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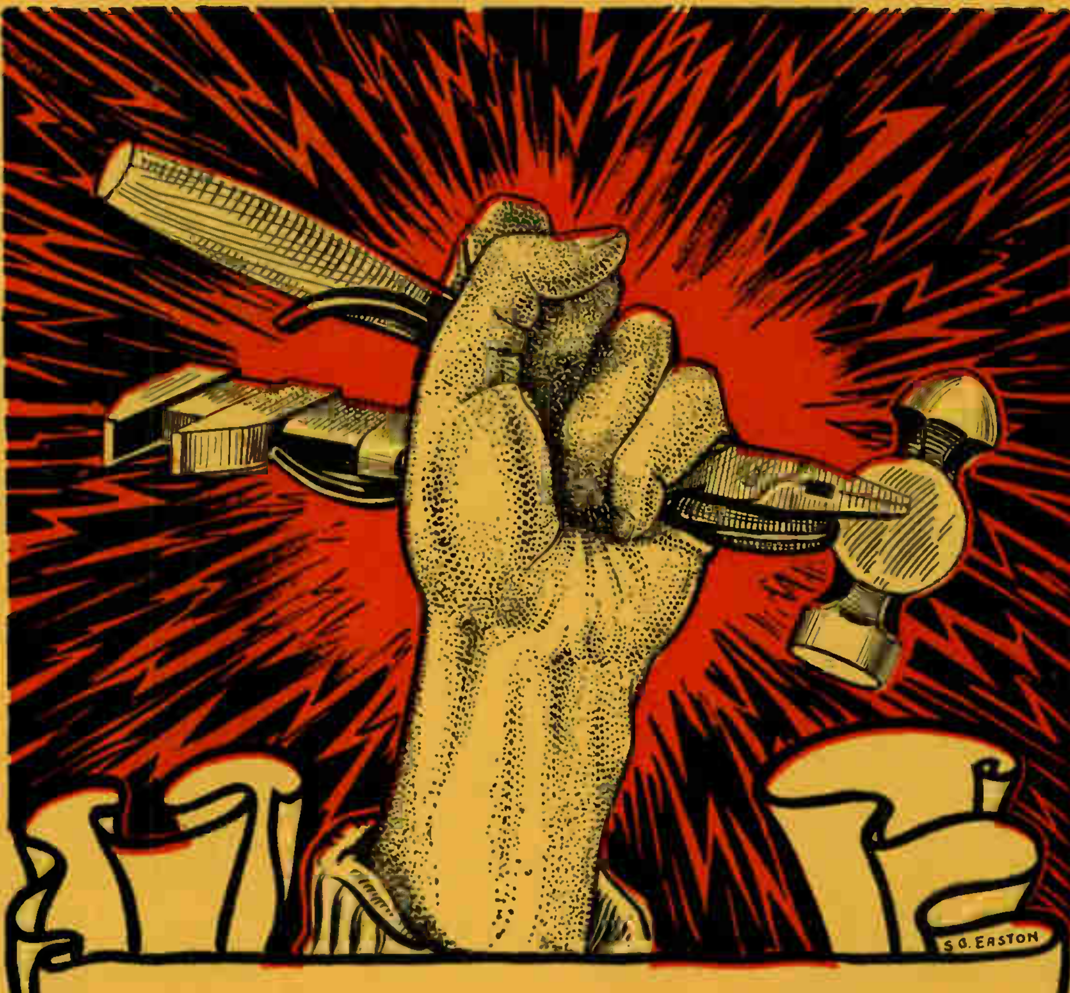

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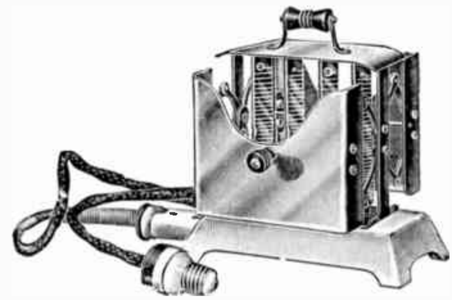

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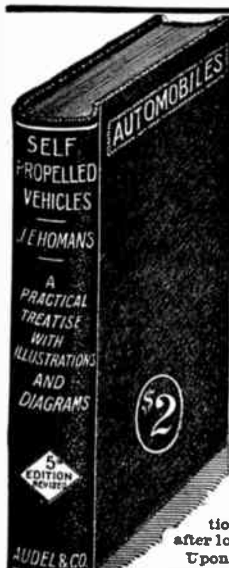

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VOL. XXII FEBRUARY, 1911 No. 2

TABLE OF CONTENTS

PRACTICAL HINTS

ELECTRICIAN & MECHANIC

VOLUME XXII — FEBRUARY, 1911 — NUMBER 2

LATHE WORK: BORING CYLINDERS

"SIGMA"

A Boring Rig

There are three general methods of boring work in the lathe and which are adapted to as many distinct classes of work. Two of these methods require the work to be revolved while the tool moves in a traverse direction, while the third method is directly the reverse of the others. A modification of the last named method consists in holding the work stationary, while the cutting tool is given both a revolving and longitudinal motion.

Of course the first two methods, making use of the chuck and angle plate, will readily suggest themselves to the amateur for work within their capacity, but if he wants to attempt something on a larger scale, he is at once in a quandary, unless he be the fortunate possessor of a large, heavily built lathe.

As these few suggestions are intended for the amateur, who, as a rule, is glad enough to claim ownership to a lathe of even 9 in. swing, only the third method of boring a cylinder is at all practicable, above certain limits, and is the only one that will be considered here. It must be admitted that these small lathes do not offer very alluring prospects as a boring tool, but they *can* be arranged to do such work, and that is all the true amateur asks—the mere fact that he can point to a piece of work with a bit of pride and much satisfaction, as having been completely finished by himself, is quite enough recompense for all the time and trouble that it may have cost him, and the degree of his conceit is in inverse ratio to the difficulties encountered, which, under the circumstances is entirely excusable.

The cylinder is held in a device similar to that shown in Fig. 1, which is clamped to the carriage, and the cylinder is bored true with a boring bar, Fig. 3, having a radial cutter and revolved between centres, while the cylinder is slowly fed toward the head-stock, with the feed screw.

The attachment shown in Fig. 1 is made of maple or other hard wood, and if possible, secure a block quite as large as the completed clamp and after fitting it to the tool rest slide as shown and running the carriage with the block in place, against both lathe centres, so as to make an impression in either end of the block as a centre for striking out the circular groove to receive the cylinder, the block can be cut apart, to make the two half-clamps by sawing out a 1 in. slice equidistant, above and below the centre of the groove.

Make the clamp as wide as the carriage and fully as long as the cylinder to be bored, and the thickness of the upper clamp at the thinnest point of the groove should be at least 1 in. After taking it off the slide, scribe a circle on each end, having a radius equal to that of the outer wall of the cylinder, and saw out the 1 in. slice. Now scribe lines on the surfaces just sawed apart, connecting the ends of the arcs, and holding the clamps in the vise, make a number of parallel saw cuts between these lines to just about meet the arc at either end, making it easier to gouge out the groove.

Having gotten the grooves nearly to size, replace the clamp *A* on the slide and locate the holes for the U bolts *e* which pass underneath and up either side of the bridge or web of the tool rest slide, and through A, securely clamping it to the carriage. If the groove is wider than the space between the ways of the lathe bed it will be necessary to incline the U bolts e, as shown in Fig. 1a, and to prevent their spreading or rubbing against the ways, a clip, f, is placed under them. These bolts should be 5/16 in. or 3/8 in. diameter and the clip 1/8 in. thick and the width of the bridge.

The top piece B is now put in place and the holes for the four corner bolts a are bored right through both pieces. These bolts are 3/8 in. or 7/16 in. diameter and threaded on both ends, one end of each being rounded off nicely to insure a firm bearing on the extending ends of the carriage slides. The rounded ends are screwed through the nuts c which are set into the wood flush with their face, to prevent their turning. As will be perceived these bolts in addition to holding down the clamp B, act to steady the whole attachment by giving a firm support at each corner and by reacting against the U bolts.

After fitting all the bolts and clamping the lower piece down tightly, screw each of the corner bolts down to a firm bearing and put the piece B in place, with a liner between it and piece A equal to that just sawed out, and clamp down. It is now ready to be bored out true, and to do this make a boring bar as shown in Fig. 3. This bar will also be used to bore out the cylinder, and is simply a length of cold rolled steel shafting about three times the length of the cylinder to be bored, and at least one-half the bore of the cylinder in diameter. It is centre-drilled at both ends, and at a distance from the right-hand end somewhat greater than the length of the cylinder, drill a hole right through the bar to receive the cutter, which may be a piece of round drill rod. A hole is also drilled at right angles to the hole for the cutter and tapped out for a small set screw. For a 3 in. cylinder the proportions of the bar and cutter may be 1 1/2 in. and 3/8 in., respectively, and the set screw 1/4 in. or 5/16 in. For boring out the clamps, grind or file the cutter as shown in Fig. 2, being careful not to get the cutting lip below the centre of the rod, and back off the end under the cutting lip so as to give the necessary clearance, also give it considerable top rake, so the cutting lip will shave, rather than scrape off the material.

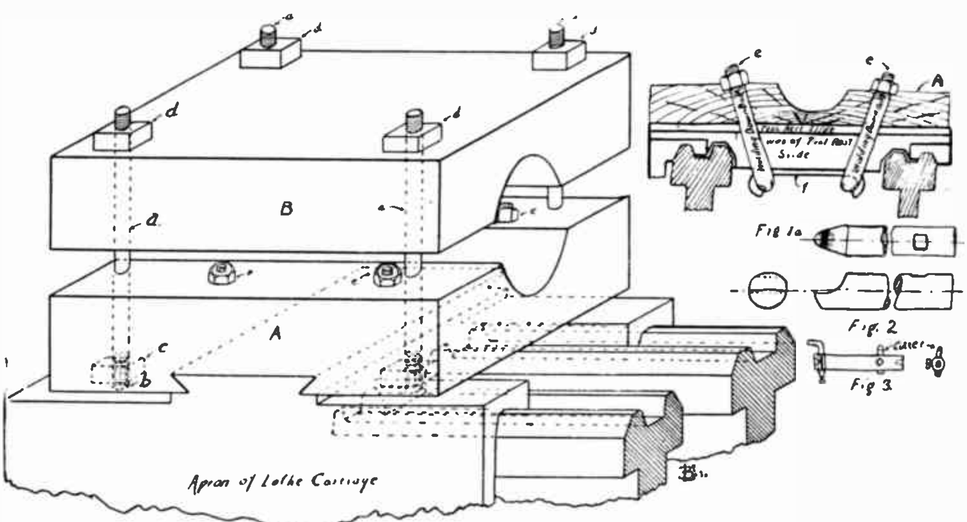


Fig I

The cutter will not need to be hardened for this job, but the edge should be honed on an oil stone. Now put the boring bar between centres, driving it from the face plate with a dog, and with the cutter set out to the proper radius, revolve it at a fairly high speed and feed the clamp to the left slowly, boring it out to the desired diameter, after which the packing may be removed and the cylinder clamped in place.

BORING THE CYLINDER

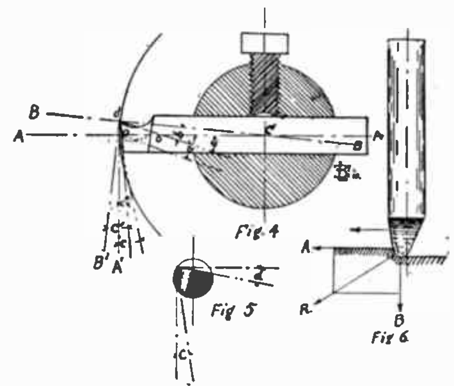
In clamping the cylinder in place, have the *bore* of the cylinder come central with the lathe centres, using paper packing if necessary, so that the same depth of cut will be obtained entirely around the bore, as otherwise you may be taking as deep a cut as possible on one side and merely skimming the hard surface skin on the opposite side, to the ruination of your tool.

As a smooth and true bore depends greatly on the sharpness and cutting angles of the tool, perhaps I will be pardoned for touching on this much discussed and important subject.

Referring to Fig. 4, let *A-A* be the horizontal axis of the *tool*, as well as that of the cylinder being bored, also let *A'o* be tangent to the arc of the cylinder at *o*, and therefore at right angles to *A-A*. Then the angle of *front clearance c*, about *o*, is made as small as possible, just sufficient to clear the cylinder wall below the cutting point. If this angle is too great, it removes necessary support from the cutting edge, which then wears away rapidly. If the tool had been ground to the shape shown by the dotted lines, the cutting edge would then be coincident with the axis of the tool, and would be given a certain amount of *top rake*, indicated by the angle *a'*. For cast iron this angle should not be greater, and may be much less than, 8 degrees, for too great an angle at this point will cause excessive "digging in," which must be avoided at all events. To get a better understanding of the proper way in which to grind a cutter for a boring bar, let us examine Fig. 6. Assuming that the cutter moves in the direction of the arrow, it is evident that if the tool has too much top rake, it will be pulled in, radially, toward the work, in the direction of *B*, which would cause serious digging in, and no top rake at all is likely to result in chattering of the tool and a tendency to spring away from its work, so we resort to *side top rake*, in order to overcome these objections. This means the sloping away of the cutting edge in a direction parallel to the traverse of the tool, and would tend to pull the tool longitudinally into the work in the direction of *A*. This cannot be objected to, but to prevent chatter we must still have a small amount of top rake, hence the tool will then be drawn into the work, both in the direction of *A* and of *B*, the resultant of these forces being in the direction of *R*, and the nearer this resultant approaches *A*, without causing chatter, the nearer will we reach the ideal shape of our cutting tool.

This top side rake is shown in the end view, Fig. 5, and is measured by the angle *d*, which should be about 8 degrees. The angle *c* is the angle of *side clearance*, and is about the same as the front clearance *c* in Fig. 4.

Now referring again to Fig. 4, it is to be seen that were we to grind the tool to the shape of the dotted lines, it would be very poorly supported at the cutting edge, therefore we grind as shown by the full line nearer the top. By doing



so, however, we have somewhat complicated the matter of tool angles; *o'* becomes the point of contact of the tool edge and the cylinder wall, and *B-B* is the coincident axis of tool and cylinder, so that *B'-o'* is now our tangent. Now an inspection of these new angles will show that we must increase the top rake, as angle *b* is less than the angle *a* = angle *a'*, which we will presume to have been found correct in the first instance, hence supposing the angle *a'* was 3 degrees, and it is found that angle *ACB* = 5 degrees, our top rake would really have a *negative* angle of 3—5 = —2 degrees, if measured in reference to the axis *A-A*, so we must increase our top rake by an amount equal to the angle *ACB*. The front clearance angle *c* is now reduced by an amount equal to the angle *ACB* (approximately), and is the angle *c"* if measured in reference to tangent *A'*, though if measured in reference to tangent B'—o', it has the angle c' which is the same as c in the former instance.

I have gone into this subject of tool shapes rather more fully than I intended, but as successful boring is entirely dependent on the proper shape of the cutting edge, I trust these remarks will induce the beginner to look into the matter of tool angles for himself, as I can assure him that an intelligent study and application of this question will produce a wonderful improvement in his work.

FACING THE CYLINDER

If the cylinder has been bored in the manner indicated, perhaps the easiest way of facing the ends is to bore out a piece of wood for a tight fit on the boring bar, and by removing the cutter and drilling a hole through the block, the same size as the cutter hole in the bar, a wooden pin can be driven through, securing the block while turning to a drive fit for the cylinder.

When turning to the proper diameter a steel pin can be substituted for the wooden one and the cylinder driven on, the block and bar serving as an arbor, making it easy to face the ends with a side tool held in the tool post.

FINISHING THE BORE

In boring a steam or gas engine cylinder, three cuts are usually taken through the bore; a rather deep roughing cut and two light cuts, the last being not over 1/32 in. deep; (Note: never stop a cut when once started, if it is to be the finishing one); but even with the sharpest tool, the surface will not be as smooth as it should be, so it must be ground smooth and polished in some manner, and if a good internal grinder is not available, the job can be done very well with the means already at hand.

After the cylinder has been faced, turn down the wooden arbor and saw half way through as shown in Fig. 7, and wrap a piece of emery cloth around the arbor, tucking the ends into the saw cut and fastening with small tacks, as shown. Be careful to drive these tacks below the surface so they cannot scratch the cylinder. Before putting on the emery cloth, glue should be applied to the under side and also to the arbor, and the glue given time to set before using, as otherwise, the cloth will pull off, wrinkle up and make all sorts of trouble. The arbor should be turned to make a nice sliding fit in the cylinder, with the cloth wrapped around it, and as the polishing proceeds, small wooden wedges may be driven into the saw cut at the ends of the arbor, thus keeping it tight against the cylinder walls.

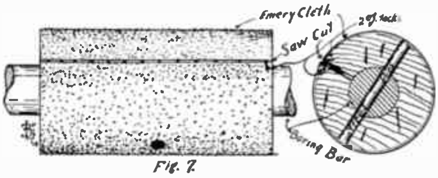


Fig. 7

To polish the cylinder in this way speed the arbor up pretty fast, putting an extra dog on the head-stock end to balance if necessary, and grasping the cylinder in both hands enter it on the arbor. You can tell by the "feel" when the emery is cutting properly, adjusting the wedges accordingly. Keep the weight of the cylinder off the arbor, and turning the cylinder around slowly, move it back and forth across the arbor, so as to insure the bore being kept true.

If these few instructions are intelligently followed, you will secure a perfectly true cylinder with a glass-like polish, which is worth all the trouble it has taken to get it, as it will insure a smooth-running piston.

(To be continued)

The *Army and Navy Journal* quotes an officer of the Signal Corps as saying that if the aeroplane had been invented before the Civil War, there would have been no "Sheridan's Ride"; for an aeroplane would have landed him on the battlefield of Winchester in less than 20 minutes. He believes, moreover, that at Santiago the question of the whereabouts of the Spanish fleet would have been settled in a few minutes by sending a man up in an aeroplane who, with a field glass, could easily have located Admiral Cervera's ships.

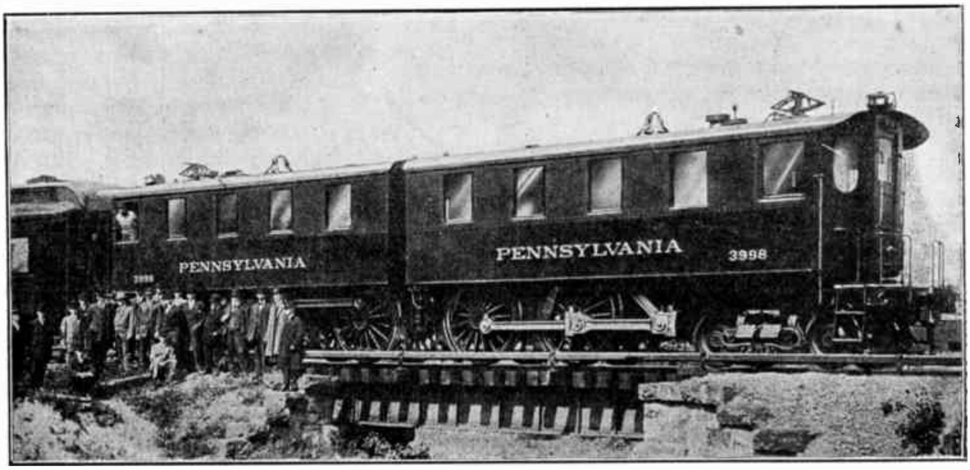
On the 28th of April, next, the railroads of Russia will pass under the control of the Imperial Russian Technical Society. This day also marks the opening of an international exposition in St. Petersburg devoted particularly to the application of electricity to railroad service.

NEW "PENNSYLVANIA" TYPE ELECTRIC LOCOMOTIVE

When work was first started on the Pennsylvania tunnels and station the engineers of the Railroad Company, co-operating with those of the Westinghouse Electric & Manufacturing Company, took up the problem of designing an electric locomotive which would cope successfully with the heavy grades necessary in the river tunnels. Since then electric locomotives have been designed, constructed and tested, and special recording track sections have been laid and electrified. Much electrical apparatus has been built, and voluminous reports and records were compiled before the completion of No. 3998, the first "Pennsylvania" type of electric locomotive to be finished, and machines which are soon to haul some 1,000 trains in and out of New York Station every day.

The first twenty-four electric locomotives to be built for service in the New York tunnels will be assembled at Altoona, Pa., where the Railroad Company's shops are located. The electric apparatus is to be built at the East Pittsburgh shops of the Westinghouse Electric & Manufacturing Company, while the mechanical features will be made in the Railroad's locomotive shops.

The "Pennsylvania" type locomotive is built in two sections; that is, there are two cabs and two running gears, jointed at the middle. Each section



The new "Pennsylvania" type electric locomotive

the one which was given its first test on the Long Island Railroad.

No. 3998 weighs 330,000 lbs. It will develop 4,000 h.p.—about three times as much as a giant freight locomotive—and could pull a heavy freight train at a speed of some 60 or 70 miles per hour. In appearance, it is similar to two passenger coaches, with huge driving wheels and rods. On each side of the steel cabins are ten square windows, while at the ends there are oblong windows similar in appearance to steamship port holes. The cabins conceal the giant motors with which the driving rods connect, but a view of the chassis gives an excellent idea of the intricacy of the has eight wheels, four of which are drivers, 68 in. in diameter, the other four being truck wheels 36 in. in diameter, constituting in their arrangement and weight distribution what in steam locomotives is called the "American" type.

The sections are permanently coupled back to back by a distinctive arrangement of Westinghouse friction draft gear and levers, so that the leading section effectually pilots the rear one. This obviates all necessity of turning the engine, as it runs equally well in either direction, and all manipulating levers are duplicated in each section, so the operative simply changes ends.

Two pairs of drive wheels are coupled not to the customary cross head and pistons, but to a crank shaft, called a jack shaft, in line with the driver axles, which in turn is coupled to a motor crank shaft, to which a single motor delivers all its power. The cranks are 90 degrees apart, so there can be no "on-centre" position. The motor crank revolves uniformly and at constant effort, differing therein from steam practice, and while the pressures on the connecting pins and rods vary throughout each revolution, the turning effort of the drive wheels is the same as for the motor, constant throughout each revolution.

Distinctive from steam practice, all rods and moving parts have pure rotation only, and are thus counterbalanced for all speeds, thereby delivering no more shock to the track and roadbed than a passenger car of equal weight.

The motor and massive side frames, jack shaft and all other gear, are spring-supported from the driver and truck wheels, so that there is no track stress other than that local to a single pair of wheels. In this arrangement of motor support and connection, the centre of gravity height closely approximates that in the best high-speed locomotives.

Earlier types of electric locomotives do not possess these features, the purpose of which is to utilize on the drive wheels directly the naturally continuous rotation of the electric motor. Of these there have been several examples, one a type with small drive wheels to secure an admirable electrical condition, others with spring-supported motors influenced by mechanical condition, both of which were classed high-speed types; and then for lower speeds, influenced by both electrical and mechanical conditions, the geared type, similar but larger than the common trolley motors.

A decided improvement in the "Pennsylvania" type is the use of a single motor for two pairs of drivers, and the benefits secured by its position. The motor is located high up from the roadbed, secure from snow, dirt and water, and space limitations are largely removed. In its design it possesses electrical features never before secured on an electric locomotive.

The single motor weighs, without gear, 45,000 lbs., and in weight and power it is the largest railway motor ever constructed. It projects into the cab and, in fact, fills a large part of it.

The main control apparatus is in a bulkhead sort of an arrangement centrally located so that there are ample passage-ways along the sides. At one end is located the electrically driven air compressor for operating the air brakes.

In the operating end of the locomotive there is a Westinghouse brake valve for high speed brake operation, and also the engineer's controller, by which all electrical manipulation is secured. These correspond to the throttle and reverse lever on a steam locomotive.

The controller on the "Pennsylvania" type is scarcely as large as that on a Hoe printing press. None of the main power passes through it, as it is really a switch corresponding to a telegrapher's key, operated by electro-pneumatic means. With a lever which can be moved with one finger, the engineer can admit to the locomotive a current equal to that available in a hundred trolley cars.

The electric supply will be secured from an electric conductor, or third rail, by four contact shoes on each locomotive. At some points where the great number of track switches will not permit this, power will be secured from an overhead conductor through an air-operated overhead contact shoe of which there are two on each locomotive.

The new locomotive is of steel construction throughout, and each section has the usual bell, sand box, and whistle. The latter is blown by air.

The first twenty-four "Pennsylvania" type electric locomotives to be built will have the following dimensions:

Total weight	166 tons
Weight of electrical parts	62 tons
Weight of mechanical parts	103 tons
Total h.p.	4,000
Maximum draw bar pull	60,000 lbs.
Maximum speed, 60 to 70 miles per hour under load.	
Diameter of drive wheels	68 in.
Diameter of truck wheels	36 in.
Weight on drivers	104 tons
Mechanical shock without injury	600,000 lbs.
Length over all	65 ft.
Total wheel base	56 ft.

FOR THE LABORATORY

CONSTRUCTION OF A SIX-INCH INDUCTION COIL

THOS. C. STANLEIGH

The Apparatus described in this series of articles has actually been constructed, and is in use at the ELECTRICIAN AND MECHANIC *Laboratory.*

No piece of electrical laboratory apparatus is more productive of interesting and diversified experiments than the induction coil. Comparatively few years ago it was regarded more as a curiosity than a useful adjunct to physical apparatus, but with the invention of the X-ray, the practical application of the coil in this field greatly increased its importance. The subsequent development of the jump-spark ignition system for gasoline engines and the invention of wireless telegraphy have still further increased the field of usefulness.

A great deal of attention has recently been given to the construction of induction coils giving a comparatively short but thick spark—admirably suited to the radiation of waves of electric energy from a wireless telegraph antenna but practically useless for experiments with the Röentgen ray and many other intensely interesting experiments, almost too numerous to mention here, but which will be described at length in a later article. Of course, a good fat spark is desirable, providing it is of sufficient length or high enough in voltage to pass through the high vacuum of a Crooke's tube. At the same time a heavy secondary current from the coil—while it is most energetic in its production of X-rays—will quickly ruin the small Crooke's tubes which are within the reach of the average experimenter's pocket book. The tubes used professionally are either provided with massive platinum targets or else are water-cooled. Still another point to be considered is the danger of X-ray burns, which must not be underestimated. Even if an experimenter was fortunate enough to become the possessor of a tube having high penetration and large current carrying capacity together with a coil to operate same, it would be foolhardiness for him to use such apparatus without first obtaining a clear understanding of its intelligent and safe operation from a physician who has had practical experience in such matters.

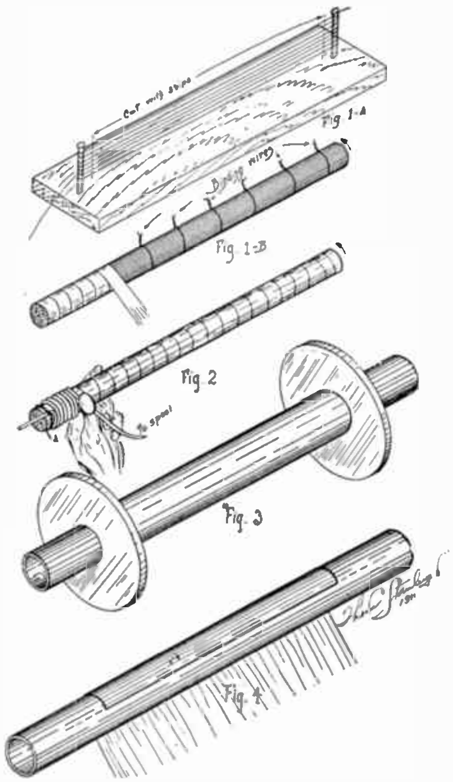
The induction coil herein described may be operated from the lighting circuit on either alternating or direct current or by means of primary or storage battery with equal ease. While it was designed to give a spark 6 in. in length between plate and point on actual test it has been made to spark between terminals which are 9 in. apart. At this point, however, the insulation is threatened and the coil is never operated continuously at more than 6 in. spark, which is ample for most purposes. While the spark is not a "fat" one by any means, still it is far from "stringy."

