknowledging receipt of an illustrated catalog from the Ohio Electric Works, Cleveland, Ohio, and we note several additions to their large and well-known line of electric novelties and appliances. Any interested reader may obtain a copy of this catalog upon application to the company.

Geo. W. Richardson, of Chicago, issues an attractive little booklet which calls attention to the desirable features of the Richardson Direct-Reading Slide Rule. It is indeed surprising that so little is known about the slide rule outside of schools and colleges, except by those who have to do with the higher branches of engineering. The slide rule is, without a doubt, one of the most valuable of labor-saving and brain-saving devices, and a knowledge of logarithms is not necessary in the use of the Richardson rule for any of the problems which ordinarily arise. This rule itself and the little book which goes with it make the user proficient with very little practice. Mr. Richardson, whose announcement appears on our advertising pages, will be pleased to forward the booklet describing his slide rule to any interested reader.

We are in receipt of a booklet entitled "For the Prevention of Fire," issued by Hammacher, Schlemmer & Co., New York. The booklet describes in detail the extensive line of fire-fighting apparatus carried by this firm, and particular attention is called to the portable automatic fire escapes which may be conveniently carried in a trunk or traveling case. The fire escape consists of a special rope with a loop at each end, which passes through a simple mechanical device hung at the window. This device controls the speed of the moving rope without any human assistance. It readily adjusts itself to any weight and a person weighing 250 lbs. will descend approximately at the same rate of speed as one weighing 90 lbs. The mechanism has no ratchet, cog-gearing or spring liable to stick or get out of adjustment. The reel or coil of rope, which reaches to the ground, is thrown out of the window. With a loop at the end of the rope at the window a slip noose is made and slipped over the head and under the arms, and the person may then descend without holding or controlling the rope in any way. It is not necessary for the second or succeeding persons to draw the rope up again. It is ready for them, as there is a loop at each end of the rope. The low price, as well as the light weight and small size of this appliance, should render it very attractive to travelers.

In addition to the foregoing apparatus, Hammacher, Schlemmer & Co. carry a very complete line of hardware, tools, and supplies, a catalog of which they will be glad to send to any reader upon application.

The School of Engineering, Milwaukee, Wis., has issued a beautifully illustrated prospectus describing courses in the various branches of engineering. Opportunities for young men in the electrical and mechanical engineering field are greater than ever before, and they are growing with every year. With this growth the demands by employers and by competition have also grown. The untrained man can no longer hold his own against the rivalry of those who have received an education in theory and technic. They are not trades that can be mastered by experience alone; they call for the highest and most thorough learning, if the greatest possibilities are to be reached.

The courses in this school are essentially practical. From the first day the student enters, he is given daily systematic practice in the laboratories, draughting room, machine shop, dynamo room, engine room, boiler room, etc. He is plunged into the actual work that is done by the plants in the line of industry for which he is receiving training. The students are taught to make practical, serviceable things, such as would be acceptable in a commercial plant. In addition to this practical experience the student receives a thorough technical training, and on graduation is ready to take and hold a job.

The booklet issued by this school should prove interesting to many of our readers.

The New Carleton 6 in. Fan

The Carleton Company, of Boston, known as the manufacturers of the "Imp" torch, has placed on the market its 1911 model 6 in. fan, the outcome of several years of experimenting and much investigation. This fan is primarily for desk use, but easily changed to the bracket type, the trunnion suspension permitting adjustment at any angle.

The bearings are bronze and of ample size; oil cups are generously large; the commutator is built up with mica insulating strips punched to shape and held in place rigidly under pressure. The brushes are of carbon with core of copper, this insuring perfect conductivity and long life. The finish is of black enamel with all bright parts nickeled on brass.

The amount of breeze delivered is surprising, and greater than would be desirable blowing directly. The manufacturers claim that the fan is suitable for use in any place where a ceiling type fan is not required, and is well adapted for general home and office use, for picture shows, telephone booths, as a hair drier, etc. It is practically noiseless, there is no sparking, and it is furnished for a.c. or d.c. at the same price, and is also wound for 7 volt battery current. The retail price is but $6.50.

BOOK REVIEWS

Practical Applied Electricity. By David Penn Moreton, B.S., E.E. Chicago, The Reilly & Britton Co., 1911. Price, cloth, $2.00; leather, $2.50.