The methods of insulating the comparatively low tension coils used for wireless are entirely inadequate in the case of a coil where the voltage reaches the 70,000 mark or perhaps higher. There appears to have been a scarcity of available information on this particular subject, at least since the wireless coil has become so popular, and it is earnestly hoped that the hints to be found here will prove of assistance to the experimenter who is interested in this most fascinating field.

In order to make the description and explanation clear, the successive stages of the construction will be taken up one at a time.

THE CORE AND PRIMARY

Many an otherwise well-built coil has given disappointing results simply because its primary was inefficient. Authorities differ as to the relative proportions of primary and secondary. It is undoubtedly a mistake to use a very thick core, as even a comparatively thin one will not be magnetized to the point of saturation. On the other hand the core must not be too small in diameter as in that case it will tend to choke the magnetic lines of force. The author does not claim to be an authority on this matter, but merely desires to give his readers the results of considerable experimenting along this line. The core and primary used in this coil proved to be the most effective of several types for a coil giving a long and comparatively thin spark. For a coil to give heavy sparks a shorter and thicker core is better.



Iron core wire can be purchased from advertisers in this magazine in perfectly straight lengths and sufficiently well annealed to use without further softening. No. 22 B. & S. is accepted as the most suitable size to use. Soft iron wire may be purchased in coils at almost any hardware store, but it is apt to try the patience of the average builder to straighten this wire. Various "easy" methods have been given from time to time, but the easiest and quickest proves intolerably tedious in practice. The author prefers the one shown in Fig. 1, *A*. The wire is wound back and forth over two large nails about 15 in. apart. The wire is pulled tightly as each turn is put on, and when cut it will be perfectly straight. For the core in question, the lengths are to be 14 in. This method involves a trifling loss of wire, but will probably be found as convenient as any. The core is to be 15/16 in. in diameter when tightly packed. Having provided a sufficient number of 14 in. lengths of wire the loose bundle is to be grasped by a hand at either end and given a twisting motion back and forth. This will soon bring the bundle into a perfectly cylindrical form, with the wires lying neatly side by side. With one hand retaining the bundle, place the centre binding wire, taking three or four turns and twisting the ends as shown in Fig. 1, *B*. Continue the twisting and binding process until the core forms a compact cylinder.

The core is now to be tightly bound from end to end with "linotape" or strips of oiled linen, overlapping each turn about one-half and releasing the binding wires, one at a time as they are reached.

The weight of the core after binding and before winding the primary is 2 lb. 3 oz., and if the wire is purchased in a coil, at least 2½ lbs. should be obtained to allow for waste and binding wires.

The primary wire is No. 12, perferably silk-covered, although cotton may be used. If great care is taken in winding, single covered wire will do. If two adjacent turns of wire become short-circuited, not only will the ampere turns be reduced but a portion of the current will be wasted in forcing current through the ring of wire, which then becomes a closed secondary circuit. The greatest care should therefore be taken in winding the primary as well as the secondary.

The spool of wire is to be placed on a rod held in the vise so that it may revolve freely, and the starting end of the wire is bound to one end of the core by means of strong cord, as shown in Fig. 2 at *A*. Only one turn of the cord is shown in the drawing, but in practice several turns are used. With the wire thus firmly held in position, the winding may be started by turning the core. Any attempt to wind the wire around the core will result in utter failure, but very little difficulty will be experienced if the core is turned with the right hand while the wire is guided by the left, as suggested in Fig. 2. After the first layer is finished, bend the wire at right angles and fasten with cord. After forming a loop, to be cut apart afterwards, secure the wire again and continue a second layer—*winding in the same direction*—over the first. A layer of one turn of oiled linen should be placed between each layer of wire. Secure the end of the second layer and form a loop as before. A third layer is to be wound on and the end fastened. By careful winding, 142 turns of wire may be put on in the first layer, while the second and third will contain 140 and 138 respectively.

The core and primary is now to be placed in a moderately warm oven for several hours, to drive out the moisture in the insulation. The oven must not be hot enough to char the insulation of the wire.

A trough is to be made of heavy tin, 18 in. long, 2½ in. wide and 3 or 4 in. deep. The bottom should be round to economize on the wax to be melted therein. The completed trough is to be suspended in a larger one which is to hold water. The joints of these receptacles may be soldered, as the temperature will never rise to more than that of boiling water. However, it is a wise precaution to lap-joint the seams, as the wax would make a serious blaze if by any chance the troughs came apart.

Pure paraffin wax is to be melted in the inner trough with a supply of water in the outer. The wax should never be melted over a flame or fire direct, as it carbonizes at a temperature slightly above 212 degrees F., and its insulating qualities are thereby destroyed.

Removing the primary and core from the oven, place a cord around either end and lower very slowly into the hot wax. By immersing the primary slowly, the air will be driven out more effectively. Leave in the hot wax until no more bubbles of air are driven off, when it may be lifted out by means of the strings attached and permitted to drain for a few moments. Suspend from the strings until the wax is cold and hard.

The vacuum process of impregnating is, of course, much more effective, but, as it is hardly within reach of the average builder who only intends to construct a few coils at most, the method will not be discussed here. The methods herein described will give very pleasing results if carefully carried out.

THE INSULATING TUBE

Much difference of opinion exists on the relative values of various materials for the important insulation between primary and secondary. For years glass and ebonite were popular. These have lately been replaced by micanite. Ebonite in itself is an excellent dielectric but its insulating qualities are lowered by exposure to air and sunlight. The most serious objection to it, however, is the defects which appear only after the tube has been in use. Small air bubbles in the wall offer weak places and invariably result in a breakdown. Of course, these defects are not always present, but the use of ebonite has practically been abandoned on this account.

Micanite has a higher dielectric strength than ebonite, but the action of the ozone produced by the spark tends to lower its insulating qualities to a large extent. It may be used with good results, if it is entirely sealed in with wax.

As this coil has a removable primary and core, the author used a form of tube which has proved highly efficient in the construction of several large coils. The foundation of the tube is of red fiber 1½ in. inside diameter, 18 in. long, and having ⅛ in. walls. Fiber in itself is not a very good dielectric as it is very hygroscopic. However, when it is dried thoroughly for several days and finally treated with wax it compares favorably with its superiors. According to Macfarlane and Pierce, paper treated with pure beeswax will resist a voltage of 540,000 volts per centimeter of thickness. The next best is solid paraffin at 130,000 volts per centimeter. In the author's

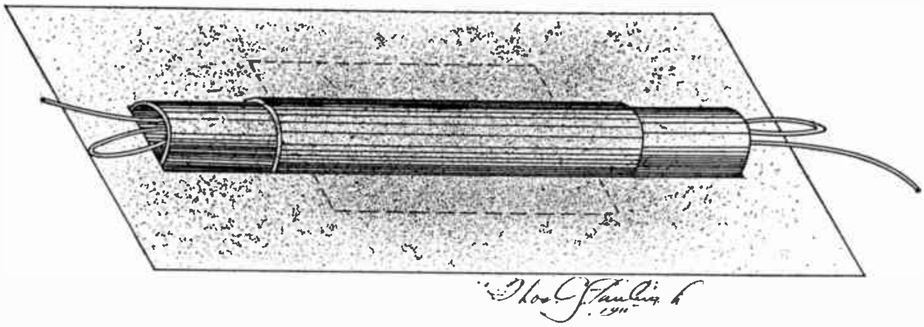


Fig. 5

experience beeswax has proved to be an ideal insulator for high tension work.

The fiber tube is placed in the oven and left there for several days. A tin cylinder closed at both ends, and of a size to slip loosely into the fiber tube is provided. This will greatly reduce the quantity of beeswax required. The wax should be purchased from a reliable druggist or chemical warehouse and the price will be about 60 cents per lb. This wax is to be melted in the trough in the same manner as the paraffin, first, of course, removing the latter and placing it in a clean receptacle for later use. The fiber tube is to be *slowly* lowered in the melted beeswax as soon as it is removed from the oven. Leave it in the wax for four or five hours at least, after which it may be drained and cooled. A piece of cord passed through the tube will facilitate removal, and some means must be provided to keep it immersed in the wax, as the air in the tin cylinder will cause it to float.

Natural finish 20 lb. Manila paper is to be used for insulating discs between sections and for the condenser as well as to increase the thickness of the insulating tube. It comes in sheets 24 x 36 in., and may be obtained at a paper warehouse.

A supply of the paper is thoroughly dried in the oven and several strips are cut 11 in. wide by 36 in. long. One end of a strip is cut squarely across and a centre line is marked on the fiber tube. Placing the end of a strip of paper on the centre line of the tube, securely fastening it by means of melted wax. Roll the tube forward as shown in Fig. 4, keeping the paper as tight as possible. Continue this process until the paper has reached a thickness of 3/32 in. Bind with fine thread to hold in place and immerse slowly in the hot beeswax. A few hours will suffice to thoroughly impregnate the paper with wax after which it may be drained and cooled.

A simple method of determining the most effective diameter and length of the secondary winding or bobbin is shown in Fig. 5. The primary is slipped into the tube and a sheet of paper having a slot cut in it sufficiently large to slip over the tube is placed as shown. The starting and finishing ends of the primary winding are connected to a battery sufficiently powerful to pass 8 or 9 amperes. Iron filings, scattered from a height of 2 or 3 ft., will arrange themselves in the shape of the path traversed by the magnetic lines of force. The denser portion will be close to the tube. A line drawn on the paper through the dense part will give the effective winding space.

THE SECONDARY WINDING

A small polishing lathe may be used for the section winder, but a more convenient arrangement is shown in Fig. 6. This is a "film rewinder," such as is used in motion picture theatres to rewind the film after it has been run through the projecting machine. The former consists of two wooden discs (Fig. 9) faced by sheet brass, and separated by a disc of fiber 1/8 in. thick and 2 in. in diameter for the centre sections. Other discs having diameters of 2 1/8 in., 2 3/8 in., and 2 5/8 in. should also be provided. One of the large outside discs should have a slot cut in it and a screw on which to fasten the starting end of the wire. Fig. 7 shows a cross section of the former complete. A small spirit lamp and an open cylinder of sheet asbestos large enough to go over a spool of wire completes the equipment.

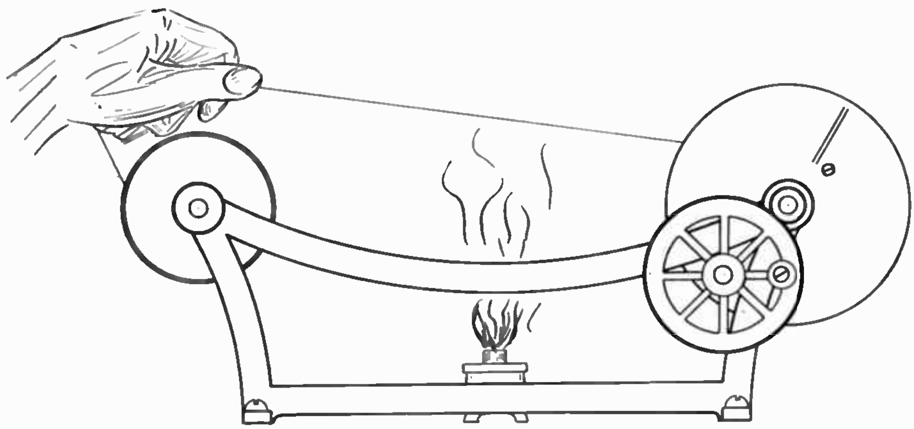


Fig. 6

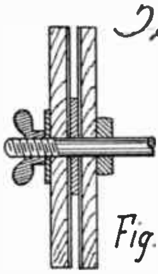


Fig. 7

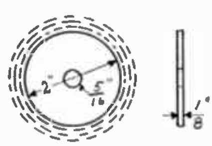


Fig. 8

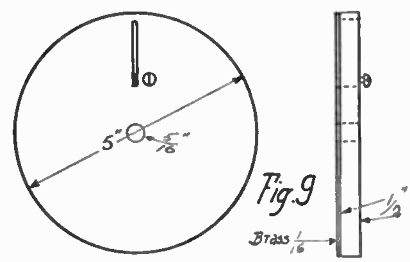


Fig. 9

The secondary wire is No. 36 single cotton-covered. Silk insulation is unnecessary, but as more turns can be placed in a given space it is highly desirable. Five pounds will be required, and it is usually sold on spools containing about 1 lb. each. The wire is placed in a warm oven and left for several days. Provide a containing can with water jacket large enough to take a spool of the wire. The hot spool of wire is slowly immersed in melted paraffin, and it will take two or three hours to drive out all of the air bubbles.

The former is assembled on the winding machine with the smallest of the fiber separating discs in position. A length of cotton cord sufficient to bring the diameter of the disc up to 2⅛ in. is wound on the former and then a strip of paper is wound over the cord.

Removing the spool of wire from the hot wax, place it on the spindle at the left of the winder and thread the end through the slot, securing it on the screw. With the spirit lamp in position, as shown in Fig. 6, turn the crank at moderate speed, guiding the wire with the left hand. A glove should be worn to protect the hand. The diameter of the finished sections will be governed by the curve of the "lines of force," and in this coil it is 4½ in. at the centre and 3¾ in. at the ends. The coil contains 40 sections in all, although the number might vary with different builders. The wire will go on in even layers with very little difficulty and care should be taken to see that no turns slip down between the former disc and the winding. The first twelve sections are wound with a 2⅛ in. aperture, the next twelve a 2¼ in., the next eight a 2½ in., and the remaining eight a 2¾ in. aperture. This is to increase the insulation at the ends where the voltage is highest.

After finishing one section, cut the wire and slip the asbestos cylinder over the spool of wire, placing the spirit lamp beneath to keep the wax soft. Remove the former from the spindle and carefully lift off the disc with the slot in it, first unfastening the wire from screw. Gently unwind the cord from between fiber disc and the paper strip which will adhere to the inside turns of wire and prevent them from unwinding. Release the annulus, or ring, of wire from the other disc by means of a "spatula" or

(Continued on page 89)

ELECTRICITY IN HOME AND OFFICE

DESIGN AND CONSTRUCTION OF A PRIVATE LIGHTING PLANT—Part II

STANLEY CURTIS

Before any insulation is put on the armature it should be perfectly balanced to ensure quiet running. If the flange castings are pretty uniform, very little difficulty will be experienced in obtaining a well-balanced armature. Two knife edges are placed parallel with each other and are made perfectly level. The armature is placed across these with the bearing portions of the shaft resting on the knife edge. Probably the armature will tend to rest in one position, due to the fact that one side is heavier than the other. The heavy side is marked, and a trifle of the metal in the face of flange is drilled out. The armature is again placed on the edges and heavy side marked. This operation is to be repeated until the armature will rest in any position in which it may be placed.

Oiled linen was used to insulate the armature core and the legs or "spider" of the flanges. A strip of the linen long enough to wrap twice around the circumference of the armature is shellacked in place. The strip should be at least an inch wider than the length of the core, so that the edges may be clipped and carried over the rounded edge of the flange. This will afford extra protection at one of the weakest points where the pressure of wire is liable to injure the insulation.

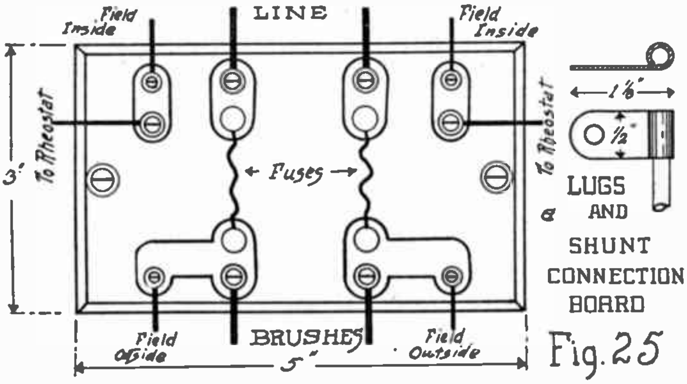
The sketch, Fig. 27, will give a general idea of the appearance of the armature before winding. Strips of the oiled linen are to be wound over and through the armature, lapping each turn about one-half, and making free use of the shellac. The legs are also to be carefully insulated by winding a narrow strip of linen down the entire length of each. A strip of white paper about 3 in. in width, and in length equal to the circumference of the armature is to be marked off into sixteen divisions. This strip may then be secured in place on the armature with shellac and the whole given a generous coat of the varnish, after which it may be thoroughly dried, finally baking it for a couple of hours in a moderately warm oven.

For the armature winding 3¼ lbs. of No. 17 D.C.C. wire will be required. The method shown in Fig. 27, will give the approximate length of wire required for each section or division. A piece of cord of approximately the same size as the wire is wound through and over the core 38 times. The length will be found to be approximately 32 ft. It is well to allow 1 or 2 ft. over this amount for the first few coils, as the wire will pile up somewhat on the inside of the core, and perhaps make the estimated length appear short.

The scheme of the winding is shown in Fig. 26. The ring armature winding is undoubtedly the most easily understood, and for a comparatively low voltage machine where the wire is coarse and the number of turns few, it is one of the easiest to wind.

A few long, slim shuttles should be cut from ⅛ in. fiber, and upon each of these is wound a length of wire sufficient for one coil or division. By passing the shuttle over and through the armature, the winding is accomplished. There will be 19 turns to each layer, and 2 layers to each coil; therefore 38 turns per coil all around the armature. The turns may overlap on the inside, but they should be closely and carefully placed on the outside of the armature as the space in which it is to revolve is decidedly limited.

The entire sixteen divisions having been filled, each coil may be tested for insulation before connecting up. A battery and galvanometer is most useful



LUGS AND SHUNT CONNECTION BOARD

Fig. 25

in this operation, although a magneto testing set will answer. Bare one end of each coil and connect battery and galvanometer in series, securing one wire to the armature shaft. By touching the ends of successive coils, a ground between coil and armature core will become apparent by a deflection of the needle. This test must be made before putting shellac on the wire, as otherwise the moisture in the wet shellac might falsify the result. If the insulation is found to be perfect, a test may be made between adjacent coils. In case a ground is discovered, the defective coil must be unwound and the insulation made perfect. This is one of the great advantages of a ring armature winding. Any coil may be readily removed and replaced without disturbing its neighbors.

The entire winding may be given a generous coat of shellac and allowed to dry.

The armature is centred in the lathe, and a strip of oiled linen about 5/8 in. wide and long enough to wrap three times around the circumference of the armature is shellacked at either end and in the centre of the winding to receive the binding wires. Spring brass wire of about No. 22 gauge is wound around the first strip of linen until a band 3/8 in. in width has been formed. The lathe should be turned backwards and the wire guided on with considerable tension. Without stopping the lathe, take a jump to the second or centre linen strip and proceed to wind a band of wire, after which the third strip is treated likewise. These bands are now to be run full of solder, great care being taken to see that the insulation is not charred by the hot iron. The appearance of the armature with binding wires and commutator in position is shown in Fig. 31.

The commutator may be slipped on the shaft and secured in position by means of a key or a pin projecting into a hole in the flange boss. The armature coils are all to be wound in the same direction so that the starting end of one is joined to the finishing end of the next one right around the armature. These junctions are to be securely soldered, one to each of the sixteen commutator segments. The armature may again be put across the level knife edges and any slight defects in the balance due to uneven winding may be remedied by the application of a drop of solder

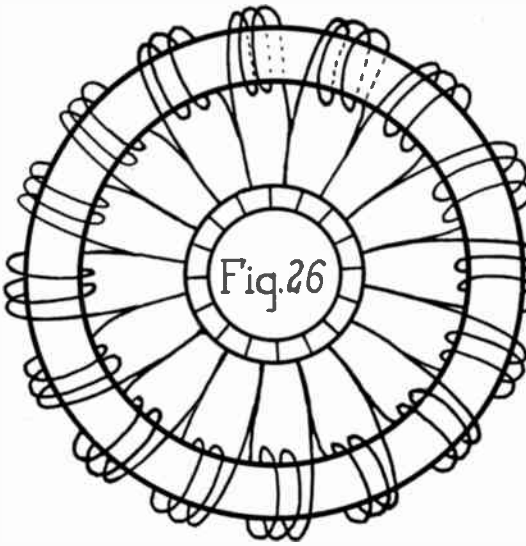
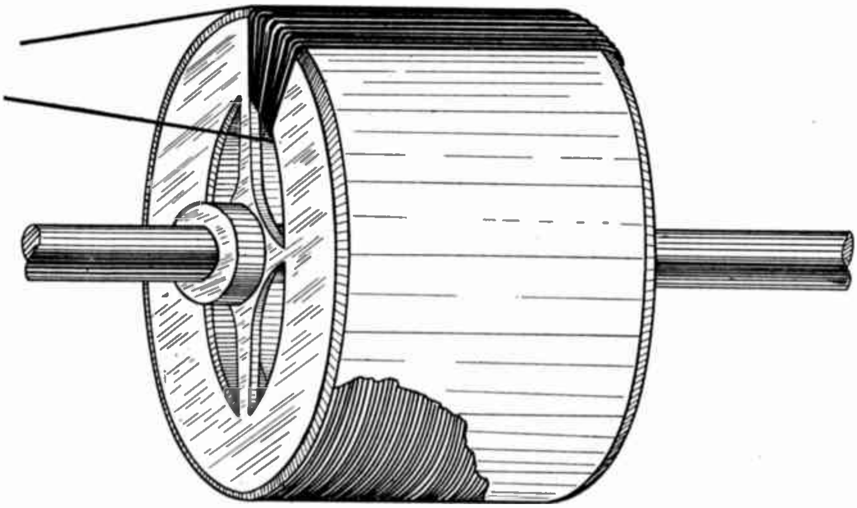
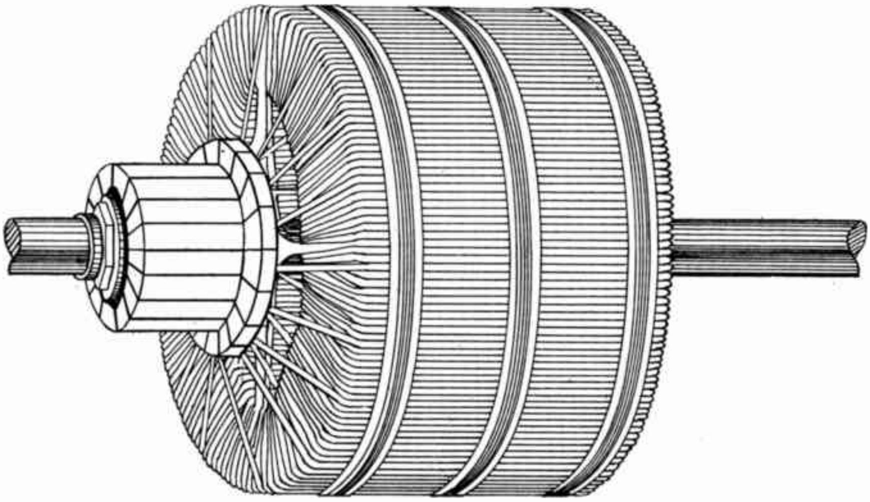


Fig. 26





Figs. 27 and 28

on the binding wires at the light points. Thoroughly shellac the winding and dry in the oven.

The field winding may be done on a former as shown in Fig. 29. The writer prefers this method to the "bobbin" type, although there is no difference so far as results are concerned. If the form winding is chosen a former may be constructed as per Fig. 29. This is centered in the lathe and the cylinder covered with tinfoil. Over the tinfoil wrap three or four layers of heavy paper and on the paper place a layer of oiled linen, the edges of which may be secured with shellac. A washer of oiled linen is also placed at either end of the former next to the flanges. 7½ lbs. of No. 18 S.C.C. wire are to be wound on the former for each of the two field coils. The starting and finishing ends are soldered to lengths of flexible incandescent lamp cord, and each layer throughout the winding is treated with shellac. The shellac on hardening will retain the turns of wire in place so that the coil may be removed from the former. The coils are to be taped as shown in Fig. 31. Both coils are wound in the same direction and with an even number of layers so that both starting and finishing ends are at the top. If the winding becomes uneven in places, a layer of heavy paper will straighten it out.

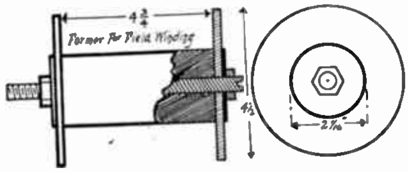


Fig. 29

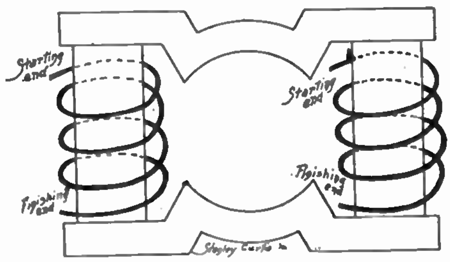


Fig. 30

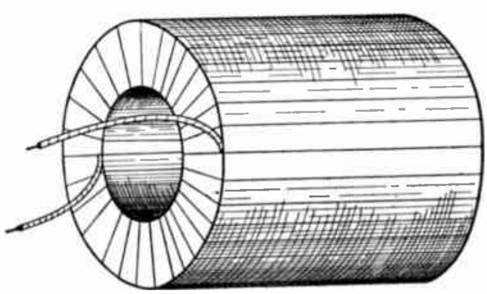


Fig. 31

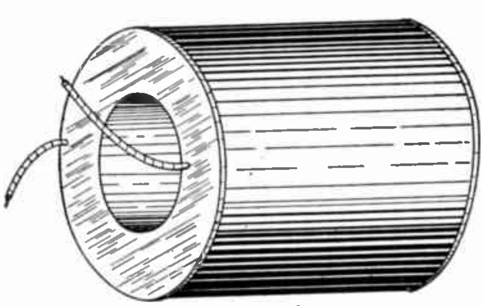


Fig. 32

The bobbin winding is shown in Fig. 32. A tin or brass cylinder large enough to slip over the cores of the field magnet is fitted with fiber flanges or ends and the wire wound on in the lathe after wrapping some insulation on the metal cylinder.

The two field coils are placed in position on the cores of the field magnet and the inside leads connected to the terminals which go to field rheostat, while the outside leads go to the plates which contain the brush terminals. The direction of the field winding is shown in Fig. 30, while the connections are shown in Fig. 25. The brush leads are composed of No. 12 flexible cable, the ends of which are soldered into lugs as shown in Fig. 25.

The machine may be assembled, and is ready to be given a trial.

(To be continued)

Recently while the writer was experimenting in his laboratory, a peculiar thing happened. A 16 c.p. incandescent drop light was hanging from the ceiling near a shelf on which stood an electrolytic interrupter, the solution being composed of sulphuric acid and water with a small deposit of copper sulphate.

The incandescent light dangled back of the interrupter jar, causing a peculiar white light to fall upon the room.

By removing the electrodes from the solution the light was placed inside the jar, in the solution. This made the room equal to daylight, the carbon filament of the light turning to the purest white; since then I have constructed a new interrupter, using the old one for lighting purposes. F. W. DENSHAM.

Six-Inch Induction Coil

Continued from page 85

palette knife, made slightly warm, and bind the inside and outside ends of the winding with waxed thread wound over and through the ring. The entire five pounds of wire is to be wound into sections, all in the same direction. Place the sections safely away until they are to be assembled.

The next article will take up the assembling of the sections and the completion of the coil.

(To be continued)

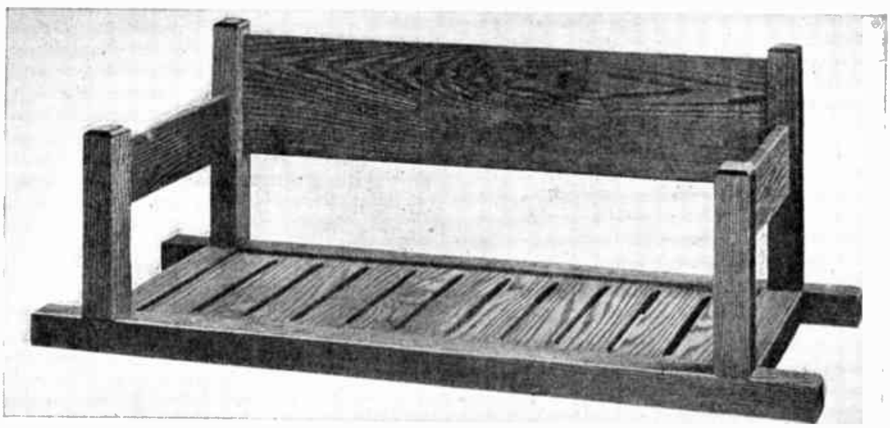
WOODWORKER

HOW TO MAKE A PORCH SWING

IRA S. GRIFFITH

The porch swing is to be made of plain sawed red oak. It is to be swung from the ceiling by means of chains, the lower ends of which are to be fastened to bolted staples in the ends of the cross ties. The back chains should be somewhat shorter than the fore chains, so as to give the seat a slight inclination backward or downward.

shows the dimensions. Also lay out and rabbet a groove on the inside edges of all the pieces, 3/8 in. wide, to receive the ends of the slats and the edges of the two outside slats. A circular saw will be found very convenient for cutting this groove, if one is at hand. If not, use a grooving plow and plow as far as is possible, gauging the sides of the



remaining parts and finishing with the chisel.

There will be needed stock as follows:

STOCK BILL FOR PORCH SWING

Seat, 2 pieces, 2¼ x 2¼ x 66 in., S-4-S.
Seat, 2 pieces, 2¼ x 3 x 23 in., S-4-S.
Posts, 2 pieces, 2¼ x 2¼ x 15 in., S-4-S.
Posts, 2 pieces, 2¼ x 2¼ x 21 in., S-4-S.
Arms, 2 pieces, ¾ x 5½ x 22 in., S-2-S.
Back, 1 piece, ¾ x 10 x 51 in., S-2-S.
Slats, 11 pieces, 3/8 x 4½ in., S-2-S.

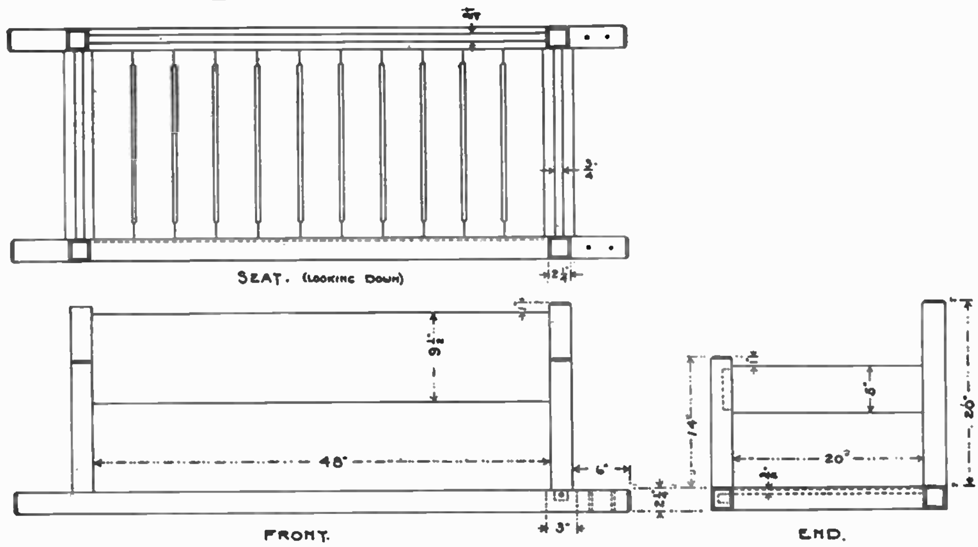
The seat may be framed first. Since the pieces are specified, mill-planed to exact thickness and width, it remains only to square the ends and remove the mill-marks with the smooth plane. The ends of the long pieces should be planed smooth as well as square. The ends of the shorter pieces need to be sawed only, since they are to form the ends of tenons. Lay out the mortises in the long pieces and the tenons on the short pieces and cut them. The drawing

Square the top ends of the posts and saw them to length. Tenon the lower ends into the seat frame and cut the mortises into which the tenons of back and arms are to be inserted. The top ends should be chamfered slightly.

Plane the slats to size, and shape the edges as shown. This will allow any water that may be driven on the porch and swing to run through.

The seat parts may be scraped and put together, good hot glue being used. The tenons ought to be pinned to the mortises, too, thus insuring a solid joint should the weather weaken the glue.

Next put the back together, having cut the tenons necessary. Put the arms together, putting the posts in place and gluing and pinning the parts.



Bore the holes for the hanging staples as shown, the size of the hole depending upon the staples to be used.

Scrape off the surplus glue, making sure all the mill-marks have been removed, and put on a finish as follows: One coat of brown Flemish water stain diluted by the addition of an equal volume of water. When dry, sand lightly and put on a coat of very thin shellac. Sand this shellac, using No. 00 paper, and put on a coat of paste filler, rubbing it off, when flatted, in the usual manner. On this filler put a coat of orange shellac, sand slightly and apply two coats of spar varnish. Rub the last coat with crude oil and pumice, pulverized, and the previous ones with curled hair. This finish will withstand the weather and protect the wood. If other colors are desired, all that is necessary is to substitute the stain desired for the Flemish and color the filler to match. The filler should be darker than the stain, whatever the color.

The pictures shown herewith are from pieces made from original designs by pupils of the Oak Park and River Forest Township High School.

—*American Carpenter and Builder.*

MAKING A TABOURET

Secure from the planing mill the following pieces, and have them planed and sandpapered on two surfaces:

For the top, one piece ⅞ in. thick and 17 in. square; for the legs, four pieces ⅞ in. thick, 4¾ in. wide and 18½ in. long; for the lower stretchers, two pieces ⅞ in. thick, 2¾ in. wide and 15¾ in. long; for the top stretchers, two pieces ⅞ in. thick, 2¼ in. wide and 13¼ in. long. No wood need be ordered for the keys, as they can be made out of the waste pieces remaining after the legs are shaped.

Begin work on the four legs first. While both sides of each leg slope, it will be necessary to plane a joint edge on each leg from which to lay out the mortises and grooves and to test the ends. It will be convenient to have a bevel square to use in marking off the slopes and for testing them. To get

the setting for the bevel square, make a full sized "lay out" or drawing of the necessary lines in their proper relation to one another and adjust the bevel to those lines.

From the joint edge lay out the mortises, grooves, and the slopes of sides and ends of the legs. Cut the mortises and grooves first, then shape up the sides. Saw the sides accurately and quite close to the lines, finishing with the steel cabinet scraper.

Next make the bottom stretchers. In laying out the cross lap joint, the working faces are both to be up when the joint is completed, therefore, lay off one groove on the face of one piece and on the side opposite the face on the other. In gauging for depth, however, be careful to keep the gauge block against the working face of each piece.

In laying out the mortises for the keys, the opening on the top surface is to be made 1/8 in. longer than on the under surface. The slope of the key will therefore be 1/8 in. of slope to each 7/8 in. of length. The drawing shows the mortise as 7/8 in. from the shoulders of the tenon. This distance is the same as the thickness of the leg and to insure the key's pulling the shoulder up against the leg firmly, should any of the legs happen to be a little less than 7/8 in., it is well to make the mortise slightly nearer the shoulder than 7/8 in.

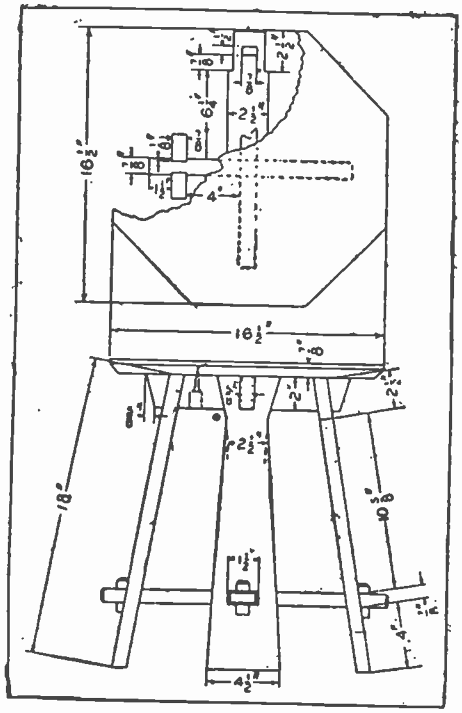
It is a good plan to lay out the mortise in the tenon at the same time as the shoulders of the tenons are laid out. Otherwise the joint edge being cut off in making the tenon there is no convenient way to locate this mortise accurately.

Lay off the top stretchers according to the dimensions shown in the drawing. Observe the same precautions about the cross lap joint as were given for the lower stretchers, except that the joint edges are to be placed up in this latter case. Make sure the grooves are laid out in the middle before cutting.

As a test, place the pieces side by side, examine the markings, then turn one of them end for end and again examine.

The grooves into which the legs pass are 1/8 in. deep and must be very carefully cut. Their purpose is to give rigidity to the tabouret frame. Bore two holes in each stretcher for the screws that are to fasten the top in place.

Make the keys, scrape all the parts



and sandpaper those that were not so treated at the mill. Use glue to fasten the tops of the legs to the top stretchers and assemble these parts.

The top is octagonal or eight-sided. To make it, square up a piece to 16½ by 16½ in. Measure the diagonal, take one-half of it and measure from each corner of the board each way along the edges to locate the places at which to cut off the corners. Connect these points, saw and plane the remaining four sides. There is to be a 5/8 in. bevel on the under side of the top. Scrape and sandpaper these edges and secure the top to the stretchers with screws.

Much time can be saved and a better result obtained if the wood finishing is done before the parts are put together. Especially is this true if stain and filler are used.—*Popular Mechanics.*

The American process of reducing milk to a powder has now been introduced into Norway. One of the new companies formed has contracted to deliver 300 tons of dry milk each year for three years to an English firm. The dry milk is used largely for invalids and convalescents, on ships on long voyages, because of its keeping qualities under all climatic conditions and its convenience of transportation.

A MAGAZINE STAND

RALPH F. WINDOES

There are very few homes nowadays that do not receive at least one magazine regularly each month. It has become a problem in some of these homes as to the proper disposition of these magazines after they have been read. Some think they have solved the problem by burning the magazines, some by giving them away, some by selling them and others by having them bound and set upon their book-shelves. This last solution is by far the best if the person can afford the price of the binding, as some magazines, like the ELECTRICIAN AND MECHANIC make excellent books for future reference for the man with a technical turn of mind. But if this person cannot afford to have them bound, he can at least supply a suitable place in which to store them, unbound, where he can get at them when needed. In an endeavor to supply this suitable place the stand here illustrated was designed. Any handy man can easily construct one during his spare moments and thereby contribute something to his education.

The stock, which should be of quarter-sawed white oak, is ordered as follows:

4 pieces	1½ in. x	1½ in. x	47 in.
4 pieces	⅞ in. x	14½ in. x	14⅝ in.
2 pieces	⅞ in. x	3 in. x	35 in.
2 pieces	⅞ in. x	6 in. x	13½ in.
2 pieces	⅞ in. x	4 in. x	13½ in.

These dimensions are exact finished sizes and should be ordered planed and sanded at the mill.

In the drawing, Fig. 1 shows the front elevation; Fig. 2, the side elevation, and Fig. 3, the plan or top view. Carefully examine each figure and be sure you understand each step in the construction before commencing the work.

The first step in the building of the stand is the assembling of the sides. Begin by cutting the tenons on the top and bottom stringers and on the two side strips. In the exact centre of the stringers chisel mortises for each of the tenons on the strips as shown in Fig. 2. Then in each corner post cut similar mortises for the tenons on the stringers. Glue and clamp these parts securely together and let them set over night. Cut out the shelves according to Fig. 3 and be very sure you have sharp, clean-cut notches in the corners, as you want a snug fit around the posts.

Now as to the fastening of the shelves onto the sides. There are a number of ways this can be accomplished and the builder must choose the one he thinks he can do the best job with. One way is to screw round head blue steel screws through the posts and side strips into the shelves. Another is to use small lag screws in a similar manner. Another is to use finishing nails and putty up the head holes. Another is to use flat head screws and cover the heads with wooden buttons or fancy headed tacks. Still another way is to use dowel pins and let the heads project through the posts where they should be rounded off a little. A number of other ways might be added to this list but the ordinary craftsman should find one here to suit his convenience.

It will be much easier to scrape and sand the sides before fastening the shelves onto them, as this is a very important part of the building and should not be slighted. Remember in sanding to always rub with the grain of the wood and thereby avoid the scratches so evident on the finished article.

Stain and wax the stand according to your own desires or according to the furniture in the room in which you are to place it. For the builder who has no choice, a good finish is the following. It is known as fumed oak, and the process which gives the color is called fumigating.

Place the stand in a dark and air-tight box, a packing case will do, and place an open dish or two of liquid ammonia on the bottom of the compartment. If there are any cracks in the box cover them by placing strips of paper over them. Be sure to place the dishes where the fumes will rise and surround the stand. These fumes of the ammonia react chemically with the tannic acid in the wood, producing a beautiful shade of deep, rich brown. This shade deepens with the quantity of ammonia used and the length of time the wood is exposed. Ten hours' exposure, using

A Magazine Stand

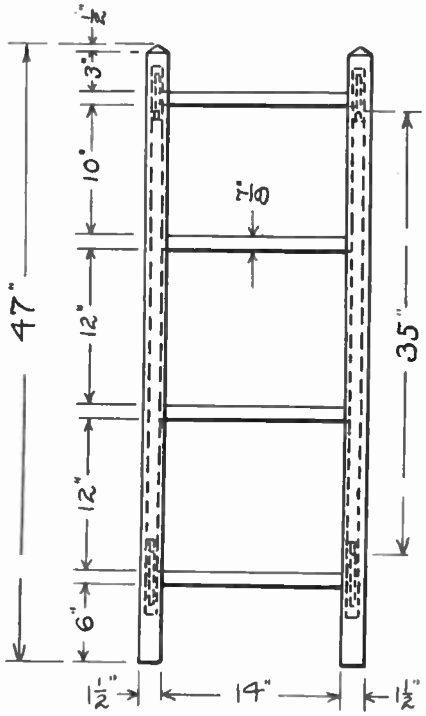


FIG. I

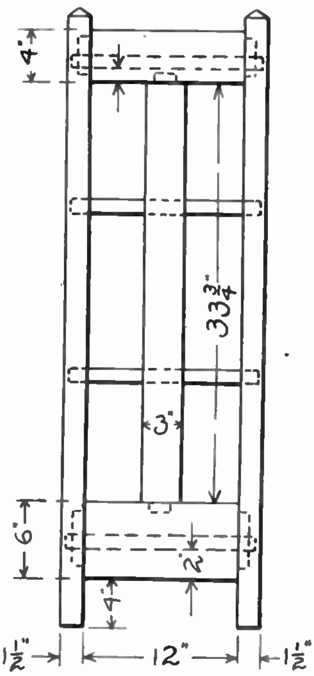
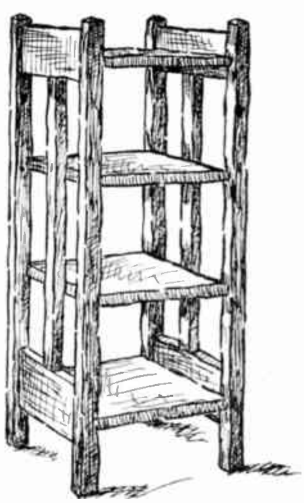


FIG 2



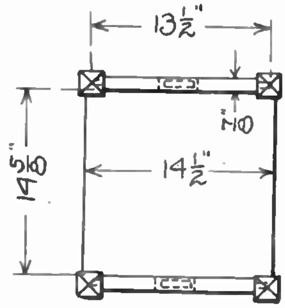


FIG. 3.

strong ammonia, should give a good color; if not dark enough let it remain longer, bearing in mind, however, that the wood will present no noticeable change until oiled or brought in contact with a wet substance such as shellac. It is well, therefore, to note the progress by touching the wood with the wet finger, when it will show at once the stage it has reached.

When the fuming process is complete, remove the stand and give it a coat of shellac. When the shellac has thoroughly dried, rub it down with No. 00 sandpaper and apply a number of coats of wax, enough to fill up the grain and produce a good polish. The prepared wax sold all over the country is very good for this work, but if the craftsman cares to be original and make his own wax, he can do so in the following manner: melt equal parts of beeswax and paraffin in a dish and while still in the liquid condition add turpentine. Allow this to cool and if it is too hard, melt it over again and add more turpentine until it is of the right consistency. In this second melting it is a good plan to place the vessel in hot water, as the fumes of turpentine are inflammable. Rub this wax into the wood and polish it briskly and you will have as beautiful a finish on oak as is possible to produce.

HANDY THINGS FOR THE HOME WORKSHOP

DONALD HAMPSON

Riveting Block

A block of lead or type metal moulded in a 6 in. ladle for riveting polished and finished work and similar jobs where the piece has to be hammered, yet the finished surface unmarred, is a very handy little helper. For punching holes in sheet metal this block is useful, too. A better way to make this is to have a cast-iron shell and pour the soft metal into it.

Anvil

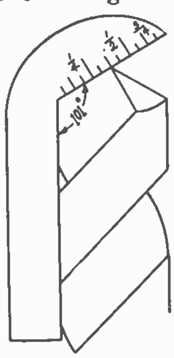
A length of steel rail about 18 in. long makes the nicest kind of an anvil for home use. If desired it can be drilled and fastened to the bench or a suitable box. Well mounted it makes an anvil as solid and almost as durable as a "store bought" anvil. The track supervisors on most railroads can and will cut you off such a section from an old scrap rail. If this cannot be obtained, a piece of heavy 6 in. I-beam or larger is fairly good, though it rings more and is springier than the rail.

Punch Plate

Procure a piece of cast iron or steel 8 in. in diameter (or of approximate area) with a number of various sized holes in it. Go to any machine shop and get an old flange or a piece of an old casting—it can be bought for the junk price, no doubt, and for a quarter more they will drill you a dozen or so holes in it. Have sizes by sixteenths from 1/8 to 1/2 and by eighths from 1/2 to 1 unless there are already some of those holes in the piece. Maybe in the shop's scrap heap you will find just what you want without having drilling done. A piece that has been machined off on one side is better than a rough one. This piece, which call a "punch plate," can be used for lots of odd jobs but chiefly for driving out pins and if you have the sizes named, you are ready for a great variety of them. Other uses: punching holes in sheet metal, use for a drilling plate, giving a round shape to whittled wood dowel pins, upsetting, etc., For larger driving of this kind a 1 ft. section of 2 or 3 in. pipe is good.

Drill Grinding Gauge

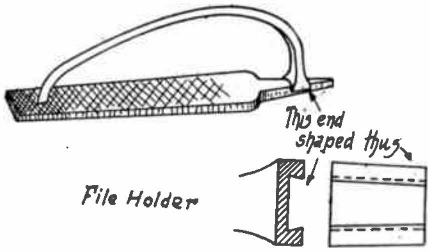
Many users of drills do not know of the drill-grinding gauge shown in the figure, which any drill manufacturer will gladly send to a customer, or one can be made very easily. If both lips of the drill are ground to the same angle as the gauge, and when so ground measure up the same length (in the figure 5/16 in.), the drill is bound to cut to size. Except for special jobs, a drill



that cuts large is a cause of a lot of trouble, and in the absence of a drill-grinding machine, the gauge shown is the best and only check on improperly ground tools. The angle of the gauge as generally adopted, is 101 degrees.

File Holder for Flat Surfaces

Every now and then one has occasion to file on a broad flat surface—a surface so large or so surrounded that a regular file handle cannot be used and in fact there is no room for the hand below



File Holder

the working face of the file. Under these conditions, it is very tiresome for the hands to grip the file by the fingers alone and do any amount of work so a holder like the one in the drawing is very helpful. The claw-shaped end is a positive driver and the arm or handle gives abundant chance to push a file and "bear on." This holder may be made by upsetting a piece of bar iron for a head and then bending the handle. The one I have is made from an old bolt which was so transformed that the dovetail could be put in the head.

About Chains

Chains that have been used for years become brittle and often break without giving any warning. Well chains are the commonest that we have to do with. They are subjected to the action of the water in addition to this crystallizing process from long use. Old chains are improved by annealing, or heating to a red heat and cooling slowly. This does not actually increase their breaking strength, but it makes them tougher, in which state they will give some warning by stretching of the links before breaking. The sudden snapping of a chain has been a frequent cause of loss of life.

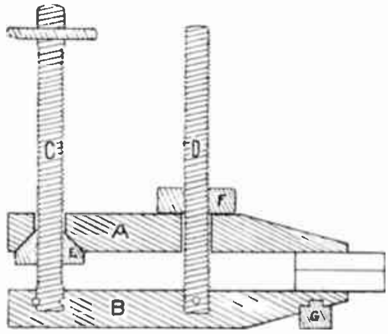
IMPROVED DESIGNS OF PARALLEL CLAMPS

CHESTER L. LUCAS

The parallel clamps shown in the accompanying illustration have been found much more convenient than the ordinary parallel clamps, and with them it is possible to hold work tighter than with others, and they may be laid flat upon the table of a drill press without swinging the table way around so as to clear the operating screws.

In the illustration, *A* and *B* are the two jaws, hardened and drawn to a spring temper. *C* and *D* are the operating screws; *D* being threaded and pinned into the lower jaw *B*, while screw *C* is let into *B*, with a pin running in the groove at its lower end, allowing the screw to turn freely, yet preventing it from pulling out. *E* is a round knurled nut, chamfered off to fit the countersunk hole in the under side of jaw *A*. The other nut *F* is a plain knurled nut, working on screw *D*. The holes through *A* are enough larger than the screws to allow the jaw to slide freely over the screws.

In operation nut *F* is twirled up and nut *E* is twirled down out of the way, and the work inserted between the jaws. Closing jaw *A* down to the work, the nut *D* is run down until it touches the jaw, then nut *E* is twirled up to *A*, and a couple of turns to the handle *H* at the end of *D* sets the clamps up solid.



For heavy work the stud *G* is inserted in a seat that is counterbored in the under side of jaw *B*. This stud is removable, and its purpose is to support the tip ends of the clamps while drilling. These clamps may be applied in the manner above described in half the time the usual clamps require to adjust.

THE MOTION PICTURE—Part IV

STANLEY CURTIS

The Use of Electricity in Projection Work (*Continued*)

A glance at Figs. 7, 8, and 9, will give an excellent idea of the appearance of a modern projecting arc lamp. Observe the handles by which the operator may feed the carbons together, raise or lower the lamp, shift it from side to side and move it closer to or further from the condensing lens. These adjustments may all be made from the outside of the lamp-house and while the lamp is burning.

The carbons are held in place by means of clamps, as shown in Fig. 7. These clamps are adjustable and may be turned so that the carbons may be set in various positions. Fig. 8 illustrates the proper method of "trimming" the carbons for use on direct current; the lower carbon advanced slightly forward of the upper. For alternating current we use the trim shown in Fig. 9 to obtain best results. In this case the carbons should both be of the same size, about ⅝ in., and should both be soft cored. For use with direct current, a ⅝ in. soft cored upper and a 9/16 in. solid lower carbon have given the writer best results. The very best grade of imported carbons should be used. On alternating currents the arc will sometimes wander around the carbons and give the operator considerable trouble. This may be avoided to a certain extent by filing a V-shaped groove along the surface of both upper and lower carbon and placing the carbons in the clamps in such a manner that the grooves will face the condensing lenses. The groove has a tendency to hold the arc on the front of the carbons. The figures in Plate 4 give several other methods of trimming. Fig. 1 shows an alternating current trim which seems to give results equal to the method described above. Fig. 2 shows the appearance of the carbons after they have burned off a bit. Figs. 3 and 4 show the direct current trim described above. Figs. 5, 6 and 7 are angles used in spotlights to a great extent, but in the writer's opinion do not possess any marked advantages over the ones first mentioned.

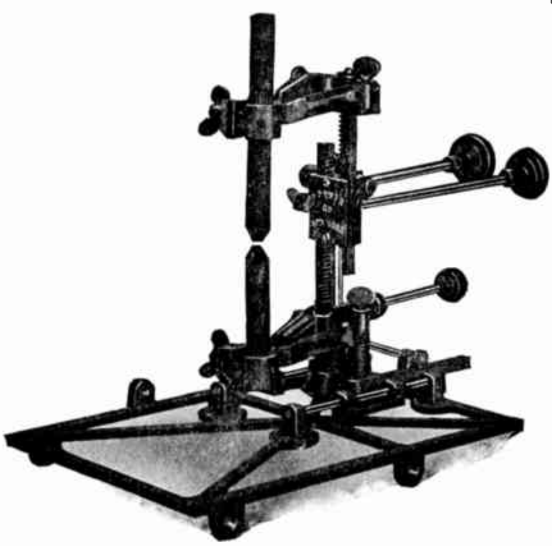


Fig.7

The arc light is started by first closing the switch, then bringing the carbons together for a second, after which they are separated about ⅛ in. on direct current but not more than 1/16 in. if alternating current is used. With alternating current, two distinct craters are formed, one on the upper and one on the lower carbon. In order to keep both craters in focus, we must have them as close together as possible, without "freezing" them. A blue "ghost" will nearly always be present in the field produced by an alternating current arc. This ghost is illustrated in Plate 6. In Fig. 1 of this plate the arc is too far away from the condensing lens and the spot of light on the aperture plate does not cover the opening. The remedy is to move the arc closer. Fig. 2 shows the ghost when the arc is too near the condenser. This ghost may also be caused by the condensing lenses being too close or too far away from the aperture. By moving the entire lamp-house back and forth on its slide rods the condenser may be brought in focus and the ghost removed. Fig. 3 shows the ghost caused by the alternating arc burning too long; that is, the carbons are separated too far. Fig. 4 shows the ghost caused by using a direct current trim on alternating current. Most of this description has been confined to alternating current ghosts, as those on direct current are easily removed. The ones most commonly found with direct current are those illustrated in Figs. 1 and 2, in Plate 6.

Generally speaking, the use of a "long arc" is preferable to a short one, on direct current, as the negative carbon gives practically no useful light and it has a tendency to form a ghost by obstructing the passage of the rays of light from the positive crater when the carbons are close together. However, there are comparatively few brands of carbons on the market that will burn a long arc without "blowing" to an annoying degree. A poor grade of carbon will invariably manifest itself if the arc is drawn out to 3/16 in. or more, by the light flaring up and blowing. Then, on the other hand, if the operator places his carbons closer together, the negative carbon will usually form a thin sharp point called a "tack" or "spit." This "tack" gradually becomes longer and longer until it short-circuits the arc entirely, causing more hissing and blowing on separating the carbons. When a tack forms, the arc should be drawn out until it burns off.