This book was announced for publication by another firm as long ago as last November, and after innumerable delays and a change of publishers, finally appeared in the last days of June. It is, however, well worth waiting for. It is an excellent text-book of applied electricity, which, while designed primarily for those who desire to study electricity at home, is also a satisfactory book for school use. A conspicuous feature is the large number of practical examples which are solved, thereby giving a useful guide in the solution of the numerical problems which come to the student throughout his work. There is, of course, no opportunity for the introduction of any great novelty in the subject, and the author has, therefore, confined his attention to enunciating well-known principles in a simple, thorough, and ordered manner, and in this he has succeeded excellently.

Mathematics for the Practical Man. Explaining simply and quickly all the elements of algebra, geometry, trigonometry, logarithms, co-ordinate geometry and calculus. By George Howe, M.E. New York, D. Van Nostrand Co., 1911. Price. $1.25 net.

The author of this book has attempted the formidable problem of compressing within the limits of 143 pages a complete treatment of the fundamentals of mathematics, including algebra, geometry, trigonometry, logarithms, co-ordinate geometry, and the calculus. It is inevitable that many things must be omitted, but the author has succeeded in carrying the pupil, assumed to know only the elements of arithmetic, through the majority of difficulties which he will meet in the study of the average text-book on a scientific subject. The book does not shirk difficulties, but requires the reader to understand them before proceeding further. It can be mastered by any clear thinking student in a very short time, and offers a valuable help to the mathematical student.

Woodworking for Amateur Craftsmen. By Ira S. Griffith, A.B. Chicago, Ill., Popular Mechanics, 1911. Price, 25 cents.

This concise handbook starts the worker with rough stock, teaches him how to use his tools, lay out and square up his stock, and then make a large number of simple and useful objects for home decoration or utility. It is an excellent treatise on the subject and well worth the moderate price charged.

The Aeroplane,—Past, Present and Future. By Claude Grahame-White and Harry Harper. With 93 illustrations. Philadelphia, J. B. Lippincott Co., 1911. Price, $3.50 net.

Mr. Claude Grahame-White is well known as the winner of the Gordon-Bennett Aviation Cup in 1910, and is hence well qualified to speak on at least the present aspect of flying. While he is named as the author of this book, a number of the chapters are written by such well-known experts as Bleriot, Grace, Farman, Paulhan, and others of equal rank, though perhaps less well known in America. The book is one which, in spite of the rapid changes in the art, will remain standard for some time to come. Its historical facts are authoritative, and the account of the progress of aviation is carefully and thoroughly written. The most notable flights up to the present time are described; the flying records are tabulated; all of the accidents which have occurred in aviation are described and analyzed, and there is a practically complete list of aviators of the world. Much valuable material on building aeroplanes is supplied, and all in all the book is indispensable to any one who desires to keep in touch with achievements in aviation to date.

The New Art of Flying. By Waldemar Kaempffert. New York, Dodd, Mead & Co., 1911. Price, $1.50 net.

Mr. Kaempffert has endeavored to explain in this interestingly written handbook, exactly how and why flying is possible. Without being mathematical or too theoretical, the mechanism of each part of the aeroplane is described and explained. The book is thus an excellent guide to the art of flying. The latter portion of the book, discussing the flying machine in war and the future of flight, is perhaps a little imaginative, but none the less interesting, as an indication of present-day thought upon the subject.

Monoplanes and Biplanes. By Grover Cleveland Loening, B.Sc., A.M. New York, Munn & Co., 1911. Price, $2.50 net.

Mr. Loening's book is devoted to a complete and careful description of every type of flying machine which has been proposed and used up to the present time. It is a very valuable compilation of theoretical considerations and practical details, of the greatest value to every person interested in the construction and operation of flying machines. The treatment of accidents and their prevention is systematic and thorough.

The Dreadnought Boys on Battle Practice. By Captain Wilbur Lawton. New York, Hurst & Co., 1911. Price, 50 cents.

The first volume of a new series by Captain Lawton whose recent contributions to the field of boys' literature have been received with much favor. The present offering relates adventures of two boys who enlist in the Navy, and no doubt their experiences will be followed with much interest by young American readers. The modern warship plays an important part in this story, which is up to the minute in every particular.

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