Now, all of this hissing and blowing means an unsteady light on the screen, which is most annoying to the spectator as well as to the operator. The remedy is to use *good carbons*. Try out the different advertised brands, giving each a fair and impartial test, and when a carbon is found which will hold a fairly long and steady arc when properly trimmed, stick to that particular brand. Correct trimming is of the utmost importance, and next to this comes proper "feeding" as the carbons burn away. In starting the arc the carbons should be brought together *gently*, not with a sharp jerk, as that will often destroy a good trim. Separate them *slowly* until the arc is of the proper length, then bring them almost together again and immediately separate them to the proper extent. By repeating this operation a couple of times, the arc will become settled very quickly. The feeding of the carbons should be frequent and very gentle, rather than occasional and with a jerk. It is far better to give the knob a slight touch every few moments than to wait until the arc is ready to blow and then feed with a sharp turn. The operator who feeds after the latter fashion invariably has an orange-colored streak of light through the lower part

Fig. 8

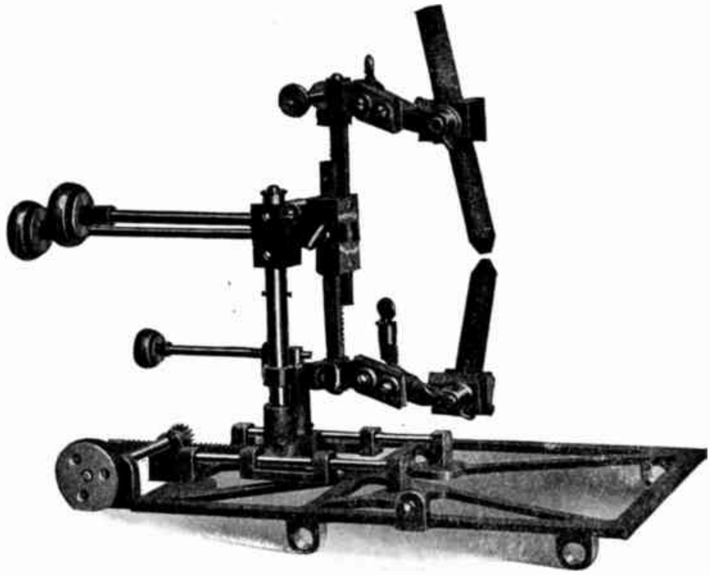


Fig. 9

of his picture just before he makes the adjustment.

Another habit among operators is that of "freezing" the carbons together every few minutes. Not only is this annoying to the audience, but it is most destructive to the rheostat. To substantiate this assertion, the writer will give the results of a test made recently in the booth of one of Boston's leading theatres. The circuit consisted of a standard Powers' Circular Rheostat, 10 ft. of No. 6 asbestos covered cable, 50 ft. of No. 6 solid conductor leading to rheostat outside of booth, 5/8 in. soft cored positive and 1/2 in. solid negative carbon of the "Bio" brand, the whole connected to No. 6 service wires. Car-

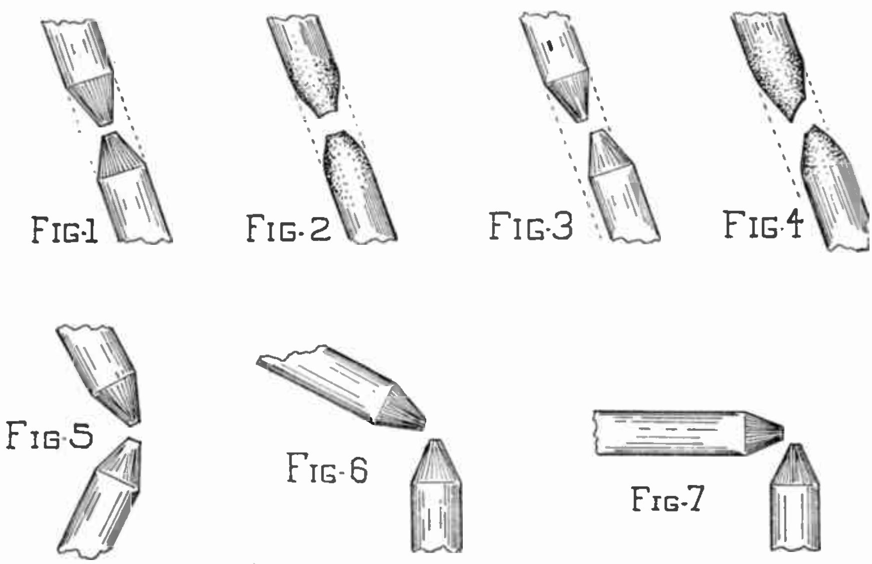


PLATE 4
STANLEY CURTIS '10

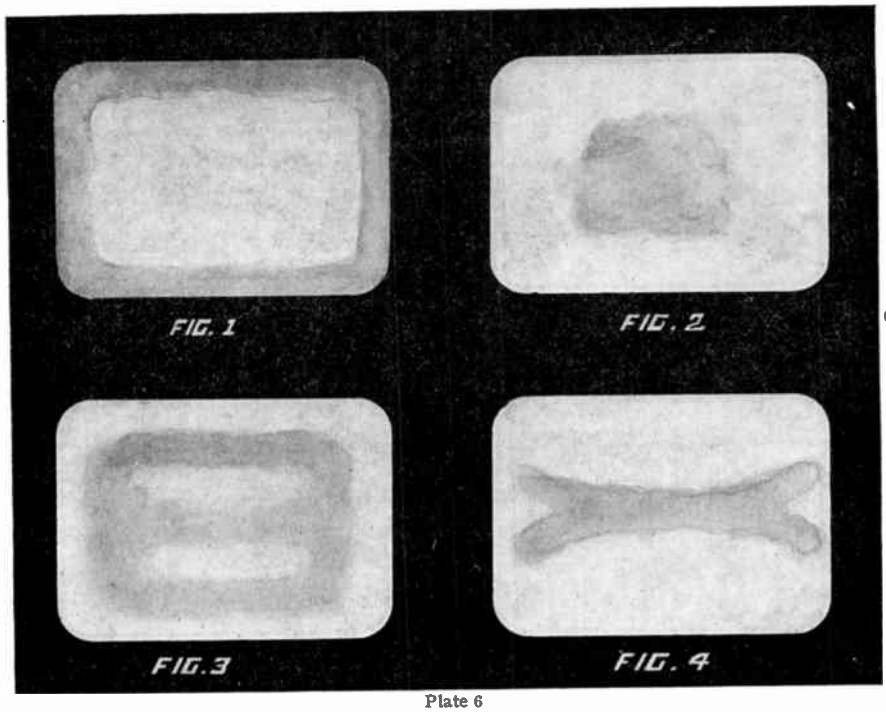


Plate 6

bons new when placed in clamps and projecting 4 in. from same. The voltage was 110, and five points were cut out on the rheostat. A Western D.C. ammeter inserted in series showed 47 amperes on striking the arc, the current falling almost instantly to 42 amperes when carbons were separated ⅛ in. After one minute the reading was 33 amperes; two minutes, 28 amperes; three minutes, 24 amperes; and after eight minutes the current was 26 amperes with 3/16 in. arc. The switch was then opened and the carbons permitted to cool for five minutes. On striking the arc the meter read 42 amperes while carbons were together and 26 amperes when separated. On freezing the carbons the current was invariably increased from 26 to 42 amperes, and this obviously heats the rheostat to an injurious degree.

It will be found necessary on alternating current circuits to use far more current to obtain a satisfactory light than on direct current. The connection shown in Plate 1, Fig. 2, in the January issue will give the desired increase in amperage. However, a far better light, at less expense, may be obtained by using a "step-down transformer" or "economizer," which will be described in detail in the next article of this series.

(To be continued)

Polonium

Madame Curie and Monsieur Debierne have succeeded in isolating the rare element polonium by treating pitchblende with hot hydrochloric acid. From several tons of pitchblende they obtained only one-tenth of a milligram of polonium. The substance has been known for the past ten years, but has not hitherto been obtained in a pure state. About 5,000 times as much radium as polonium can be obtained from the same quantity of a radioactive mineral. Polonium also breaks up, or decays, 5,000 times as rapidly as radium, and its activity, weight for weight, is in the same ratio. The radiation of polonium is entirely in the form of alpha rays. Chemists are now greatly interested in the apparent evidence given by these experiments that polonium changes into lead. Professor Rutherford says that another of the products of its decomposition should be helium.

MAMMOTH CLOCKS OF THE TWENTIETH CENTURY

H. FRANK MEDDRIL

Immense Modern Clocks that Eclipse the Marvels of the Middle Ages. America Leads the World in Electric Clock Construction

The announcement that a century-old clock manufacturing concern in Connecticut has been awarded the contract for installing a mammoth tower-clock in the new Bromo-Seltzer Building, Baltimore, Md., is another indication that one of the glories of the present century will be its achievements in clock construction. The modern alliance between electricity and advertising evidenced in this new clock, as also in the immense time-piece on the Colgate factory in Jersey City, N.J., and that on the Metropolitan Building, New York City, will have much to do with future triumphs in this field. The era in which we live has been very appropriately named "the electric age." In every sphere of human activity, the subtle fluid has been pressed into service, and to such an extent in the clock makers' art, that the much-honored horologist of a former day will be soon superseded, to a large extent at least, by the electric and mechanical engineer.

While electricity has long been used in the illumination of clocks, it is only in recent years that it has figured to a large extent as motive power in their operation.

The beginning of the present century was marked by a notable achievement in clock construction—the great timepiece in the tower of the Philadelphia City Hall. This, however, was not in any sense an electric clock, the motive power being compressed air, the same power being used to drive the hands and to light automatically the 600 incandescent lights which illuminate the dials. The Philadelphia clock has four dials, 25 ft. each in diameter. This was an advance in size over the Milwaukee clock with four dials, each 23 ft. 4 in. in diameter, and the Westminster clock in London, with dials 22 ft. 6 in. in diameter. There is a clock on the continent which boasts of a 40 ft. dial, but it has only one dial and the time is indicated by an hour-hand only. An improvement on the latter in size was the single-dial tower clock installed in 1908 on the Colgate factory, Jersey City, N.J.; the dial of which is 40 ft. 6 in. in diameter. In the four-dial clocks, another step in advance was made in the great clock in the tower of the Metropolitan Building, New York City, each of the four dials being 26 ft. 6 in. in diameter. In mere immensity of proportion this is doubtless about the limit in tower clock construction, which is indicated in the fact that the new clock now in process of construction for the Bromo-Seltzer Building, Baltimore, above referred to, has four dials—two day dials 24 ft. and two night dials 15 ft. in diameter.

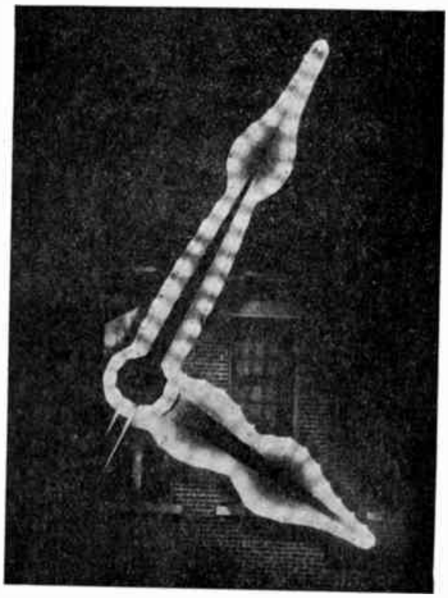


Fig. 1
Hands of the Colgate clock by night

As before stated, the Philadelphia clock is in no sense an electric clock, compressed air being the motive power. The air compresser system is, of course, operated by electric motors, and only to this extent and for illumination does the mysterious fluid play a part in the operation of this mammoth time-piece. As suggestive of the immense proportions of the Quaker City clock, it is sufficient to state that the four dials, including the frame work and glass weigh 40,000 lbs.; the reflectors, braces, etc., weigh as much more, making the weight of each face and its supports about 20,000 lbs., and the total weight of the four faces, 80,000 lbs. The hands, which are of sheet copper, are 12 ft. and 9 ft. in length, respectively. The hour periods on this clock are not indicated by figures, but by copper plates about 5 ft. long and from 1 to 2 ft. wide.

Fig. 2
Copyright by Herman C. Korfhage, Louisville, Ky.
Largest electric clock ever constructed

As the vibration of tall structures is a factor to be taken into account in tower clock construction, it is interesting to note that the Philadelphia clock is located 362 ft. 6 in. above the street level and the clock on the Metropolitan Building, 346 ft. above the pavement; the latter being located about the middle of the tower which has an altitude of 700 ft. 3 in. above the street level. As is generally known, this tower is the highest in the world with the exception of the spectacular Eiffel tower in Paris, which is a curio rather than an architectural achievement for human tenantry.

The Colgate clock, which was primarily intended for advertising purposes, is chiefly remarkable for its extraordinary dimensions; the single dial, as heretofore stated, being 40 ft. 6 in. in diameter. This clock is equipped with a gravity escapement similar to that invented by Sir Edmund Becket, the famous British horologist, for use in the great Westminster clock on the Parliament buildings in London. The pendulum rod weighs 76 lbs. and is 8 ft. long. The cast iron pendulum bob is cylindrical in form and weighs 330 lbs. The iron weights used to propel the hands, weigh 1,500 lbs. The hands of this clock, which in the accompanying illustration, Fig. 1, are shown illuminated by night, were the largest constructed up to that time. The minute hand is 20 ft. long and the hour hand, 15 ft.; the total weight of minute hand and counterpoise is 640 lbs., and of the hour hand complete, 500 lbs. The numerals on the dial consist of heavy black strips 5 ft. 6 in. long and 30 in. wide. The background is painted white, and in the daytime the black hour marks show up distinctly. At night, the hour marks are designated by a row of incandescent bulbs placed in a trough 5 in. wide and 5 in. high. At night, the hands are outlined with incandescent lights; there being 27 lamps in the hour hand and 42 in the minute hand.

The many thousands who had the pleasure of attending the Electrical and Industrial Exposition held in Louisville, Ky., in 1909, had an opportunity to see one of the most remarkable electric clocks ever constructed. This clock, which was the work of a Louisville clockmaker, was in the form of a pendulum hung from the ceiling in one of the exposition buildings, and was 48 ft. in length and 20 ft. 3 in. in width. It weighed over 3,000 lbs. and contained 5,500 multi-colored bulbs, for which 11,000 connections were necessary. The number of lights used on this clock was its most startling feature. It was calculated that the number of lights exceeded the entire number of incandescent globes used to illuminate the cars of the whole street car system of Louisville, and over a mile of wire was required to make the connections on the clock alone. The dial was 20 ft. 3 in. in diameter and differed from the ordinary clock dial in that it indicated hours, minutes and seconds without hands. The time by minutes was indicated by sixty series of lights, each containing thirty-two electric globes and radiating from an ornamental centerpiece to the outer edge of the dial; shorter rows of different colored lights indicated the hour, and these changed their position twelve times each sixty minutes. The seconds were shown by sixty lights placed at equal distances around the extreme outer edge of the face. The hour figures were 3 ft. high and outlined in colored globes. The mechanism of this immense machine was controlled by a small master clock, and the fact that no motive power was visible made the exhibit all the more mysterious and remarkable.

Fig. 3
Clock in Metropolitan Tower, New York City

In the clock (Fig. 3) in the Metropolitan Building, New York City, we reach for the first time an electric clock properly so called, as this remarkable timepiece is operated wholly by electricity. The magnitude of the different parts of this clock is well evidenced in the hands, the larger of which weighs 1,000 lbs., and the smaller 700 lbs. The minute hand is 17 ft. end to end and the hour hand 13 ft. 4 in., while the former measures 12 ft. from the centre of the dial to the point, and the latter 8 ft. 4 in. The hands are constructed of an iron frame sheathed with copper, and are operated by a mechanism installed in a small chamber back of the dials within the tower (Fig. 4). The dimensions of this chamber, being only 14½ x 25 x 34 in., furnished a striking comparison between massive mechanism and the concentrated motive power.

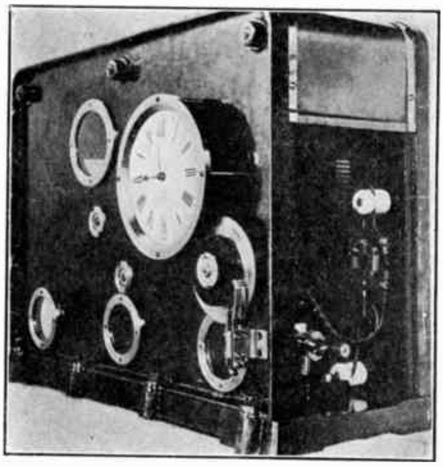


Fig. 4
One of the movements used for the four pairs of hands in Metropolitan clock

We now come to that part of the clock which brings it in direct touch, every quarter of an hour during the day, with the millions of people to whom it impressively proclaims the time. Four great bells are hung 269 ft. above the dials, the largest weighing 7,000 lbs. and measuring 70 in. across the mouth. It is toned to B Flat and strikes the hour, besides participating in the general choir. The second bell, an E Flat, weighs 3,000 lbs.; the third, an F natural, weighs 2,000 lbs., and the fourth, a G, weighs 1,500 lbs.; a total weight of 13,500 lbs. These bells are hung 615 ft. above the street level, being more than twice the height of any other peal in the world. In the machinery which operates these bells we again find a notable contrast between the magnitude of mechanism and concentrated motive power, the operating apparatus for the bells being contained in a case 48 x 35 x 24 in.

Another novel innovation which evidences the ingenuity necessary to the construction of this immense timepiece is the fact that the bells are silent during the night, an effective substitute for the tolling of the hour being provided in a great gilded lantern on the top of the tower, which by flashes tells the time with the same accuracy. As twilight falls, whatever the period of the year, the great bells are automatically silenced and remain so until a prearranged hour in the morning when they are automatically released for their work of the day. At the moment of silencing the great lamp becomes automatically operative, and by means of flashes, the hours and quarter hours are indicated. As this great lantern, which, on its cloud-piercing perch, simulates a flashing constellation, is really a part of the clock, the unique character of the timepiece becomes more impressive. During the night this lantern sends its dazzling electric rays over the city without interruption except on the hour when the light disappears and the time is told by single flashes. A single red light announces the first quarter, two red flashes the half hour and three red flashes the three quarters. At the hour

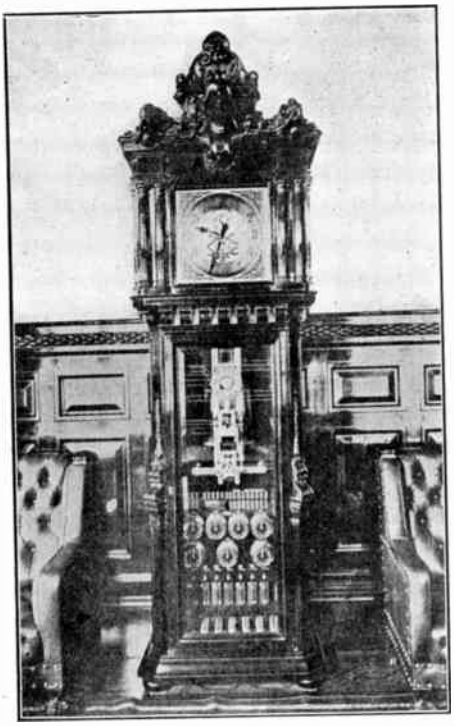


Fig. 5
Master Clock in Metropolitan Building

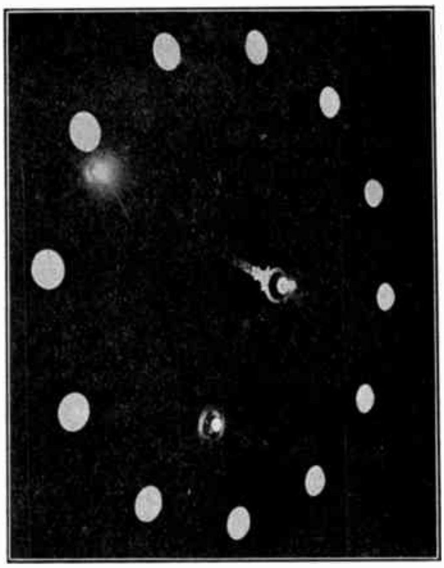


Fig. 6
Clock with revolving dial on Federal Building, Newbern, N. C.

the white arc light disappears and there is a momentary darkening of the lantern, and then follows in quick succession the requisite number of flashes to indicate the hour. The efficiency of this vast mechanism as a timekeeper is due to a master clock (Fig. 5), resembling somewhat a grandfather's clock, which quietly attends to its great task from the wall of the president's room on the second floor of the building. Our illustrations convey an idea of several important features in the mechanism of this great clock.

A mammoth clock with several unique features was erected during the present year on the Federal Building, Newbern. N.C., in which are located the United States Post Office, Court House and Custom House. This clock has a revolving dial (Fig. 6) and is the only clock in the world with this feature. The dial is without numerals to indicate the hours, there being used instead twelve opalescent glass discs. These show white in daytime and at night there is an electric light in an aluminum reflector, back of each disc, which makes twelve lights to indicate the hours. (Fig. 7) There are windows in the building behind each dial to permit the renewing of the lights. The dials may be revolved to bring the several lights where they may be reached through the window.

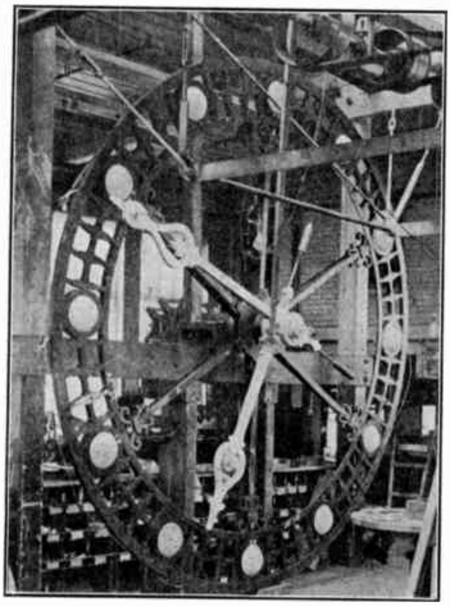


Fig. 7
Showing construction of dial of clock on Federal Building, Newbern, N.C.

A hand wheel and gearing is provided in the building back of each dial to revolve it; also a locking device to retain the dial in its proper position after changing the lights. The frame of the dial is wrought iron construction, similar to bridge-work construction, with cast metal circles to hold the discs and minute spaces. The hands are specially designed, being of cast aluminum, each carrying an electric light at the hub of the hands. These lights are 100 watt lamps, which show red at night so as to distinguish them easily from the dial lights. The time at night will be read by the location of the red lights. Special contact rings are provided, with brushes and wiring to convey the current. The four dials weigh three tons and the clock complete weighs about five tons. The dial can be read from a distance of about two miles.

The next clock to claim attention is that now in process of construction for the Bromo-Seltzer Building, above referred to, the descriptive details of which are not yet available other than that the two day dials will be 24 ft. in diameter and the night dials, 15 ft. It is known, however, that the clock will have many features entirely different from any of those above described, and will quite probably prove yet another triumph for the tower clock industry of the United States.

As there are several large manufacturing concerns now making a specialty of these immense clocks, we may expect remarkable achievements in this field in the near future.

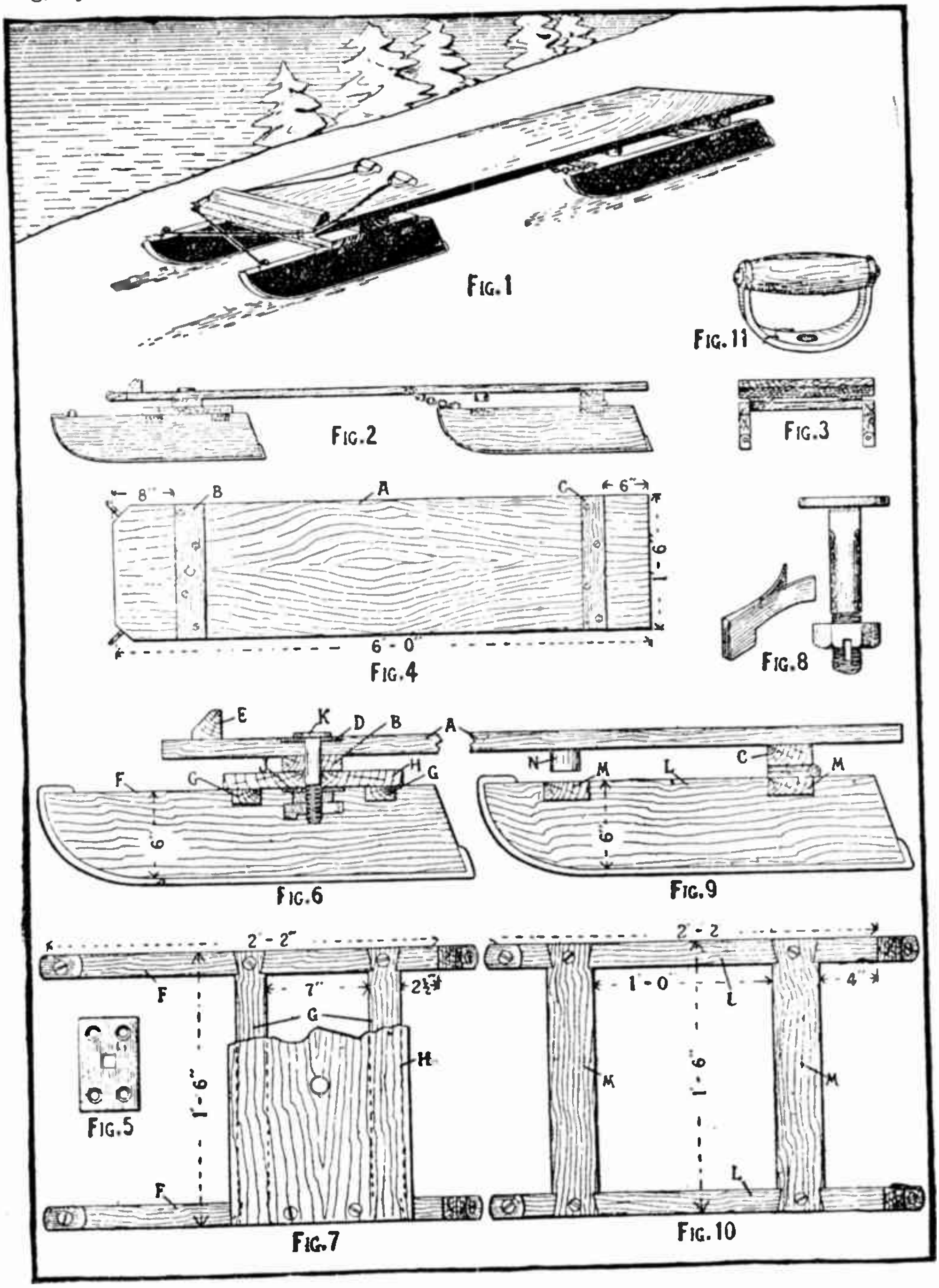
HOW TO MAKE A DOUBLE RUNNER WITH STEERING ARRANGEMENT

Coasting provides a very exhilarating sport in the winter season when the country is covered with snow. Providing one possesses the sled, the sport may be indulged in on any hill, sloping field, or country road. An ordinary sled consists of a flat platform mounted upon fixed runners, the steering being accomplished by means of the feet, but a steerable sled is much to be preferred. A sled of the steerable type is shown in Fig. 1; although it is rather more difficult to make, it is preferable to all other kinds, and is large enough to carry several passengers. It consists of a platform about 6 ft. long by 1 ft. 6 in. wide, which is mounted upon four runners. The runners are fixed in pairs, those at the back being hinged in position, while the front pair are pivoted, the steering being accomplished by means of a pair of crossed wires and handles, which are fixed to the front ends of the runners. Figs. 2 and 3 show side and back elevations respectively, while Figs. 4 to 11 give the details, and the principal dimensions. In making the sled it is recommended that a hard wood, such as ash, oak or birch, be used.

THE PLATFORM

The platform, *A*, will be the first consideration. A plan of the platform is given at Fig. 4. It is 1 in. or 1¼ in. thick, and should be cut to the dimensions given. If one piece of board of sufficient width cannot be obtained, two or even three pieces could be jointed together to make up the width required, the joints being either grooved and tongued, or dowelled, and glued together.

The front cross-piece *B* is 1 ft. 6 in. long, by 4 in. wide, by 1 in thick; and the back cross-piece *C* is 1 ft. 6 in. long by 3 in. wide by 1½ in. thick. These rails are prepared and screwed to the bottom of the platform in the positions indicated at Fig. 4. A hole ¾ in. in diameter is then bored exactly in the



middle of the cross-piece *B*, and is continued through the platform, and an iron plate *D*, similar to that shown at Fig. 5, is let into the platform exactly above the hole. The plate should be 6 in. long by 4 in. wide by ¼ in. thick. A ¾ in. square hole is provided exactly in the centre of the plate, and it is fixed in position with four screws. The platform is then completed by preparing and fixing a foot rail *E*, which is 1 ft. 6 in. long by 2 in. wide by 2 in. deep, and is fixed 2 in. back from the front edge of the platform with screws, which are driven from underneath.

THE FRONT RUNNERS

The front runners *F* have an over-all length of 2 ft. 4 in., and are 6 in. deep by 1¼ in. thick. The back ends of the runners are cut away to a bevel of 2 in., and the front ends are shaped as shown at Figs. 2 and 6. The runners are connected by two cross rails *G*, which are 2 in. wide by 1 in. thick. The rails are dove-tailed into the top edges of the runners in the positions shown at Fig. 7, and are fixed with screws. The bearing board *H*, which is fixed above the cross-rails *G*, is 1 ft. 6 in. long by 1 ft. wide by 1 in. thick, and it is fixed in position with screws which are driven into the top edges of the runners, and with others which are driven through the cross-rails. A ¾ in. hole is then bored through the bearing-board *H*, exactly in the centre, and an iron plate similar to the plate *D*, which has already been fixed to the top of the platform, but with a ¾ in. round hole in the centre, is fixed to the underneath side of the board, exactly underneath the hole.

The runners are connected and pivoted to the platform by means of the bolt *K*, an enlarged view of which is given at Fig. 8. The bolt is ¾ in. in diameter; it has a large flat head, and the portion immediately underneath the head is square in section. The end of the bolt is screwed and fitted with a hexagon nut. A slot should be cut in the bolt and bottom edge of the nut, so that a split key similar to that shown may be inserted to prevent the nut from unscrewing when the bolt is fixed in position.

THE BACK RUNNERS

The back runners *L* are similar in shape and dimensions to the front runners, and they are connected by two cross-rails *M*, which are 1 ft. 6 in. long by 3 in. wide by 1 in. thick. The cross-rails are dovetailed into the top edges of the runners in the positions shown at Fig. 10, and are fixed with screws. The runners are hinged to the platform by means of a pair of hinges. Ordinary 3 in. butt hinges will be most suitable, and they are fixed to the back cross-piece *C*, and the back cross-rail *M* with screws. A rubber stop *N*, which should be 1½ in. in diameter by 1½ in. thick, should be fixed to the underneath side of the platform, directly above the front cross-rail *M*, to take any undue strain off the hinges. A short chain should also be provided between the platform and runners, as shown at Figs. 1 and 2, the chain being fixed with small iron staples. It would also be found desirable to protect the bottom edges of the runners with iron plates, or shoes, which should be of half-round iron, carried around the edges of the runners, as shown in the illustrations, and fixed in position with screws.

FINISHING THE SLED

The last consideration, as far as the construction is concerned, is the steering gear. This consists of two pieces of stout wire, which are fixed by means of iron staples to the front ends of the front runners. The front corners of the platform are cut to an angle as shown, and a stout screw-eye is inserted at each corner. The wires are threaded cross-ways through the screw-eyes, and handles are fitted at the ends of the wires. Suitable handles are shown at Fig. 11, consisting of a wood handle piece about 4 in. long by 1 in. in diameter, which is fixed by means of a long rivet to a shaped stay. Holes are provided in the stays to which the ends of the wires are fixed.

When complete the sled should be given a coat or two of paint, to act as a preservative, and may be given a name which could be painted on.

A handy funnel for pouring liquid into a bottle may be quickly made anywhere by taking a piece of thick, smooth white paper, rolling it into a cornucopia and fastening it with a pin. Cut the pointed end off and it's ready to use.

APPLIED TELEPHONY

HENRY TOWNSEND, JR.

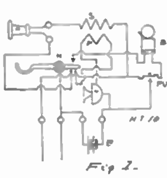
Every year sees the application of the telephone extended more and more for private purposes and it is intended to give the details here of some of the systems used for this class of work, such as the common battery, intercommunicating, etc.

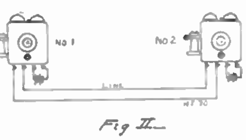
For the benefit of those who are not familiar with telephone work, the wiring of a common two-party battery phone, such as sold at from $3.00 to $5.00 will be given.

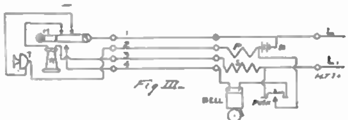
This phone usually contains a call bell, double contact push button, for calling the other party, automatic switch hook, transmitter and receiver, induction coil, two-battery and two-line terminals. The connections of these various parts, one to another, are given in Fig. 1.

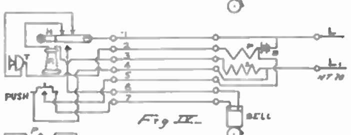
The circuit for two of these phones, as generally used is diagrammed in Fig. 2.

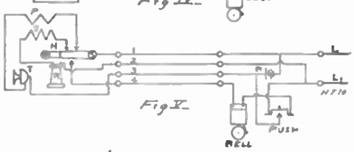
It often becomes necessary to use desk phones of the common battery type, and a diagram is shown in Fig. 3 for a desk phone, and a flexible cable, of four wires, connecting it to a wall block, containing the induction coil, push button, call bell, battery and line terminals.

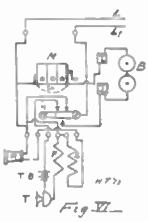


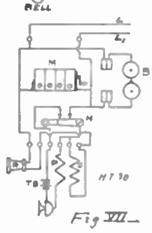












The necessary connections for a desk phone with the push button mounted on it, and requiring a seven-wire cable, is illustrated by Fig. 4.

In Fig. 5 is depicted a diagram for a desk phone with the induction coil mounted in the phone, but with the call bell and push button separate, as in Fig. 3. In all the phones so far treated the battery at each phone serves the double purpose of a talking and ringing battery.

A type of telephone with a magneto generator for calling is much used in suburban work and lines extending over 1,000 ft. They are usually of the type known as the series or bridging, depending upon whether the different instruments on a system are connected in series or in multiple.

The series phone is shown in Fig. 6, and the bridging or shunt type in Fig. 7.

The magneto generators used for ringing have a rating of 120 ohms in the series, and 1,600 ohms in the bridging type, and in the series instrument are provided with automatic shunts, which short-circuit the magnetos when not being turned, so that the incoming ringing current (A.C.) can easily ring the polarized call bell, without passing through the high impedence winding on the magneto armature, which would materially cut down its energy, besides having a demagnetizing effect on the permanent magneto magnets. Many a magneto has lost its power, from seemingly no reason whatever, and the trouble was none other than that the A.C. had passed through its armature winding, and consequently destroyed the permanent magnetism in the steel magnets surrounding it.

Before taking up the different intercommunicating systems, we will give our attention for a few moments to a very interesting type of phone, the plain series instrument, having a transmitter and receiver only, no induction coil being used.

The instrument of this type, and used in some large installations by the writer, is known commercially as the "Ander's Telephone," and the complete instrument, including hook and push button, is little larger than the ordinary buzzer.

The working parts comprised in it are the receiver, transmitter, push button, switch hook, line and battery terminals. The call bell or buzzer and battery are mounted separately, the one battery serving for both ringing and talking.

Without an induction coil the author has talked over 50 miles with this instrument, but on large private installations, a small inductance placed in series with the common talking wire, was found to be advantageous and improved the talking qualities.

The connections for a standard two-party series phone are given in Fig. 8.

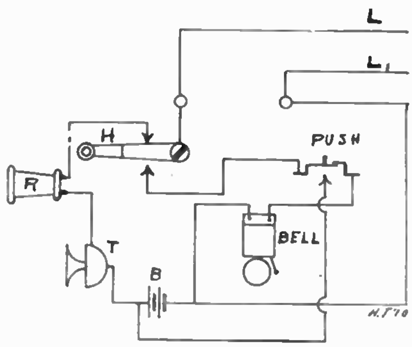


Fig. VIII

The intercommunicating system as applied to hotels, private residences, etc., will now be taken up and a few systems treated which have worked very well in practice.

It is often the case that, having a number of common two-party instruments, it is desired to arrange them to operate on an intercommunicating system, and this can be readily accomplished by connecting them up in the manner depicted in Fig. 9.

Here the battery is retained at each phone or station, but it is often very desirable or necessary to have the battery centralized, or made common to the system, which may be done by using an extra common battery wire in the cable, as Fig. 10 will make plain.

A system much in use, and employing hand microtelephones, is seen in Fig. 11.

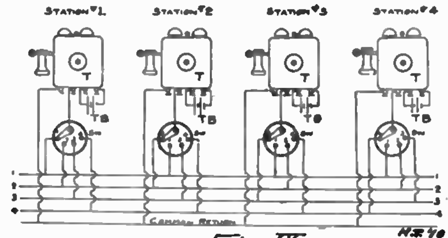


Fig. IX

The receiver, transmitter and lever switch are mounted on the frame of the microtelephone held in the hand, while the bell station switch, induction coil and battery are mounted separately and connected to the microtelephone by a flexible cable.

This phone is very handy around shops, factories, offices, and other places, for if it is in the way when not in use, it can be suspended on a cord over two pulleys, with a counterbalancing weight as shown in Fig. 12. When through using, it is given a push upward and remains out of the way, but within reach, until again wanted.

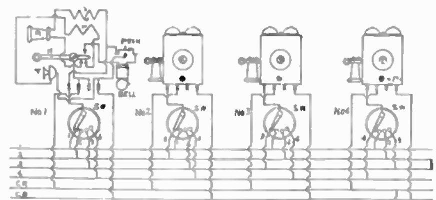


Fig. X

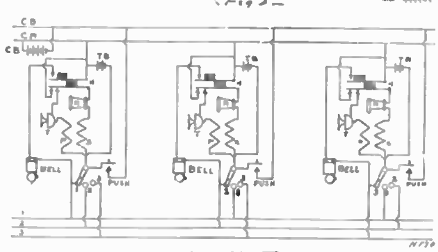


Fig. XI

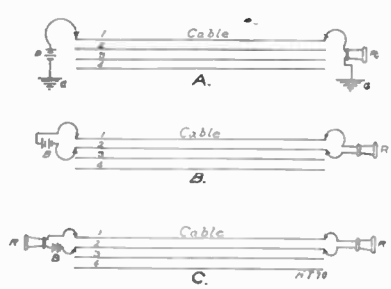


Fig. XII

For regular telephone lines, No. 18 annunciator wire is generally employed for circuits not exceeding 600 ft. in length one way. For circuits longer than this No. 16 wire should be used.

Cables for intercommunicating sets, may be built up of the required number of No. 18 annunciator wires and then taped with ordinary friction tape, lapping it about half.

Considerable trouble is sometimes experienced in testing out telephone systems, and a few hints which have proven of practical use may not be amiss here.

Generally, it is possible to make connection to a ground at the cable terminals so that if a battery is connected

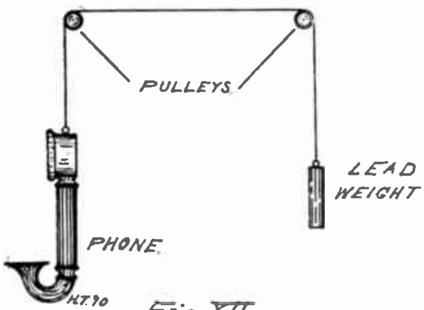


Fig. XII.

to one of the cable wires and the ground, a telephone receiver or buzzer connected to this wire (see Fig. 13A) and the ground at the other end it will respond, and thus forms a simple method of finding the different wires.

However, it often happens that the cable wires must be tested out without the aid of a ground and the proposition becomes a little more difficult. The following method may be used to gain the desired results, and is one of the simplest and quickest known.

Referring to Fig. 13B,—B is a battery, empirically connected to any two cable wires at one terminal, and numbering them 1 and 2; at the other cable terminal a test is made with a receiver, until it clicks, and the tester knows that he has Nos. 1 and 2 wires of the cable; but which is No. 1 and which is No. 2?

To find this out, proceed as follows: Disconnect one of the battery wires and join it to a near wire, marking it No. 3; also join Nos. 1 and 2 together on the other battery terminal.

The tester at the other cable terminal now hooks the two wires just found together, and connects one receiver wire onto the twisted pair; the other receiver lead being tried on different wires until a response occurs, and when it does, the single wire just found is No. 3 wire, as will readily be perceived. It is now an easy matter to connect the battery on Nos. 3 and 2 or 3 and 1 and find which wire is No. 1 or No. 2. The other cable wires may now be easily tested out, as wires Nos. 1, 2, and 3 are had.

It will be found the quickest in testing out cables, etc., if two telephones can be used so that one workman can instantly tell the other what numbers he is working on.

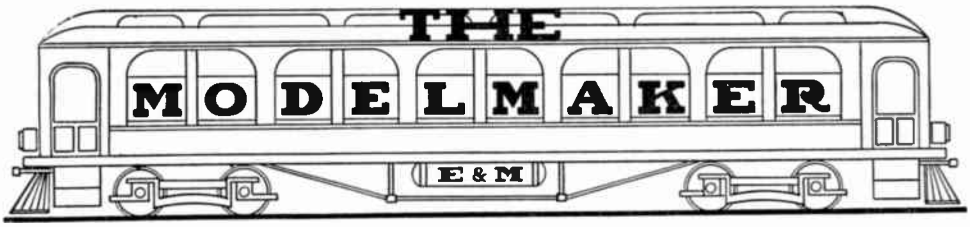
Failing this convenience, an approach to it, for short distances, not exceeding 500 ft., two receivers, connected as per Fig. 13C, will be found to talk very well in either direction.

It is commonly known that the ground or a pipe line may be used for part of a telephone circuit (preferably the ringing circuit), but a rather peculiar use of this was once made by the author.

In testing out an old telephone cable in a residence, and which did not permit of removing any part of it or adding to it, one wire was found to be open between the testing point on the third floor and the basement.

For a few minutes it began to look as if the only thing to do was to cut out one station on the system, but a second investigation revealed the fact that within 2 ft. of the cable, was a gas pipe, and no time was lost in getting a ground clamp fastened to it and also one on the gas pipe in the basement; thus, the open circuit was bridged by a ground which has served well for the past five years, and bids fair to last many more.

How two stereoscopic pictures on one plate can be made, has been revealed by E. Estanave. He shows that when the grating placed in front of the photographic plate has horizontal lines as well as vertical ones, suitable exposure through an objective with four apertures at the corners of a square give the necessary elements from which are obtained two different stereoscopic pictures on the one plate.

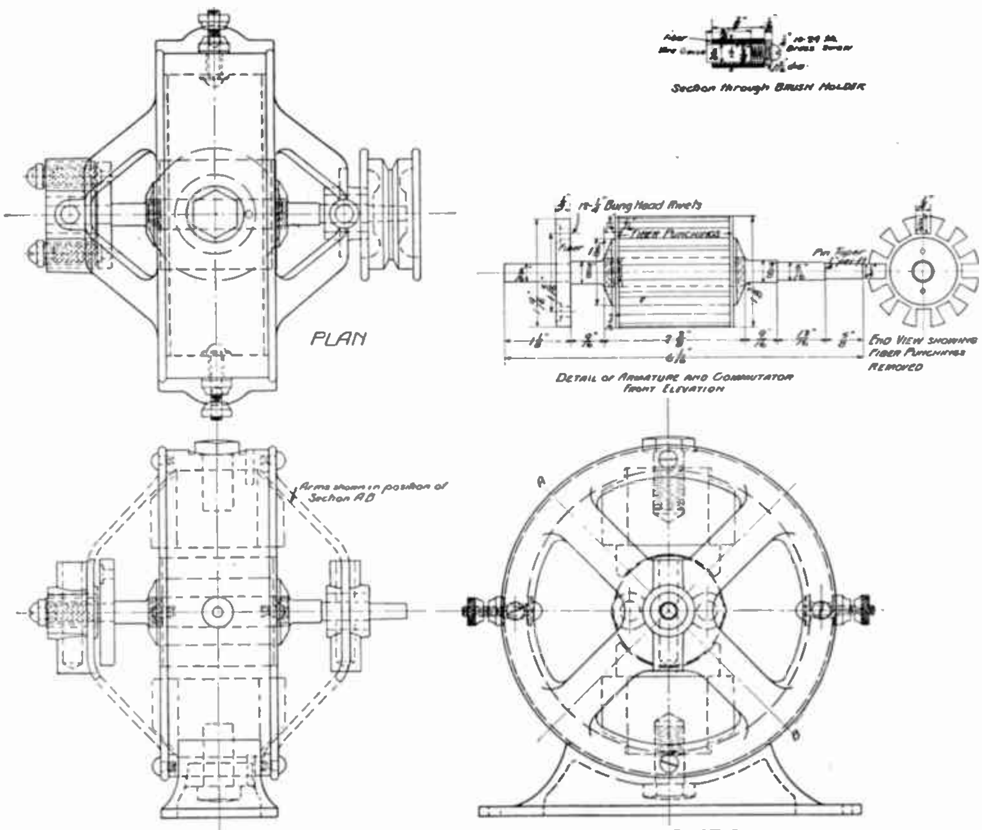


75-WATT BIPOLAR DYNAMO WITH WROUGHT IRON FIELD MAGNET

WM. C. HOUGHTON

The dynamo or motor here described combines to some extent at least the advantages of easy construction with modern design and for so small a machine, fairly high efficiency. The capacity given above is based upon a speed of 3,500 revolutions per minute. With higher speed it may be considerably increased.

The machine work may be done on a lathe of 8 in. swing or even smaller. If the builder can make his own pattern (only three or four are required) the total cost of materials will be $2.00 or $3.00. Directions for making the patterns are given and are such as to enable anyone who is fairly skilled in woodworking to obtain castings at a nominal price.



75 WATT BIPOLAR DYNAMO
WITH WROUGHT IRON FIELD MAGNET
DESIGNED BY WCH DRAWN BY GCS

PATTERNS

The base pattern needs no special description. A piece of white pine 1¼ in. x 2 in. and about 10 in. long is required. The extra length is to make it easy to hold in the vise while carving to shape. When nearly done it is cut to length and the cut end finished up.

In carving it to shape it is best to begin with the hollow on the lower side. The sides may then be cut to the proper curve, making the upper part nearly perpendicular, with only enough slant for proper draft. The top curve is then laid out and cut to shape and the ⅛ depression carved out. Then form the ends and lastly cut the lugs at each end to correct shape. The holes are not provided in the pattern as they are small and are best drilled. No allowances need be made for machining.

BEARING PATTERNS

Only the pattern for the commutator end will be described as that for the pulley end is exactly the same except the bosses for the brush-holders, and a little difference in the dimensions. Get a piece of white pine at least 2½ in. thick and large enough to make three 6 in. discs or octagons. Fasten one of these by rather short and thick screws through the face plate of lathe.

Make two templates, pieces of thin wood or heavy cardboard cut to the shape of the pattern, one fitting the inside and one the outside as shown in the sectional drawing.

Turn out the inside of the "hat" which forms the foundation of the pattern, using the template and checking the same by measuring carefully from time to time as the work proceeds. The core-print in the centre should not be turned from the solid, but a small hole, say ⅜ in. diameter, should be bored, in which a separately turned print may be glued. Dimension given in the detail (pattern) drawing should be followed, all necessary allowances for finish having been made. When the inside is finished, including the shoulder and flange, the block is taken from the face-plate and chucked by the shoulder in a shallow recess turned in a second block. Great care should be taken to see that it runs true and is firm in the chuck. The outside is then turned by template and measurement as per drawing. The outside core-print is inserted the same as the inside one. The four "windows" are now carefully laid out, a hole bored in the centre of each and the bulk of the waste material sawed out with a coping saw, after which they are cut to the lines with a sharp knife. The parting of the mould will be on the inner edge of the arms and the draft should be made accordingly.

Next turn cylindrical plugs for the oil cups and also for brush-holder bosses on commutator end. These should be set into holes bored in the bearings and glued fast. The whole pattern should be well filleted, as there are many corners around the bosses which would cause the sand to break and give a rough casting.

Sandpaper the pattern and give a coat of orange shellac all over. When shellac is thoroughly dry, sandpaper again, using very fine paper to take off the rough surface where the shellac has raised the grain of the wood. The second coat may then be put on, using black shellac for the pattern proper and orange for the core-prints. A third coat may be put on after the second is dry. The patterns are then ready to go to the foundry. No core box will be required as the foundry will supply ordinary straight round cores.

THE FIELD MAGNET

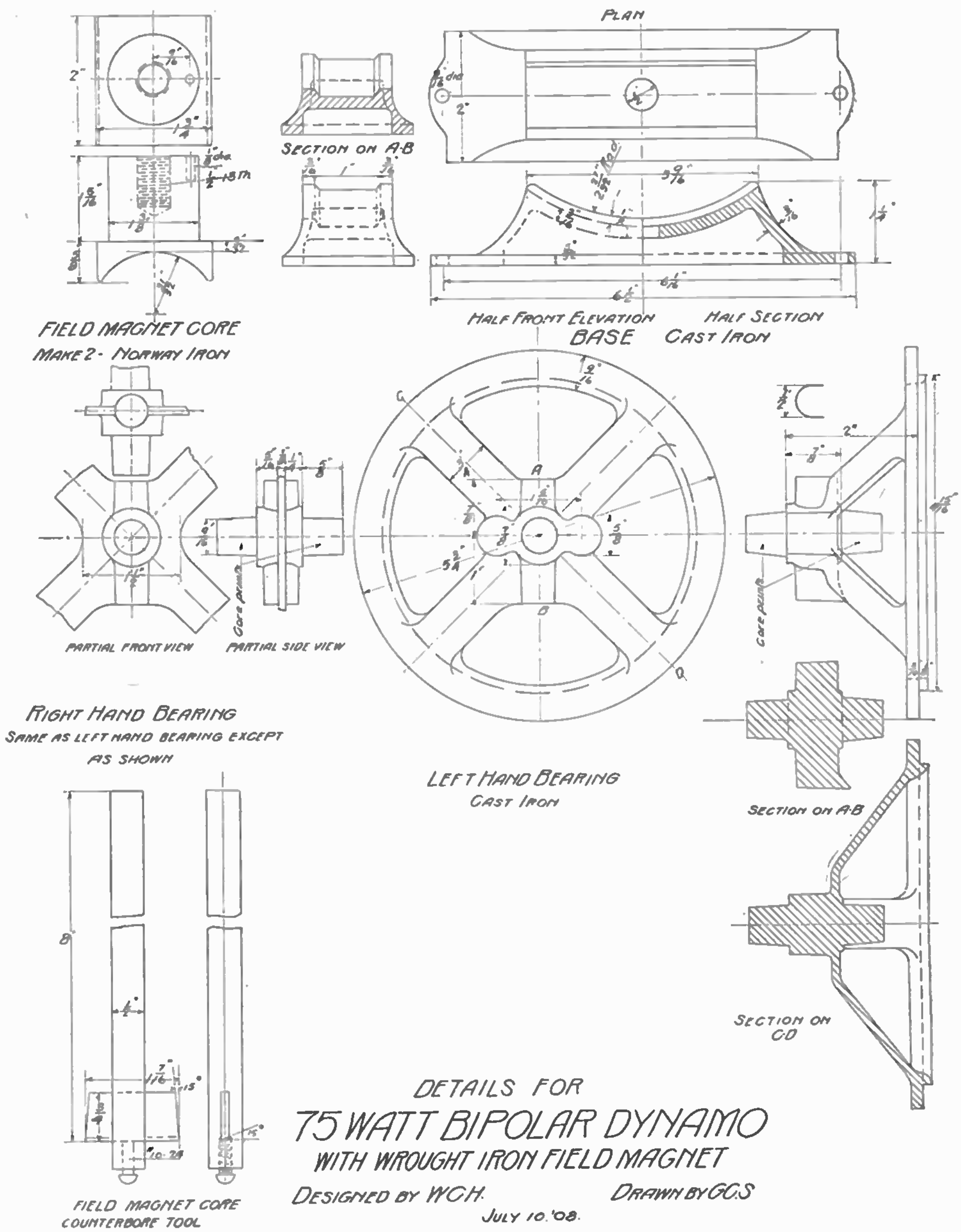
For the field magnet a piece of extra heavy 5 in. wrought iron pipe 2 in. long and a piece of Norway iron bar 1¾ in. x 2 in. and 4 in. long will be needed. Rough forgings of the pole pieces may be made if desired, but it is easier to machine them from the bar. The bar may be held in a chuck if a large one is available, or worked between centres. The ends should first be squared up, giving particular attention to getting them true and smooth. The cores may then be turned to 1⅜ in. diameter and each 1$\frac{5}{16}$ in. long. Next drill a $\frac{13}{32}$ in. hole 1 in. deep in each end and tap out ½ in. by 13 threads for standard cap screw. The two core pieces are then sawed apart, or a ½ in. and two ¼ in. holes may be drilled through the middle first. (Note that the holes are drilled the 2 in. way of the stock, not the 1¾ in.) They are then separated by sawing apart the remaining stock, and laid aside until the field ring is prepared.

FIELD RING

Hold the piece of 5 in. pipe in a chuck and turn off the front face true. Also bore the end to 5 in. diameter and 1/8 in. deep. (The pipe will be a little less than 5 in. internal diameter.) Reverse and turn other end in the same way, leaving the width of the ring (length of pipe) 1¾ in. If no chuck sufficiently large is at hand this job may be done by fastening a block of wood to the face plate and turning down till the field ring can be forced on it.

Four points are next laid out, spaced equally around the middle circumference of the ring and holes for field magnet bolts and binding posts drilled ½ in. and ¼ in. respectively.

Next comes the job of counterboring for the seats of the field magnets on the



inside of the ring. This will require a special tool as shown in lower left-hand corner of detail sheet. It is made of a piece of ½ in. cold rolled steel with a slot drilled and filed through near the lower end in which a hardened steel cutter 1⁷⁄₁₆ in. long is inserted and fastened with a set screw. If there are no facilities for hardening tools at hand, a good cutter may be made from a thin file ground to shape on an emery wheel. It must then be drawn to a pale yellow temper, which may be done by laying it on the top of the stove, watching closely until the color begins to show. Put the shank of the counterbore in chuck of drill-press or lathe, slip on the field ring, then insert cutter and fasten with set-screw. Start counterbore, feeding very slowly, otherwise it will catch and break. Counterbore barely to a flat surface. Care should be taken to have the blade set squarely and the two ends even. If the counterbores are not flat the magnet cores will not make a good joint. Take out blade, reverse ring and counterbore second hole.

The base of the machine should now be taken in hand. The casting should be snagged and the bottom filed or planed flat. The curved top should also be filed enough to make the ring set firmly in place. The ½ in. hole in the centre and a ¼ in. one in each lug should then be laid out and drilled.

The field magnet frame may now be assembled, the base, ring and two cores being fastened together by two ½ in. x 1¼ in. cap screws. The cores are placed with the 2 in. dimension parallel with the axis of the cylinder. A ³⁄₁₆ in. hole is drilled through the ring and ⅜ in. into each magnet core and a soft iron dowel pin driven in to keep cores from turning. The whole frame is then mounted in the lathe chuck or bolted to face plate and the armature tunnel bored out to 1¹⁵⁄₁₆ in. diameter. The frame should be centred by the outside. The sharp edges of pole pieces should then be rounded off.

BEARINGS

The bearings may now be taken in hand. If the castings are good and true to size with a sharp shoulder, the flanges need not be turned.

A better job will be done, however, by turning up the faces of the flanges and turning and polishing the half-round bead edges. The ends of bearing bosses should be turned true in any case. This may be done by putting bearings on an arbor. ½ in. holes should be drilled in the centres of the bosses for brush-holders and a ⁵⁄₁₆ in. hole vertically through each oil reservoir. The lower end of this is later plugged. The four screw holes may next be laid out and drilled for No. 10-24 machine screw, round or fillister head. The bearing brackets are put in place, the screw holes spotted through, and tap holes drilled in field ring.

ARMATURE

Take a piece of ½ in. cold rolled steel, centre very carefully. Square up ends to length, 6¹⁄₁₆ in., and turn ends down to ⅜ in., the commutator end 1½ in. and the pulley end 1⅞ in. The finishing of shaft must not be attempted until armature is assembled. Thread both ends of the ½ in. portion for about ½ in. 20 threads. Prepare two nuts about ¼ in. thick and 1⅛ in. diameter tapped to match. Screw one nut on shaft and fasten upright in a vise. Place a fibre punching on shaft and then thin iron punchings enough to make 2 in. in length when pressed tightly together. The compressing should be done with the vise from time to time, as the discs are put on. No attempt should be made to draw them together with the nuts, these being used only to hold them in place. The teeth of the discs may be brought in line also by clamping each in the vise. A fibre punching is put on the top of the stack and the nut screwed down. The two holes shown, parallel to the shaft are for two ¹⁄₁₆ in. wire pins to hold the punchings and nut in place, but these are not absolutely necessary.

The machine will have a little better electrical properties if the discs are painted with thin japan before assembling. This also is not of vital importance.

The armature should now be put in the lathe and the nuts turned to flat conical shape shown in drawing and the shaft bearings finished as per drawing. The pulley end should be turned to a taper of 1/4 in. per foot and the bearings finished very smoothly.

BEARINGS

Wrap several turns of heavy paper around the armature and put it in place in the field magnet. Make four cardboard or fibre washers 1 in. in diameter with 5/16 in. hole. Slip one washer on each end of shaft and put on bearing brackets screwing them in place. Slip on the other two washers, and put a short piece of 5/16 dowel rod or make a wooden plug to push into the lower end of oil hole, pushing it clear up to the shaft. Melt a little good babbitt metal ("Magnolia" is good) and pour into bearings. Remove brackets, drill out upper oil holes where the metal ran in, to 3/16 in. size. Ream out bearings 5/16 in. with fluted reamer or compress the metal with a polished steel arbor.

COMMUTATOR

Take a piece of hard fibre, preferably black, but red will do. Drill a 5/16 in. hole in the centre of a 1 7/8 in. square. Place on an arbor and with a pointed tool in the lathe turn a circle 1 5/16 in. diameter on one face. Set dividers to radius of this circle, 21/32 in. and divide in six parts. Divide each part in two and centre punch and drill twelve holes at these points. The size of these holes should be governed by the size of the shank of the copper rivets which are used for the commutator, a drive fit. The rivets should be 3/8 in. long and are of the kind known as "bung head," used by tinsmiths, and having thick heads about 3/8 in. diameter. The ordinary kind used by harness makers will not serve the purpose. Counterbore the holes 1/4 in. diameter and 1/16 in. deep. Hold the rivets in a drill chuck by the shanks and turn down the heads to 1/4, using a sharp tool and rather high speed. Remove any burrs left on edges and press or drive rivets in holes in disc. The heads should be flush with surface.

BINDING POSTS

These are made of 1/2 in. brass rod. Round rod is used if the builder has a knurling tool for milling the edges, but if not, hexagon rod may be used. This makes a head that can easily be tightened with the fingers. The rod is held in a chuck, centered and drilled and tapped 10 x 24 in. threads, the four parts are then turned as shown, and cut off. The screws are brass, 1 1/4 in. long 24 thread round head machine. Two fibre washers and one brass washer are used on each screw. The shank of the screw is insulated by wrapping with a ribbon of tough paper to 1/4 diameter. Paper may be held in place by shellac.

PULLEY

The pulley shown is double flanged 1 7/8 in. diameter and 3/4 in. face with a groove, so that it may be used with either a flat or a round belt. If this is to be made of cast iron a simple pattern will be needed, but this will not require any description. The hole is reamed out with a pin reamer, but it should not be put in to full depth until it is tried on the shaft of the finished machine. A few taps with a light hammer will fasten it very securely and it will run perfectly true if the work has been carefully done.

The winding and assembling of the machine will be the subject of the next article.

At first thought, one might be inclined to consider it incongruous to use an electrical vehicle as a hearse, but as a matter of fact the electrical hearse, moving with stately silence, is really more dignified than one drawn by horses. Such a hearse was recently constructed for a Chicago firm, and has been in continuous service ever since. Power is communicated from the motor to the rear wheels by means of silent chain drive. The battery is supported under the main body of the vehicle in a compartment between the front and rear wheels, and is adapted to furnish sufficient current to propel the hearse for a distance of 50 miles.

In a paper recently read before the Western Society of Civil Engineers, the bridge engineer of the C.B. & Q. Railway advocated the substitution of concrete for wood in railroad trestles, the construction consisting of concrete piles, capped with reinforced concrete stringers and overlaid with a floor of concrete slabs. When using machine-moulded concrete piles, structures of this character have been built up to a length of 250 ft. at a cost of from $20 to $25 per lineal foot.

FLIGHT

THE PRACTICE AND THEORY OF AVIATION—Part II*

GROVER CLEVELAND LOENING, A.M.

The Present Successful Types of Aeroplanes

Part A.—Description of the Most Prominent Types—(*Continued*)

2. THE CODY BIPLANE

Col. Cody, an American, who has for some time resided in England, distinguished himself several years ago as the successful operator of man-lifting kites. His work in this line, with regard to army use and scouting, attracted much attention in England. In 1907, Col. Cody commenced work on a motor aeroplane of huge dimensions. At first the tests of this machine were very unsuccessful, but with remarkable perseverance Col. Cody gradually turned the failures into successes, and finally in the late summer of 1909 he accomplished a superb flight of over an hour, establishing the cross-country record of the world. The machine has been altered many times, and in its present form is the largest successful aeroplane in use today.

The Frame.—Bamboo is used extensively throughout the frame, but all joints are carefully wound with steel wire. In addition there are many upright members of ash. At the centre several members meet in the supporting chassis, which is very heavily built. Steel wire is used for bracing.

Supporting Planes.—The main planes are rectangular in shape with rounded rear edges and are identical and directly superposed. The surfaces are made of canvas stretched tightly over wooden ribs. At the centre the distance between them is 9 ft., but they converge toward either end, and are there separated by only 8 ft. The spread is 52 ft., the depth 7.5 ft., and the area 780 sq. ft.

The Elevation Rudder.—At the front of the machine, supported by large bamboo outriggers from the central cell, are two equal surfaces on either side of the centre. These are jointly movable, and serve to control the elevation of the machine. They are governed by the forward or back motion of the stanchion upon which the steering wheel is mounted. If the aviator wishes to rise he pulls the wheel toward him. This motion, by means of a lever system, causes the elevation rudder surfaces to be tilted up to the line of flight and the machine ascends.

The Direction Rudder.—For steering to one side or the other two surfaces are used. At the rear of the machine is a large vertical surface, which is the main direction rudder, while at the front is a smaller vertical surface used for the same purpose. These rudders are moved jointly by a cable and steering wheel, as in automobiles or motor boats. Their area is about 40 sq. ft.

Transverse Control.—Two balancing planes of 30 sq. ft. area, one placed at either end of the main cell, control the transverse inclination of the machine. They are moved inversely by cables leading from the steering gear at command of the aviator. If the right end of the machine should be depressed, then the wing tip on that side is turned down, but at the same time the wing tip on the other end is turned up. This causes not only the depressed side to rise, but also the raised side to be depressed, thus righting the machine. When making turns the machine can be artificially inclined with this apparatus. In addition to the wing tips, the transverse equilibrium can be controlled by the inverse movement of the two halves of the elevation rudder, the one on the

*Accepted as thesis for the degree of A.M., Columbia University, June, 1910.

depressed side being elevated while the other is turned down.

Keels.—There are no keels in this machine, all surfaces serving either to lift or to direct the aeroplane.

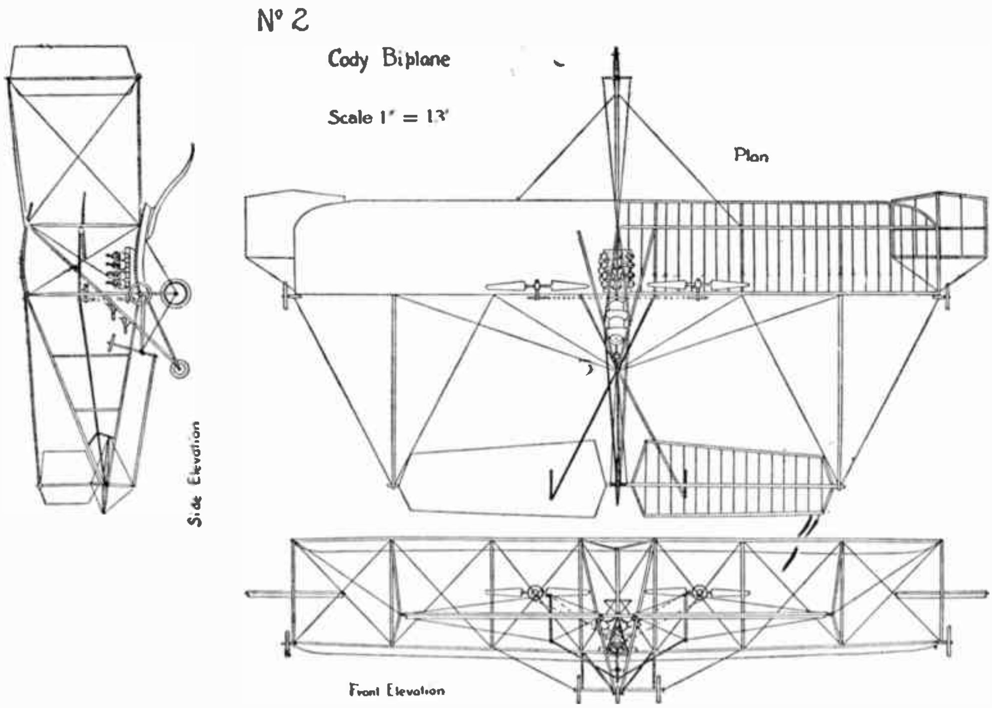
Propulsion.—The motive power is an 80 h.p. E.N.V. 8 cyl. motor. Two two-bladed propellers placed at the front of the main cell are driven in opposite directions by chains at 600 revolutions per minute. Their diameter equals 8.25 ft., and their pitch 6 ft.

The Seats for aviator and one passenger are placed low at the centre in front of the main cell. The lower seat is for the aviator, while the other was designed for the use of an observer in war time to take sketches of the enemy's position, etc.

The Mounting consists of a large pair of wheels, which carry most of the weight, a small wheel in front of them, and a skid in the rear. Wheels are also fixed on each end of the lower plane to carry the machine easily over the ground if it should alight on one end.

The total weight is from 1,900 to 2,100 lbs.; the speed, 37 miles per hour; 25 lbs. are lifted per h.p., and 2.57 lbs. per sq. ft. of surface. The aspect ratio is 7 to 1.

Recent Alterations.—Col. Cody has recently altered his biplane. The E.N.V motor has been replaced by two 50 h.p. 4 cyl. Green motors, both driving a single propeller instead of the twin propellers formerly used. Either motor can be operated individually, the main advantage of this disposition being that if one motor breaks down while in flight, the other can still be used to drive the machine.

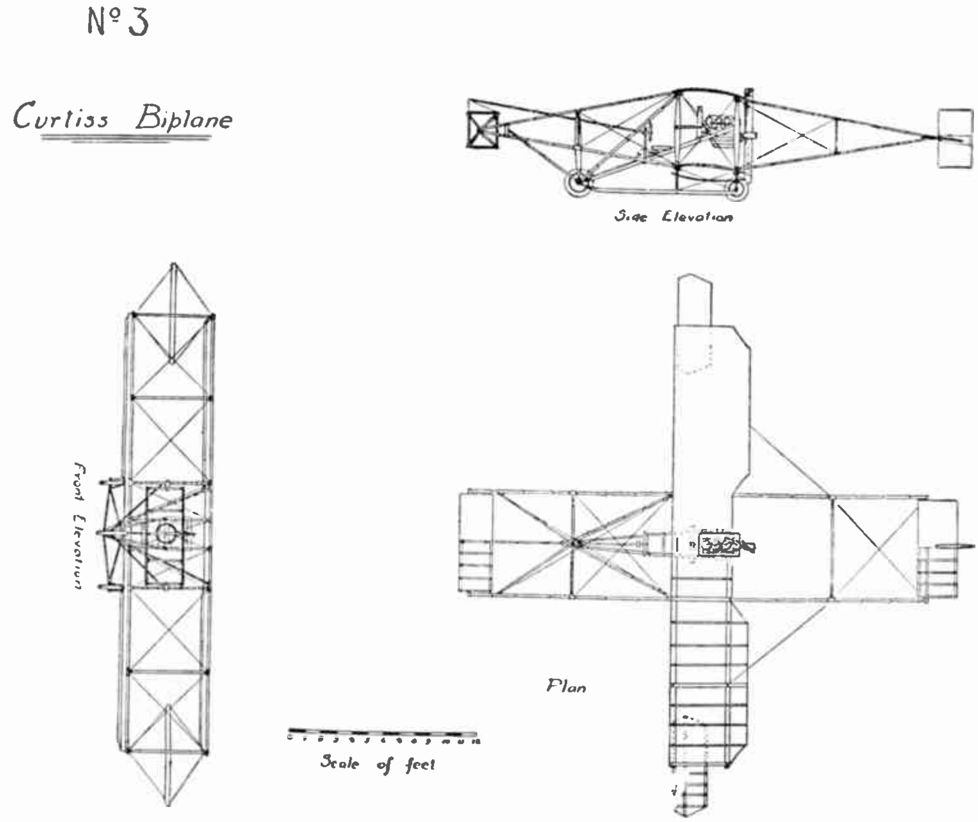


3. THE CURTISS BIPLANE

The Curtiss biplane, manufactured by the Herring-Curtiss Company, embodies in its construction several features that distinguish the aeroplanes built by the Aerial Experiment Association, of which Mr. Curtiss was a member. In June, 1909, the first flight of this type was made. At Rheims, in August, this miniature biplane, ably piloted by Mr. Curtiss, captured the Gordon Bennett Prize and Cup as well as several others. It is one of the fastest biplanes now in use. Several machines of this type are being flown, notably by Messrs. Curtiss, Mars, Hamilton, Willard, McCurdy, Ely, Post and Baldwin.

The Frame.—The main cell and smaller parts are made of ash and spruce, and the large outriggers of bamboo. Several members of the frame meet at the front wheel. Small cables as well as wires are used for bracing.

The Supporting Planes.—The main carrying planes are of very finished construction. They consist of two identical directly superposed surfaces made of one layer of Baldwin rubber silk, tacked to spruce ribs and laced to the frame. A distance of 5 ft. separates the surfaces. Their spread is 26.42 ft., the depth 4.5 ft., and the area 220 sq. ft.



The Elevation Rudder.—The elevation rudder is a small biplane cell consisting of two identical surfaces, 24 sq. ft. in area, mounted at the front on bamboo outriggers. It is governed by a long bamboo rod attached to the stanchion on which the steering wheel is mounted. By pushing out on this, the rudder is turned down and the machine descends. By pulling in, the machine is caused to ascend.

The Direction Rudder.—The rudder for steering from right to left consists of a single vertical surface placed in the rear and operated by the steering wheel and cables, which are run inside the bamboo outrigger. Its area is 6.6 sq. ft.

Transverse Control.—Two balancing planes of 12 sq. ft. area each, one placed at either end of the main cell, are used to preserve lateral balance. They are tipped inversely by means of a brace fitted to and swayed by the aviator's body. If the machine is depressed on the left side, the aviator leans toward the right, and in so doing moves the brace, causing the wing tip on the left side to be turned down and the one on the right to be turned up, thus righting the machine. By "turning down" is here meant a motion relative to the axis of the wing tip itself and not to the line of flight. When a wing tip of this sort is turned down, its incidence, *i.e.*, the angle it makes with the line of flight, is positive and it therefore exerts a greater lifting force.

When making a turn to the right, for example, the aviator, by leaning to the right, and thus causing the left end to lift up, can make a sharper turn than by use of the direction rudder alone.

Keels.—A horizontal fixed surface is placed in the rear and steadies the machine greatly. Its area is 15 sq. ft. A small triangular vertical surface is sometimes placed in front and aids in turning.

Propulsion.—A 25 h.p. 4 cyl. Curtiss motor, placed well up between the two surfaces at the rear, drives direct a two-bladed wooden propeller at 1,200 revolutions per minute. The propeller has a pitch of 5 ft. and a diameter of 6 ft.

The Seat for the aviator is on the framing in front of the main cell and in line with the motor. When a passenger is carried a seat is provided to the side and somewhat below the aviator.

The Mounting is on three rubber-tired wheels, rigidly fixed to the frame, no springs being provided.

The total weight is from 530 to 570 lbs., and the speed is 47 miles per hour; 22 lbs. are lifted per h.p. and 2.5 lbs. per sq. ft. of surface. The aspect ratio is 5.65 to 1.

Recent Alterations.—Mr. Willard has recently begun flying a larger type of Curtiss biplane, in which he has succeeded in carrying three passengers besides himself.

This machine is precisely of the same general design as the regular Curtiss type, but differs from it in size.

The supporting planes have a spread of 32 ft., a depth of 5 ft., and an area of 316 sq. ft. The elevation rudder is 31 sq. ft. in area, and the direction rudder 7.5 sq. ft. in area. The rear horizontal keel has an area of 17.5 sq. ft., while the ailerons are each 27 sq. ft. in size. A Curtiss 8 cyl. 50 h.p. motor is used and drives direct a 7 ft. propeller at 1,100 revolutions per minute. The maximum total weight in flight is 1,150 lbs. 22.6 lbs. are carried per h.p., and 3.64 lbs. per sq. ft. of surface. The aspect ratio is 6.4 to 1.

—*Scientific American Supplement.*

(*To be continued*).

WHEN THE BIRDMEN SOAR

In the report of Professor Robert W. Willson, of Harvard, who had charge of the measurement of altitude attained by competitors in the Harvard-Boston aviation meet, to Charles J. Glidden, chairman of the contest committee, are interesting and valuable contributions to the science of aeronautics. Without time enough to make an inquiry into the experience acquired elsewhere, Professor Willson and his associates devised a method which not only was accurate, but by which, had it been desired, the altitude of the flyers could have been announced every few minutes. Two systems of measurement were used, and they checked each other almost exactly, demonstrating the accuracy of the measurements.

The first system for measuring the height for the aeroplanes when soaring for altitude consisted of two stations at either end of a 5,000 ft. base line running north and south, the centre of the line being about in the centre of the aviation field, where the aeroplanes started. The north and south direction was taken in order that the line of sight from each station might be as far as possible from the sun at that time of day when the conditions are favorable for flight. With this base line was established a vertical plane of reference, and the aeroplanes were observed when they passed through this plane.

At each end of the base line was an English made sextant reading to 10 seconds and selected from a number of similar instruments belonging to the Students' Astronomical Laboratory of Harvard, as having small corrections for eccentricity in no case greater than 30 seconds. These sextants were provided with extensions of both horizon glass and index glass for convenience in finding the aeroplanes and making an approximate setting with the naked eye as the time of transit approached, to facilitate accurate observation with the telescope at the critical moment. To show the carefulness with which the observations were made, Professor Willson stated that the point determined was, as nearly as possible, the centre of the aviators body, or when this was not distinctly visible, the estimated centre of the wings of the aeroplane.

Sextants were chosen because angles could be measured continuously up to and beyond the zenith without change of the position of the observer's eye. The sextant stations were connected by telephone and the telephone line passed through the central station adjoining the contest committee room on the aviation field. The recorder at each station immediately reported the measured angle to the central station, where a graphic table or chart was used to determine the altitude at once, and it would have been possible and was intended to announce the result within half a minute of each crossing the line. "It seemed best to the committee, however," says Professor Willson, "in view of the method of counting points for the award of prizes, to make no announcement of heights until the close of each day. In the absence of competition, as in an attempt to break the world's record, or an exhibition flight, such a close following of the flight would be of great interest to the spectators."

The other system of measuring the altitude and a check upon the first system, consisted of two stations on nearly an east and west base line of 6,236 ft. One station was at Forbes Hill, Quincy, 128 ft. above the centre of the aviation field, and the other was on the estate of Mrs. E. M. Carey in Milton, 71 ft. above the aviation field. From these stations the angle of elevation could be measured without an eyepiece prism up to an altitude of more than 15,000 at the centre of the field. The instruments used at these stations were a special theodolite magnifying thirty times and reading horizontal angles to 10 seconds and vertical angles to 20 seconds, and a mining transit reading both horizontal and vertical angles at 20 seconds. These stations were connected with each other and with the central station at aviation field by a telephone line. Regarding the observations Professor Willson says:

"It was thus possible to insure simultaneous observations at the two stations in both co-ordinates. That they were practically simultaneous is clearly shown by the complete discussion of the results. By the combination of the observations we were able to compute not only the altitude of the aeroplanes at intervals of about 45 seconds, in some cases 30 seconds, but also to locate their corresponding positions as projected vertically on the ground plane, and to plot so many points of the spiral both in ascent and descent as to form an interesting and useful record of all the details of the flight. It may here be remarked that the use of the last described method of observing seems perferable to any that requires the aviator to attain his maximum height in a given point of line. If thus restricted, the Bleriot monoplane especially is at a disadvantage, as its construction renders it extremely difficult for the operator to see the ground at points anywhere near directly beneath him. The discussion of his ascending spiral checked by observations of his descent fix his highest point quite accurately without placing any burden upon the aviator himself.

"At the central station on the field, with a head piece carrying at one ear the telephone of the sextant circuit, and at the other the telephone from the distant base, and with the two transmitters side by side in front of him, the chief operator, Professor G. W. Pierce, to whose skill much of our success is due, held command of the whole system, and with this complete control it was found possible to accomplish more than we had considered it necessary to provide for. It was not intended, for instance, to observe more than one flier at a time, but on one occasion, at the request of the committee the attempt was made. A biplane was assigned to the sextants while the distant base for a time observed a monoplane, the choice being determined by the fact that the biplane was crossing the field base at pretty regular intervals according to schedule, while the monoplane was describing a spiral of great extent far from the centre of the field.

"The great interest of the spectators in such a double flight leads me to suggest that in a repetition of this method, it might be well to have two complete stations at each end of the distant base, each measuring its own object. To avoid the difficulty of identification at times when the machines apparently approached or even crossed, it is not enough to have numbers or letters attached; each should carry a mark which may be distinguished by its shape, sphere, cube or cone."

Tables included in the report show in detail the observations of the flight of Brookins on September 12. The sextants gave a maximum altitude of 1,964 ft. by chart, 1,958 ft. by computation. The Quincy station showed a maximum altitude of 1,949 ft. and the Milton station a maximum of 1,955 ft.

Discussing the use of the baroscope for measuring altitude, Professor Willson says:

"As it seemed desirable to experiment on various lines, it was planned to send up with each aviator a bulb which should be closed by a stop-cock to be turned by him at the moment when he supposed himself to be at his greatest altitude. Such a bulb was kindly taken by Mr. J. B. Benton on his ascent in the 'Boston' from Lowell on August 30. The stop-cock was closed when his barograph read 7,200 ft., and his thermometer 58 degrees F. On September 1 the pressure in the bulb was measured at the Jefferson Physical Laboratory in the usual way by weighing the mercury drawn up under the reduced pressure, and the height of the balloon computed from this pressure and the temperature 58 degrees; the value thus obtained was 6,600 ft.

"It was evident that the successful application of this method would require more time for study than could be given, and on consultation with Professor W. C. Sabine and Professor H. N. Davis it was agreed that it was unwise to require of the operator any attention whatever at his highest point. The further investigation of this problem was undertaken by Professor Davis, who will report his conclusions later. One form of apparatus, while not to be trusted for an accurate value of the absolute height, served a useful purpose during the double flight of Brookins and Grahame-White on September 8. The observation of the former was assigned to the sextant base, and he reached the height of at least 3,835 ft.

"Both machines carried baroscopes of the same form, and a comparison of the two, immediately after the descent, showed the height reached by Grahame-White was about 350 ft. less. He was therefore credited with 3,500 ft. The transits were fully occupied with the flight of Brookins and without the baroscope observation it would have been difficult or impossible to determine the relative heights, as the Bleriot was so far off the course that it could not be observed with the sextants."

The results of the measures taken by Professor Willson and his assistants, upon which the final award of prizes was made, are as follows:

Date.	Name.	Points.	Provisional Height.	Revised.
Sept. 7	Grahame-White	3	3440	3275
	Johnstone	2	2875	2834
	Brookins	1	2670	2668
Sept. 8	Brookins	3	3860	3835
	Grahame-White	2	3500	3500
Sept. 9	Brookins	3	105	135
Sept. 10	Brookins	3	4732	4723
	Grahame-White	2	1919	1917
Sept. 12	Grahame-White	3	2120	2126
	Brookins	2	1963	1957
Sept. 13	Brookins	3	725	.....
	Grahame-White	2	180	.....

Total—
Brookins........ 1 3 3 3 2 3—15
Grahame-White........ 3 2 2 3 2—12
Johnstone........ 2

Robert Loraine, the actor airman, has been taking part in experiments in transmitting wireless messages from an aeroplane in flight, to the ground. Mr. Loraine used a Farman biplane and the transmitting apparatus was designed specially by Thorne Baker. The portable transmitter, weighing less than 14 lbs., was attached to the passenger seat and aerial wires were stretched along the length and breadth of the aeroplane. The Morse key for tapping out the messages was fixed at the airman's left hand.

The receiving station on the ground consisted of improvised masts with aerial wires stretched across, parallel to the ground, but in different directions. The Marconi electro-magnetic detector, with a head-piece and telephones, used to pick up the signals, was linked up with two sets of aerials, one pair of which could always present itself broadside on to the aeroplane.

Wireless communication was thus maintained with the airman up to nearly a mile from the receiving station. A member of the Marconi staff who witnessed the experiments expressed the opinion that with a tuned Marconi receiver communication should be easy with the present transmitter up to ten or twenty or perhaps fifty miles.

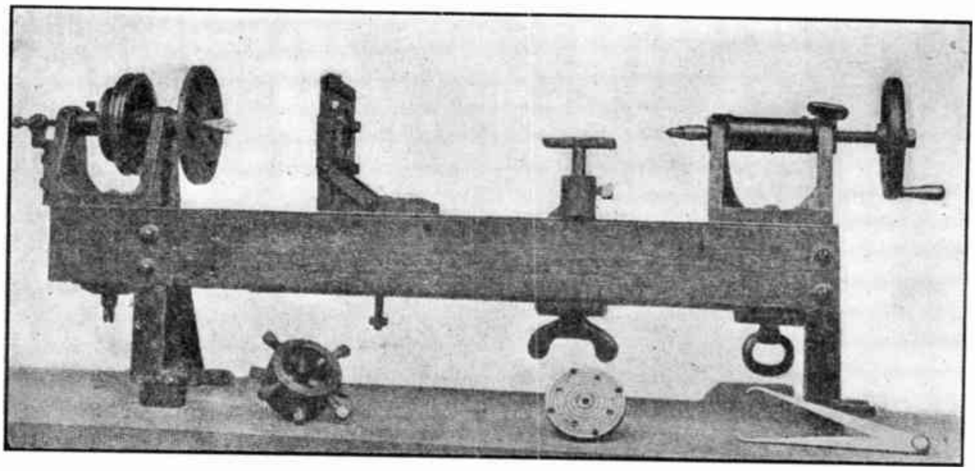
THE WORKSHOP

HOME-MADE LATHE

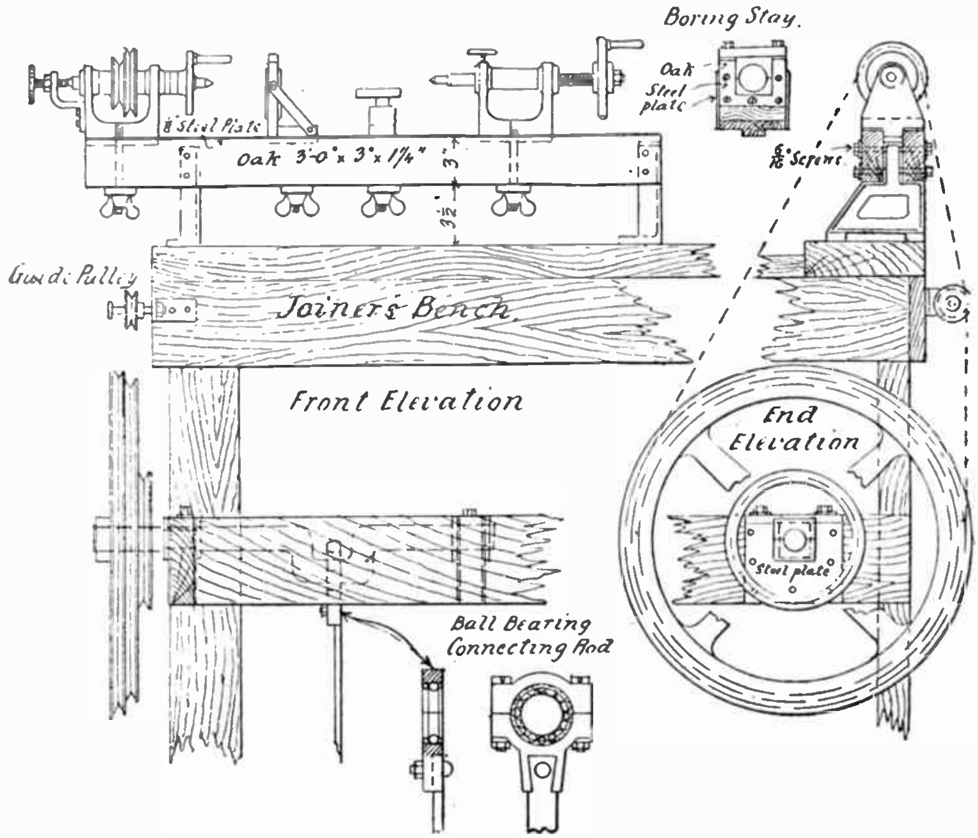
J. H. POLLARD

The lathe is such an all-important item in an amateur's workshop that a short account of a home-made one, which has proven a complete success, may prove of interest to our fellow-readers.

The sketches herewith illustrate a simply-made lathe of 3½ in. centres, which I have just completed, and the making of which has afforded me probably quite as much pleasure and interest as I shall ever get from anything which I may turn on it. Such a tool will present little difficulty in the making to any amateur who has any knowledge of tool-using. Having long had a desire to possess a lathe, but having no room at my disposal for anything larger than one that might be placed on a joiner's bench, I decided on one of this type, arranging the flywheel and crankshaft on suitable stretchers, which form part of the underframe of bench. The general arrangement is shown in sketch.



I commenced by making wood patterns of such castings as I should require, *i.e.*, the headstocks (one pattern does for both), bracket to carry lathe-bed on bench, faceplate, catchplate, and hand-rest. These were cast for me at a local foundry. The bed is made from two pieces of dry oak, 36 in. long by 3 in. by 1¼ in. These are secured to the foot brackets by 5/16 in. screws, as shown. The top and bottom of oak bars are faced with steel plates, 1¼ in. by ⅛ in., fastened down every 3 in. by wood screws, then filed up smooth. The flywheel, crankshaft, and brasses were the only parts I bought ready-made, as I had no facilities for making these at home. The wheel is 22 in. diameter, has three grooves, and is turned all over. I have balanced it by attaching weight to spokes so that the crank is always at half-throw, ready to start work. It is secured to crankshaft by ⅜ in. setscrew. The shaft is 1⅜ in. diameter by 2 ft. 6 in. long, turned all over, and is about 2½ in. throw. It has a semi-circular groove turned in centre of crank-pin, evidently to suit a connecting-rod of round section; but instead of using a rod of this type with the ordinary hook end, it struck me I could make a much better job with very little trouble. I had an old brass eccentric strap, about ½ in. larger in internal diameter than the bottom of groove in crank-pin. By sweating a ring of thick brass wire into each side of hole in strap, it is at once converted into a very efficient ball-bearing race. It takes 17 steel balls, ¼ in. diameter, and runs with next to no effort at all. I was much puzzled at first how to get the balls into their place. They went into the bottom half of the strap easily enough, but I was unable to make a hole in the top half sufficiently large to admit them, the strap being too weak. I solved the difficulty by simply fixing them into a thin steel plate, cut out to admit brass, being screwed on each side of stretcher. The shaft was bedded into place with red lead and scraper, and runs very freely. The belt I use is ⅜ in. round leather, the ends being secured by plain steel wire hook. I find this is quite efficient, and I can take a heavy cut in steel without any slip. The treadle motion is made entirely of flat wood battens, the rocking bars being simply attached to back stretcher of bench by means of two long door hinges. The arrangement is perhaps crude, but it answers its purpose very well, and that is the main thing.



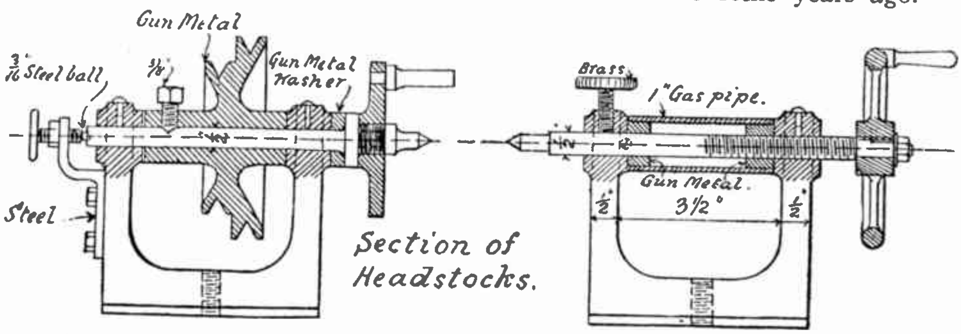
the top half by plastering them thickly round with tallow. I could then invert the whole without their dropping out, and the thing was done at once. I have since found that the brass strap wears too rapidly, and I have turned one out of steel and properly case-hardened it.

The crankshaft brasses were fitted into recesses cut in stretchers of bench;

I next tackled the headstocks, and had more labor and trouble with these than all the rest put together, as nothing less than very accurate work is admissible here. I had two pointed rods of ½ in. bright silver steel, which I proposed to use for temporary mandrel and back centre, while I turned a proper mandrel. I first got a ½ in. bore hole drilled through bosses of both headstocks. This was done outside, as lack of suitable means prevented my doing it at home, a ⅜ in. hole also being drilled through base for clamping bolts. The headstocks were then placed on bed, clamped firmly down, and a ½ in. reamer passed right through all four holes at once, thus ensuring exact alignment of spindles. The latter were ground into place with washed pumice powder and water, and ran true without shake. A temporary single-speed wood pulley was secured on to mandrel by setscrew put through an iron collar driven on to boss of pulley, and a small catch plate drilled and secured on to end of mandrel by setscrew.

The hand-rest, of ordinary pattern, which requires no description, was now put together, and the whole machine

I now commenced turning, and made first of all a wood pattern of two-speed pulley, in sycamore. This I had cast in gunmetal. It has a long boss at back end, and nearly fills up the space between faces of headstock. I first turned both ends of boss parallel, and then bored a ¼ in. hole right through, supporting the end being bored by means of a boring stay made of oak and fitted with loose oak blocks (see sketch), the stay being bolted down to lathe bed, the necessary hand-feed being given to back centre by means of a loose boring head of oak, fitted with long ½ in. screw put through a long gunmetal sleeve fastened to head with wood screws. All these details were made from scrap I had by me, all necessary holes being drilled where possible with the drilling machine I made some years ago.



Section of Headstocks.

was sufficiently like a lathe to enable me to start turning a proper mandrel with its pulley. The back centre, I should say, was screwed for half its length, and let through a barrel of 1 in. gas pipe, the ends of which were plugged with gunmetal, one end being tapped to fit the screw of mandrel. The barrel was prevented from rotating by means of a ¼ in. grub screw, let half into barrel and half into facing of headstock, a clamping screw of gunmetal and handwheel for spindle being also fitted. These latter I had by me. I should mention that before fitting the barrel, I had previously trued up all the eight faces of both headstock bosses, by means of a flat steel cutter put through a dovetailed slot in a small cast-iron boss, which was secured on to end of loose spindle, which had been originally turned down to ⅜ in. diameter. This I worked slowly with a brace until all the faces were true and flat.

I next opened out the hole through pulley with a ½ in. twist drill, and this proved a tough job. The lathe would not drill the hole at all, even with very slow speed, the drill having far too keen a cut. I therefore threw the belt off and worked pulley round towards me with the left hand, holding drill up by a hand-vise and feeding by hand. I managed eventually to get it done, and, putting the reamer through, found the hole true.

I now set to work on the mandrel, and this proved a long job, as I meant making it a good one. I had a forging made in mild steel, which I first annealed well, and found to work easily. I may here say that I was very careful to make my tools with correct shape and angles. They were made at home, from 5/16 in. square tool steel of high grade, carefully filed to shape, then made nearly dead hard and set on an oilstone. By careful usage I have had no trouble at all with edges cracking or splintering. These points are most important and quite worth all the time and trouble they take up. The mandrel is ½ in. diameter in the body, with collar 1¼ in. diameter by 3/16 in. thick, and ⅝ in. screwed nose, bored and tapped 5/16 in. to suit loose centres. After turning and polishing mandrel, which took a long time, I ground it into its place with pumice powder, as with the first one. The front bearing is slightly taper, and collar does not quite come up to face of headstock boss. A steel bracket is screwed into back of fast head and fitted with hardened steel tail screw, the point of which bears on a ¼ in. steel bicycle ball recessed half into a hole drilled in back end of mandrel. This I find very easy to adjust, and the mandrel runs true and easy, without any shake. I have also fitted a 6 in. faceplate of cast iron. This proved a very tedious job, as the centre hole was so badly tapped that the plate ran one-eighth out of true on the face. All this had to be turned off, and took a very long time to do. The slots in plate were not cast right through, enough metal being left to enable plate to be turned quite flat and true. The slots were then drilled and filed out, steel dogs, with 5/16 in. screws, being afterwards fitted.

The whole apparatus has proved a a most satisfactory job, and I have done a lot of turning in steel with it since its completion. It is constructed throughout of the simplest and cheapest material and various odds and ends, but has turned out a thoroughly good tool. It is light, and yet quite rigid, and I have had no trouble with "chatter" marks, as I had anticipated. It has occupied in making about five months of my spare time in the evenings.—*The Model Engineer*.

HOW TO MAKE A SMALL FORGE OUTFIT

W. S. FARREN

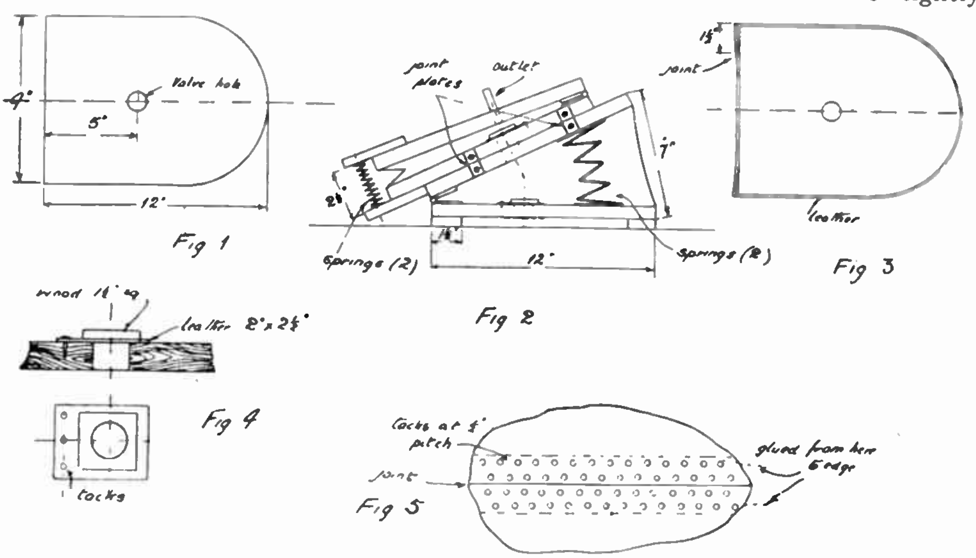
The following article describes the construction of a handy forge outfit for use with coal gas. It has been found capable of forging and brazing up to ½ in. square iron—and larger, at a pinch. The cost of the various items is given to show how cheaply it can be made, even if everything has to be bought. As a matter of fact, it cost the writer considerably less, as much of the material was at hand, and some was begged from a friendly bicycle maker. The various parts of the outfit will be dealt with in order.

BELLOWS

First make a cardboard template to dimensions shown in Fig. 1, and from it mark out, on a piece of ¾ in. planed board, four pieces. These must now be cut out with a bow-saw, and finished in pairs with a spokeshave. Mark a centre line on each board. For the pump (the lower part of the bellows) take one pair and bore a 1 in. hole in each board 5 in. from the back edge. Fix them together with 1½ in. square iron hinges, centre lines outwards, taking care that they come together properly. Next, wedge them apart to the distance marked (7 in.), and take a piece of brown paper 7 in. by 40 in., with centre lines marked on it. Tack it on the middle, so that the transverse centre line registers with those marked on the boards, and stretch it round, letting it overlap 1 in. at the back. There must be no cockles in this, if a neat result is desired. The longitudinal centre line should pass through the hinge line, if it is fixed on properly. Cut down the paper level with the wood, and remove. This is a pattern for the leather which, together with the springs, may now be procured. The kind to ask for is "basil" leather, and it will probably be found that the piece cannot be got out in one.. If so, make it stretch from 1½ in. beyond one corner to 1½ in. beyond the other, as shown in Fig. 3. A separate piece will then be required for the back. Enough leather must be bought for the two bellows, and some to spare, for valves, etc. The springs (two) are ordinary 7 in. furniture springs, procurable from any furnishing ironmonger's for about ten cents each. The next job is to make the valve, Fig. 4, which is made of a rectangular piece of leather tacked down along one edge, with a piece of wood glued on top, to make it return more readily to its seating. Then fix in the two springs with staples, keeping them clear of the valve and the edges of the bellows. Note that both springs fit into one pair of bellows—namely, the pump.

We now come to the fixing of the leather. First, cut it out, ¼ in. wider all round than the pattern. Mark centre lines from the pattern, and fix in lightly with two tacks in the centre, compressing the bellows to the necessary amount and binding right round with cord (or, better, tape, to protect the leather), to take tension off the leather until it is more firmly fixed. Then stretch the leather round to the corners, and see in the inner rows (Fig. 5). The piece along the back can now be fixed in a similar manner. The joints should overlap at least 1 in., and should be fixed with glue and tacks right through both pieces of leather.

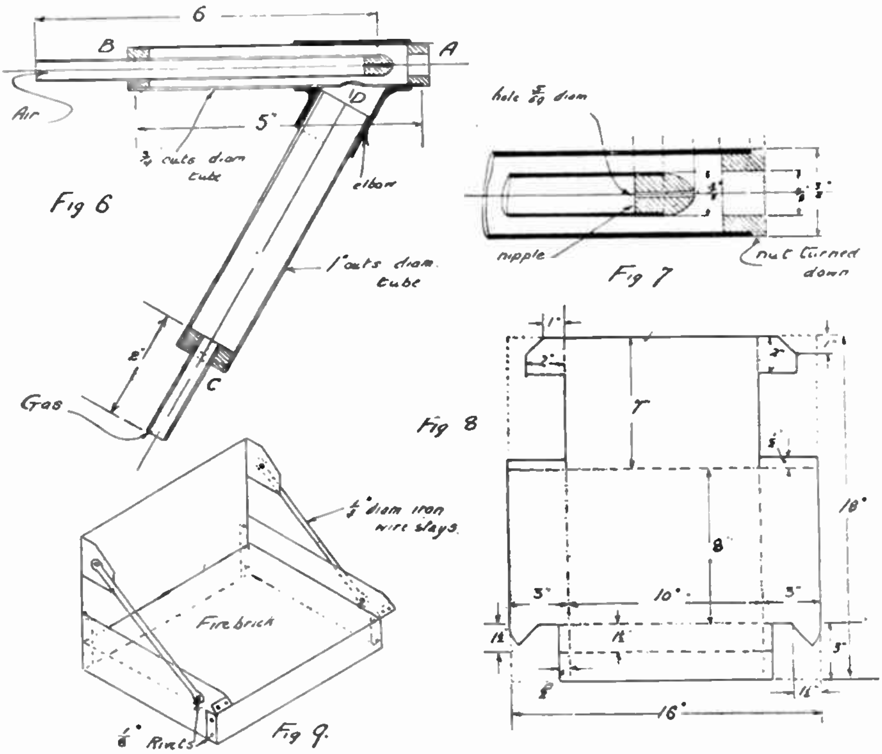
The other bellows, for the reservoir (the upper pair), are exactly similar, with two exceptions. Firstly, the top board has only a ⅜ in. hole in it (for the outlet pipe); and secondly, the springs are differently arranged. Care must be taken that the boards of this pair are at full opening when the leather is fixed, or the result will be puckers in the bellows. Next, prepare four pieces of brass 1½ in. by ½ in., as shown in Fig. 2, for fixing the pump to the reservoir. The two must be tightly



Details of Construction of Bellows.

that it is central and square in every way. Fix with two tacks at each corner. It may now be permanently attached, first making sure that the valve beds down properly, as this cannot be altered afterwards. If the valve leather is not flat, a little judicious stretching will right matters. A row of ½ in. tacks at ½ in. pitch may be put in first, on the *inside* edge of the boards. Then take off the binding string, turn the leather away from the wood, and glue with good thin glue. Press down firmly and put in another row of tacks, near the *outside* edges, and opposite the intervals between those clamped together, with the clear hole in the pump registering with the valve of the reservoir, and holes bored for screws for fixing on the brass strips. Then screw on these, to see if they fit properly, and draw the bellows together tightly. One screw may now be taken out of each piece, and a leather washer glued round the valve hole of the reservoir (on the outside, of course). Then glue the outside of this washer and round the outlet-hole of the pump, and screw together again. If, on testing, air leaks through this joint, it must be broken, and two washers put in instead.

On the underside of the pump fix



SHOWING CONSTRUCTION OF THE BLOWPIPE; AND THE SHEET-IRON HEARTH

three feet, ½ in. thick by 1½ in. square, and over the inlet valve put a piece of copper gauze, to keep out dust, etc. To compress the reservoir, two strong springs, 2½ in. long by ¾ in. diameter, are needed. They may be procured from any ironmonger. These are to be fixed on as shown in the drawings (Fig. 2). A piece of ⅜ in. brass gas pipe, glued in the outlet hole of the reservoir, completes the bellows.

The approximate cost is as follows: leather, $1.00; wood, 30 cents; springs, 50 cents; tacks and hinges, 25 cents.

BLOWPIPE

The blowpipe was constructed from an old saddlepin, which was given to the writer by a friend. The general design is plainly shown in Figs. 6 and 7. The ends of the tube *AB* are plugged up with hexagon nuts ⅜ in. diameter; these should be bored out to ⅜ in. and turned down, all but ⅛ in., to ⅝ in. diameter, to fit in the tube. A nipple must be made for the air tube to fit tightly in a piece of ⅜ in. brass gas tube, 6 in. long. Its dimensions are given in Fig. 7. This tube should now be soldered in the nut *B*, so that the end of the nipple is ¼ in. from nut *A*. Then solder in the two nuts, taking care to get the nipple central with the hole in *A*. The gas enters at *C*, which is plugged up with a piece of scrap brass, a piece of ⅜ in. pipe being soldered in for the connection. If the tube *AB* goes right through the elbow-piece, then a hole, *D*, must be punched in it, to allow the gas to go through. This blowpipe has, of course, to stand a fair amount of heat, and it would be advisable to braze in the nut *A*, if possible. In some saddlepins the end *A* is already stopped up. This is, of course, more convenient and neater. Care must be taken, in this case, in getting the hole for the flame quite central. As a matter of fact, this blowpipe has been used on a large number of jobs, some up to its full capacity, without any signs of coming to pieces. At any rate, the plugs must be a tight fit in their tubes, especially the nipple. With this simple apparatus a very powerful flame 11 in.

long, or a fine one 2 in. long, can be obtained with ease by a simple regulation of the gas. The air is best regulated by the pedalling.

A word on soldering these steel tubes: the writer uses Fluxite for most soldering; but has found it rather troublesome for tinning this kind of steel tubing. Killed spirits, or zinc chloride (under the name of "Solderine"), was used in this case with great success. The application of a little on a piece of brass wire, when the work is hot, cleans the metal bright, and the solder runs at once. With Fluxite the addition of more seems only to make matters worse. A sooty covering forms, even with an absolutely smokeless flame, and has to be scraped off before anything can be done. Perhaps some reader can indicate what precaution has been neglected. The writer has used Fluxite with great success ever since it came out; but in this job, and in another similar one, it failed.

A hook should be soldered on the gas tube, to hang the blowpipe up by when not in use.

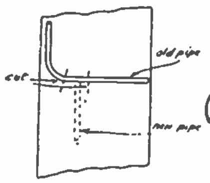
The outside cost of this blowpipe would be: saddlepin, 25 cents; three nuts, 15 cents; brass tube, 15 cents.

FORGE

For this procure a piece of stout sheet iron 18 in. by 16 in. by about 1/32 in. and a piece of firebrick 10 in. square by 1½ in. thick. This fire-brick might well be ½ in. thick only; but nothing under 1½ in. could be procured. Set out the iron as in Fig. 8, and cut along the full lines and bend along the dotted ones. Rivet up with 3/32 in. or ⅛ in. copper rivets, and put in two ¼ in. iron wire stays (Fig. 9). Cut a strip 2 in. wide off the firebrick, by chipping a groove along each side about ¼ in. deep, and break by a smart blow on, say, a doorstep. Fill the forge level with small purified coke, procurable from any bicycle maker for a small sum (or sometimes for the asking). Half a dozen 2½ in. wire nails will fix this to the wall. If this is wood, use three or four 1 in. round-headed screws, and put a sheet of asbestos between.

GAS CONNECTIONS

These involved making a T joint in ⅜ in. compo pipe in an awkward place. A description of the way it was done may be helpful. (Readers in the know must excuse the barbarisms, but the writer knows nothing of this work except what he has found out by experience.) It was first attempted to do the job *in situ*. This resulted in a melted pipe, as the T was arranged as in Fig. 10, and



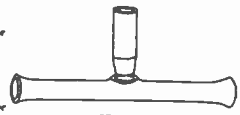


Fig 11

Fig 10

the solder ran down instead of keeping in the joint, as it should have done. So a piece 4 in. long was cut off the new pipe (by the way, the easiest way to cut this is with snips, and open out the hole with pincers and a centre punch), the ends opened out and a hole bored in the centre, as in Fig. 11. Then the end of the new gas tube was filed down taper, put in this hole, and held firmly, the short piece being horizontal and the long piece vertical and *upwards*. Some Fluxite was put on the joint and the whole gently heated with a blowlamp. When the Fluxite flashed, the blowlamp was directed on the end of a piece of solder held just above the joint, and at the same time keeping the pipe hot. When the solder melted it ran round the joint neatly, and a firm job was the result. Then the ends of the old pipe (which had been cut) were tapered down with a file and inserted in the ends of the short piece forming the top of the T. These were soldered in in a similar way, but, being up a dark corner, were not so easy to do neatly. This, to practised workers, may seem a barbarous method; but to one who does not get much of this work it is the simplest way, and cheaper than fixing by means of a T piece. Of course, if the new pipe had been in an upward direction the T joint could have been made straight off. The pipe must, in any case, be pulled clear of the wall when working, and a piece of metal put behind to protect the woodwork.

It is very handy to have a by-pass against the tap, as shown in Fig. 12. These are not expensive and, when forging, are very useful, as a touch reduces the flame to a mere flicker, and when a new heat is necessary another touch restores it to its original size. This by-pass should not be on the blowpipe itself, as it will only cause a smell of gas when the pipe has become somewhat the worse for wear.

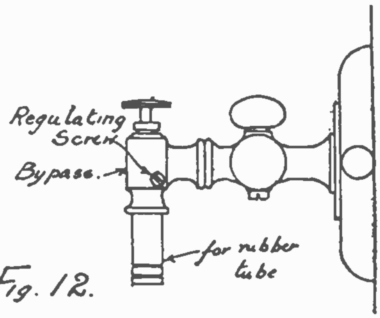


Fig. 12.

FORGE TOOLS

To begin with, a poker, a rake, and a pair of tongs will be required. It is good practice to make these. For the first, take a piece of 5/16 in. or 1/4 in. round iron, about 12 in. long, and heat about 2 in. of one end to a bright red. Flatten this out on the anvil, at the same time tapping the edges, to keep it square and of even width. Try to get it all done in as few heats as possible, and to leave as little as possible for trimming up afterwards with a file. Hit lightly with the hammer, and not too much in one place, or the job will be uneven. Remember, it is much easier to thin than to thicken a piece such as this; so, don't be too vigorous at first.

Now, for the handle. Draw first on the bench, in chalk, a full-size outline of this, and measure off the length of material from the bend marked 1 (Fig. 13) to the end. Chalk the rod at this distance, and bend over a piece of 3/8 in. diameter iron in the vice or the bick of the anvil (if you are fortunate enough to possess one with a bick). Work the other bends in the same way, taking them in the order shown on the drawings. The whole art lies in getting the end of the rod to come close to the shaft, and, at the same time, not making the eye uneven. At any rate, ensure the latter, as otherwise the result will be an eye-sore. The rake is similar, except that the business end is bent as shown. A piece about 18 in. long will be found about right for this. As in the case of the eye, draw a chalk diagram first, to measure from, and compare the result with it, for guidance in future work.

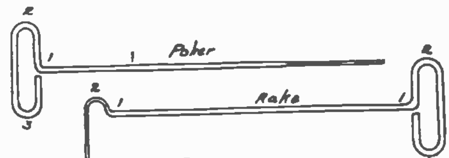
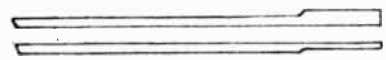
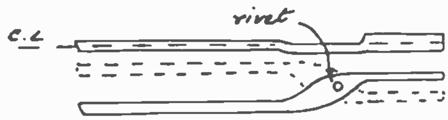


Fig 13



stage 1. Fig 14



stage 2 Fig 15

We now come to the tongs, which are much more difficult. For these, procure 2 ft. of 3/8 in. round iron. First flatten about 2 in. of one end till it is about 1/4 in. thick, or a little less. Then, at right angles to this, another 2 in. Fig. 14 shows the first stage, and Fig. 15 the finished forging. The point to remember is, that the centre line of the handle, the working face of the hinge, and the centre line of the jaw must be in the same straight line. It will need some careful work to ensure this, and it is a good test of skill. If a block can be found the right width to hammer the hinge face on, it will save some filing. The jaw and the handle must now be bent over, as in the diagram. This is best done in the vice. The other jaw, etc., must now be made on the other end, and is exactly similar in every way to the first one. Great care must be taken to see that the second is not made left-handed, or it will all be of no use. When both ends are as nearly alike as it is possible to get them with the hammer, cut the rod in two. Trim up, where necessary, with a file, and rivet together, as shown. Let the rivet be as near to the jaws as possible, to get the greatest possible leverage. These tongs, while not so good or so nice to look at as professionally-made ones, will be found to hold quite well. But always try, if possible (as when forging lathe tools, etc.), to avoid having to use tongs, by keeping the tool on the bar until all forging is done.

This concludes the description of the forge outfit. An exactly similar one has been in use for some time, and has been found very satisfactory; so the amateur who wishes to acquire a similar one may confidently adopt the methods explained. While these may in many cases be somewhat different to the most modern practice, yet they will be found to answer very well, especially for those whose pockets are not well lined. The total cost is very moderate, and can easily be lessened by judicious use of "scrap" material.

In conclusion, the writer ventures to hope that this article will not prove tiresome to more advanced readers, but that those who cannot derive any information or help therefrom may at least derive some amusement.

—*The Model Engineer.*

Note on the Cause of Erratic Behavior of Fuses

Fuses are simply pieces of metal alloys in the form of bands or wire, which connect the circuit with the source of power. It seems as though the fuse question would be apparent from any standpoint whatever. At any rate, certain elementary considerations can be touched upon for the purpose of discovering why such doubts, as are sometimes expressed with regard to their operation, have good foundation.

A metal alloy of this character is only made up for the purpose of obtaining volatilization when a certain temperature is reached. For the further success in accomplishing this purpose, fuses are made to melt or volatilize with a certain current. This is where the difficulty occurs. Any piece of wire is subject to the influence of temperature under such peculiar conditions. A piece of fuse wire, melting at its correct amperage, would not perform its function properly in a region exposed to Arctic cold. On the other hand, within the Torrid belt, the abnormal heat would make it melt all the sooner. The question, therefore, of why fuse wire betrays such irregularities, is best answered by the remark that the irregularities, if any, are the results of periods of high and low temperature. A fuse up near the ceiling is affected by a blanket of hot air. A fuse further down, or in a cold hall, is really one capable of standing a heavier current. Although the point at which a fuse blows is predetermined, it is not to be forgotten that this point is only correct for a certain external temperature. If a fuse is erratic in that it cannot be depended upon, then the metal is at fault. But until this is ascertained the heat and cold are reasonable answers to all such questions.

ROBT. E. BRADLEY.

On October 9, 1890, twenty years ago, after thirty years' work, Clemten Ader succeeded in rising from the ground on his flying machine, the Eole, and moving through the air for about fifty yards. On October 9, 1910, a list of fifty-one aviators who have qualified for the pilot's license granted by the Aero Club of France was printed, bringing up the total so granted to 258.

On the same day an Englishman, Oscar C. Morison, started to fly from Paris to London, and so little interest was aroused by the start that the Paris evening papers dismissed the subject in about three lines.

In Sprechsaal Hans Fleissner applies Brücke's report on the colors of dimmed mediums to dimmed glass which looks reddish yellow when held toward the light, but blue if viewed in reflected light. The formation of the dim medium in the glass is due to partial devitrification. The light-dimming particles have not yet reached the size required to prevent the appearance of the blue color, so that a chromatic decomposition of white light can take place. Upon the further progress of devitrification, the blue color disappears and the glass becomes quite dim and white. The author suggests the possibility of utilizing this phenomenon industrially.

WIRELESS TELEGRAPHY

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

DESIGN OF TRANSMITTING APPARATUS FOR A HIGH POWER WIRELESS TELEGRAPH STATION

W. C. GETZ

In several of the previous numbers of this magazine I have described the building of a concrete wireless station, and the erection of suitable masts and antenna for a long distance wireless outfit. This article will therefore consider the equipment of the transmitting apparatus, such as an up-to-date high power station should contain.

While relatively few in the number of parts, the transmitting side of a wireless plant is by far the most expensive, and for that reason, the least efficient usually, inasmuch as there are but few experimenters who can afford good transmitting outfits and the available data on this topic can only be gleaned from the results these experimenters obtain. In fact, it is safe to assume that for every experimenter that owns a good transmitting outfit, there are one hundred others who are only equipped for receiving.

In considering the transmitting apparatus we naturally first think of the transformer or induction coil, by which we step up the low voltage power to a suitable electromotive force for the operation of the oscillating circuits.

In the early days of wireless it was thought that the longer the spark of an induction coil, the greater the efficiency. With the advent of the tuned circuit apparatus this was disproved, and now it is a rare thing to see a transformer of a modern type designed for over twenty or thirty thousand volts on the secondary for wireless work.

Transformers are of two general types. For use on a direct current source of power, the open core transformer commonly known as the induction coil is used. This consists of a primary winding of a few turns of heavy wire around an iron core, and connected in series with a suitable interrupter, to the direct current supply. Over the heavy winding is another winding of many turns of fine wire, which is known as the secondary.

Fig. 1

The open core transformer is also successfully used on alternating current circuits. In fact, if properly designed, it will give much better service for wireless work if connected directly across the alternating current circuit, than when used with the interrupter on the direct current supply.

The closed core transformer is designed exclusively for alternating current work. It consists of a primary winding of heavy wire and a secondary winding of finer wire on a core which forms a closed magnetic circuit. In

Fig. 1 is a photograph of a transformer of this type built by the writer for wireless work. This transformer was described at length in the June and July, 1909, issues of ELECTRICIAN AND MECHANIC.

In this type of transformer the primary is wound on a square core built of lengths of sheet iron. The secondary is wound in sections which are insulated with linotape, before placed in position. It should be noticed that the primary and secondary windings are split into two divisions, one of each of which is on each "leg" of the core. This is the most efficient method of assembling unless the magnetic leakage gap, patented by the Clapp-Eastham Company, of Cambridge, Mass., is employed.

Fig. 2 shows the closed core transformer built by the Clapp-Eastham Co. In this type the primary winding is on one "leg" and the secondary on the other. A magnetic leakage path, consisting of a central "leg" without any winding, is ingeniously inserted between the two coils. In a description of this transformer furnished the writer by Mr. Luscomb of that company the following *important* features are noted:

"*First*—the transformer is self controlling, and requires no rheostat or impedence coil, and can be connected directly to the alternating current mains of any voltage or frequency for which the transformer is designed.

"*Second*—the transformer has a high power factor, usually between 80 and 90 per cent. as against a usual 50 per cent. power factor for the ordinary open core transformers.

"*Third*—a great freedom from spark gap troubles, owing to the fact that to maintain a condition of resonance, the condenser must be across the secondary terminals. At the instant of spark discharge the condenser is to all intents and purposes, cut out of circuit and the secondary of the transformer short circuited by the spark gap. Under ordinary circumstances the tendency at this point is for an alternating current arc to follow the condenser discharge and produce heating. With the type "E" transformer, however, the moment the spark passes, the secondary condenser is out of the circuit and the transformer no longer in resonance. This being the case, the current immediately drops, so that an arc will not form. As soon as the condenser discharge has taken place the transformer is again in resonance and the current immediately rises.

"*Fourth*—the ability to produce practically any potential desired in the

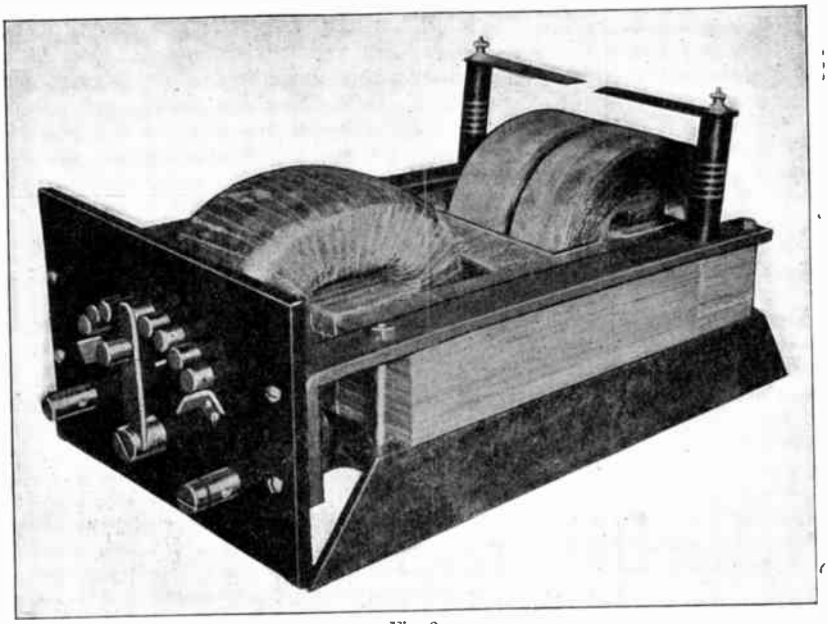
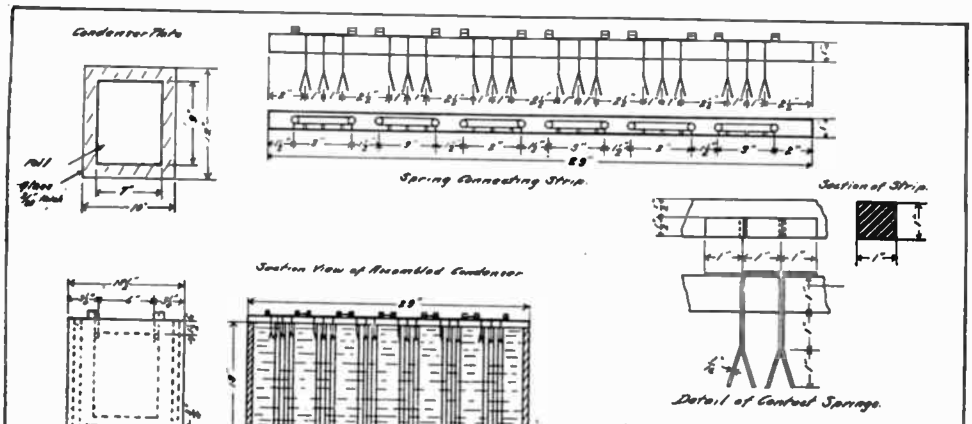


Fig. 2



Oil Immersed Condenser
Fig. No. 3.

secondary regardless of the number of turns ratio. This, of course, is due to the ability of a resonant circuit to build up to an almost unlimited potential as long as it is kept swinging."

In a test made by the author of two 3 k.w. transformers of the Clapp-Eastham Co.'s make, excellent results were obtained. An important feature not mentioned in the foregoing extract, was that of the overload ability of the transformer. The limit of the capacity of any electrical machine is the heating effect due to the load. On the above transformers, the temperature rise on a 5-hour run at 50 per cent. overload was only 40 degrees F. above the temperature of the room. As 70 per cent. is usually allowed for this length of run with only 25 per cent. overload, it may be easily said that the transformers would successfully operate for all practical purposes on a 5 k.w. load.

Before concluding the subject of transformers, it would be well to call the attention of the experimenter to the claims of certain supply houses who offer so-called "1 k.w." transformers for from ten to fifteen dollars. These transformers will no doubt consume 1 k.w., but it is the output that a transformer should be rated by, as it is the ratio of the output in watts to the input in watts that determines the efficiency of the set.

A properly designed impedance coil can be made to consume 10 amperes on a 100 volt circuit. However, beyond the fact that it is consuming this power, and giving it off in heat losses, it is doing no useful work. For the same reason a cheap transformer can consume 10 amperes on 100 volts in the primary, and deliver about 10 milliamperes at 20,000 volts on the secondary. The efficiency of this transformer then becomes $\frac{20,000 \times .010}{100 \times 10}$ which equals 20 per cent., approximately. That is, for every k.w. that is being consumed, only one-fifth of 1 k.w. is available for useful work. Pretty expensive after all, isn't it?

We will now consider the form of condenser for our closed oscillating circuit. The Leyden jar type of condenser is usually employed in all marine installations, and has proven very satisfactory. However, the oil immersed type of condenser seems to be more usually adopted in shore stations, and for that reason, it will be the type considered in this article.

In Fig. 3 is given the design of an oil-immersed plate glass condenser, together with the details of the important parts. It will be seen that this condenser consists of six groups of five plates each, enclosed in an oil-proof case. In the upper left-hand corner is given the plan of these plates. They consist of 3/32 in. glass cut 10 in. x 12 in., having fastened on each side, a tin foil sheet 7 in. x 9 in. It will require, for the complete condenser, thirty of these glass plates, and 60 sheets of the foil. The foil should be cemented smoothly to the glass, all wrinkles pressed out, and care being taken to see that it adheres perfectly at all points.

Referring to the section view of the assembled condenser, it is seen that the plates rest on strips in the bottom. These strips have notches cut in them at ½ in. intervals (2 in. between groups) in which the plates rest.

At the top the plates are separated by hard rubber strips carrying springs, the latter making contact with the foil. Details of these springs and strips are given in the remaining figures in the drawing. As every other sheet of the condenser foil must be oppositely connected, the springs are spaced 1 in. apart, and 2½ in. at the sections. At one end the first section is 2 in. and at the other end 2½ in. to the end of the strip. This allows the two strips to be made up alike, and by placing them in reverse to one another, the springs in one set will all connect with the opposite plates to the springs in the other set.

The springs consist of 1/16 in. spring brass, fitted as shown on the enlarged detail. They are ½ in. in width and each has a total length of 4 in. Thus, it will require about 40 ft. of ½ in. spring brass to make these springs.

Suitable binding posts are placed in each end of each group, on the top of the strips, and connecting bars of ⅛ in. x ½ in. brass are fitted across each group, screwing under the binding posts, thus performing the double service of making contact to the binding posts with the springs, and holding the springs in position.

The case should be of wood, lined with zinc. All seams and joints in the zinc should be soldered, so that finished, it is a perfectly oil-tight vessel. The outside dimensions of the case are 29 in. x 13 in. x 12½ in. The case should be filled with the best grade of transformer oil to a point at least 1 in. above the foil of the condenser—after the plates of the condenser have been placed in the required position, and the spring-clips make contact. It will require approximately 20 gals. of this oil. A suitable cover should be fitted over the complete condenser.

The spark gap is the next thing to require our attention. In the early days of wireless the spark gap invariably consisted of a pair of brass balls mounted on rods and so arranged to be adjusted to various distances from each other. The advent of the alternating current transformer with the 20,000 volt secondary, and high wattage output, made it necessary to adopt a spark gap of a different design that would not heat and oxidize so readily.

The first improvement along these lines was the use of rods of brass. Then it was discovered that a spark between zinc electrodes seemed to be much more efficient, having certain characteristics which make it as valuable for this work as iron is for magnetic circuits. Combinations of zinc and other metals have been successfully tried, and spark gaps may be now purchased that wear evenly with little or no perceptible oxidization.

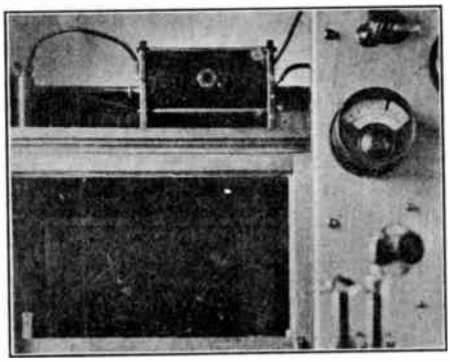


Fig. 4

The noise of the spark also made it necessary to place the electrodes in a case or "muffler." This type of gap is shown in the photograph in Fig. 4, on top of the cabinet. A "peep-hole" of mica is provided so that the operator may at all times be able to observe the condition of the spark without removing the casing. This gap is also fitted with an air-circulating system, which removes the excess metallic vapor and keeps the electrodes cool.

In Fig. 5 I have drawn a type of spark gap that combines many of the good features of the other types of gaps, and eliminates some of the bad ones. It consists of an insulated aluminum wheel mounted between two zinc electrodes, the wheel being provided with "teeth" that face the opposite electrodes. The wear on the elements of this gap are less than on the regular type, and the rotation of the wheel generates sufficient air-current to keep the electrodes cool. At the same time, the wheel can be provided with any number of teeth the experimenter desires, and thus obtain a high pitch spark which is conceded to be the best for long distance operating.

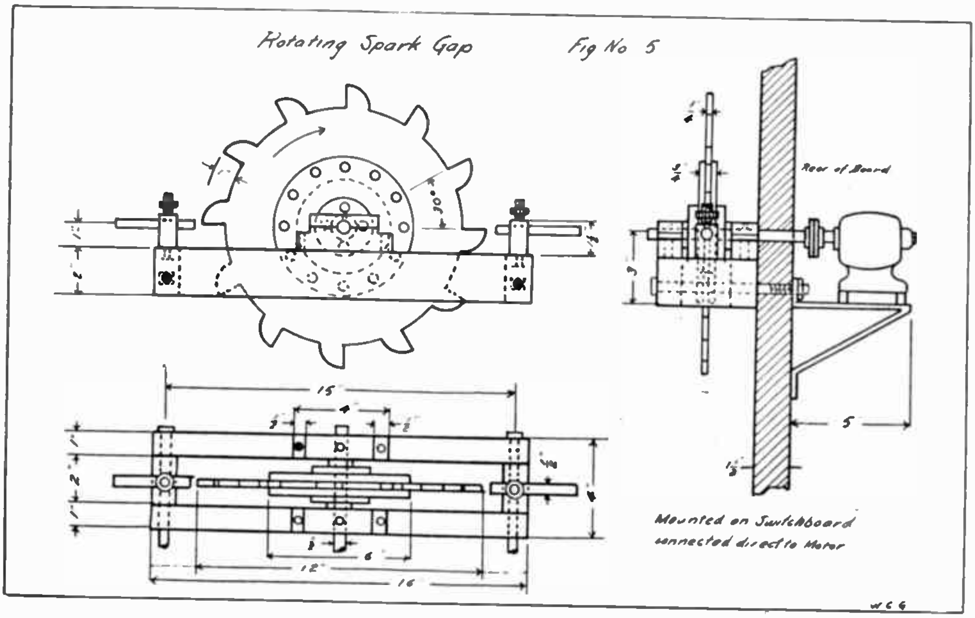
The zinc rods are adjustable, and may be placed up to a maximum distance of 1 in. from the rotating element, but in practical work it is rarely desirable to have each more than 1/8 in. or 3/16 in. from the wheel.

The construction of the rotating spark gap is as follows: a frame work of 1 in. x 2 in. mahogany is made, having the outside dimensions as shown on the plan, of 16 in. x 4 in. In the centre of the side pieces two brass journal boxes or bearings are placed, these to fit a 1/2 in. shaft, and provided with oil holes.

to hold the insulating discs in position. In the exact centres of these insulating discs, a 1/2 in. hole is bored through which the shaft will fit.

Two brass washers or flanges 2 1/2 in. in diameter and 3/8 in. thick, bored with a 1/2 in. hole are now riveted to the insulating discs, one on each side. These are to give additional strength to the insulating discs, so that they will not "wobble" when the aluminum plate is run at the required speed. Two brass washers each 1 in. in diameter and 1/4 in. thick complete the movable element fitted to the shaft.

A steel shaft, 1/2 in. in diameter is



The wheel consists of a disc of 1/4 in. aluminum, the perimeter of which is divided into twelve equal parts. The diameter of the disc is 12 in. and the teeth are cut 1 in. deep. Each tooth is spaced 30 degrees from the next tooth, and is rounded off on one side and cut square on the other, thus allowing it to gradually approach the zinc electrodes and abruptly leave them. In the centre of the disc, a 4 in. hole is made, as shown by the dotted circle in the elevation in the drawing.

Two discs of hard rubber or micanite, 6 in. in diameter and 1/4 in. thick are now riveted one on each side of the aluminum disc, the centres of the three discs being the same. Twelve rivets are inserted

now carried through the wheel, as described, the washers being placed on each side, and the wheel made fast to the shaft. The wheel and shaft are now placed in the frame and the upper half of the bearings fitted in position. The wheel should revolve freely in the exact centre of the frame without any irregularity or side movement whatsoever.

The zinc rods are made of 1/4 in. metal and are supported by brass uprights, 3/4 in. in diameter and 1 1/2 in. high. The tops of these uprights are provided with No. 8-32 machine screw studs for clamping the rods, and on which are placed thumb nuts which serve to hold the jumper wires in position and lock the studs at the same time.

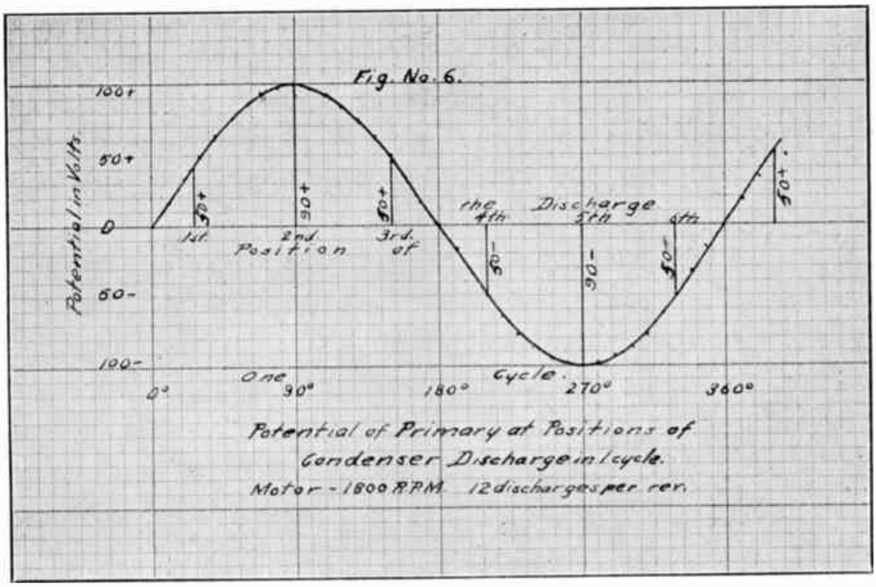
The framework is provided with two ⅜ in. holes spaced 15 in. apart, running through the ends, for bolting the gap to the instrument board, 6 in. stove bolts being used for this purpose.

The gap is to be rotated by a synchronous alternating current motor of about 1/16 h.p., and which is operated from the 110 volt 60 cycle supply that feeds the transformer. At this point it would be well to say a few words about the operation of this motor.

A synchronous alternating current machine, as the name implies, varies in speed proportionately to the variation of the supply circuit. Thus with any variation of the frequency of the main supply, the motor will vary accordingly, and the rotation of the spark gap will then be in proportion to the exciting potential of the transformer primary.

For our purpose a 1/16 h.p. motor such as is used on electric fans, can be used. Assuming that the motor is of the 4-pole type, then the number of revolutions for a supply circuit of 60 cycles frequency will be $\frac{2 \times 60}{4}$ per second, or 30 x 60 equals 1,800 revolutions per minute. Since the aluminum wheel has 12 teeth in it, the number of teeth passing the electrodes in one second is 30 x 12 or 360. Hence, in one cycle, $\frac{360}{60}$ or 6 teeth pass the electrodes. As ordinarily the tone of the discharge is composed of two surges per cycle, for the maximum values of each alternation, in our case we have six surges per cycle, and hence a higher pitched note, which is supposed to be better for operating purposes.

However, the potential of the supply circuit is not the same in the six surges. Referring to the curve shown in Fig. 6, which represents one complete cycle from 0 degrees to 360 degrees, it is seen that the first position of discharge is when the positive alternation is increasing at 50 plus; the second position when the positive alternation is at between plus 90 and plus 100; the third when the positive alternation is decreasing at plus 50; the fourth when the negative alternation is increasing to minus 50; and so on. However, as the transformer charges the condenser, the latter may be assumed as a pressure regulator, and the difference in the discharge potential is constant regardless of the charging potential of the primary at the time of discharge.



In installing this set on the instrument switchboard, the motor is mounted in the back of the board, and the shaft of the gap coupled to the shaft of the motor with a standard coupling. As the aluminum plate has been built so as to be insulated from the shaft and bearings, no insulated joint is necessary between the motor and shaft to prevent it "kicking-back" through the motor and supply circuit to the transformer.

The direction of rotation as shown by the arrow is such that the teeth of the wheel gradually approach the electrodes and abruptly leave them as elsewhere stated. Before starting, it should be seen that the shaft is well oiled at the bearings, and that the motor is in true alignment with the rotating element. The gap should run noiselessly, and should in no ways interfere with the working of the receiving set, if left running after completing transmission. The motor is controlled by a snap-switch situated on the instrument board, which will be shown in a following drawing. The motor is mounted on angle iron supports, to the back of the instrument board.

(To be continued)

A SIMPLE METHOD OF CALCULATING INDUCTANCE

ERNEST C. CROCKER

On many occasions the wireless worker would like to know the amount of inductance that a certain coil possesses, but is deterred from any attempt to calculate this when some formidable formula is presented to him for the purpose. For some reason, there has been no attempt made, up to this time, to publish any simple methods for this purpose, and it is my desire to present one in this article.

For practical work it is not desired to know the inductance precisely, but to get a close approximation of it. The method which follows, will, in most cases, give a result agreeing within one per cent. of the actual figures, and this is accurate enough for all ordinary purposes.

All coils of wire possess what is known as self-inductance, and when two coils face each other, there is another inductance, known as mutual inductance, which exists between them. For the present, only the self-inductance will be considered, as it is much easier, both to comprehend and to calculate.

The self-inductance, which I shall call simply, "inductance," depends on two things: the magnetic circuit of the coil and the number of turns of wire on the coil. The magnetic circuit is influenced by changing the shape of the coil or its diameter. The following formulas make all allowances for shape and size of coil, and it is only necessary to substitute the value in figures for the letters in the formulas. The unit by which inductance is usually measured is the "centimeter."

For cylindrical coils of one layer:

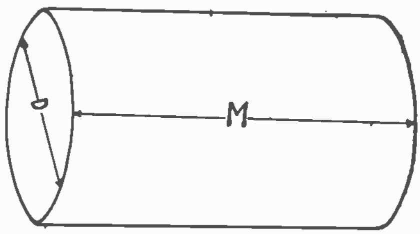
$$\frac{(5 \times D \times T)^2}{M + \frac{1}{3}D} = \text{inductance in cms.}$$

where

D = diameter of coil in inches

T = total number of turns of wire

M = length of coil in inches.



The following cases will illustrate the use of the formula.

Example 1:—Find inductance of coil 6 in. diameter, 5 in. long and 100 turns of wire.

$$\frac{(5 \times 6 \times 100)^2}{5+2} = \frac{(3{,}000)^2}{7} = \frac{9{,}000{,}000}{7}$$

= 1,285,700 cm. of inductance.

D = 6; M = 5; T = 100

Example 2:—Find inductance of loading-coil 3 in. diameter and 10 in. long, of 400 turns of wire.

$$\frac{(5 \times 3 \times 400)^2}{10+1} = \frac{(6{,}000)^2}{11} = \frac{36{,}000{,}000}{11}$$

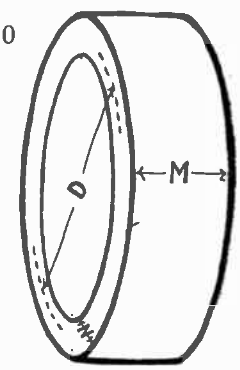
= 3,271,818 cm.

D = 3; T = 400; M = 10

There are many cases in which a coil has more than one layer of wire, and in these cases we may use the following formula:

$$\frac{(5 \times D \times T)^2}{\frac{1}{3}D + \frac{3}{2}M + \frac{5}{4}N}$$

= Inductance in cms.



where
D = average diameter of coil in inches
M = length of coil in inches
N = depth of coil in inches
T = total turns of coil.

Example 1:—Find inductance of copper strip coil, 12 turns ($\frac{1}{2}$ in. apart) 6 in. depth of winding, 1 in. long (width of strip) and 12 in. diameter (6 in. hole, 18 in. outside).

$$\frac{(5 \times 12 \times 12)^2}{4 + 1\frac{1}{2} + 7\frac{1}{2}} = \frac{(720)^2}{13} = \frac{518{,}400}{13}$$

= 39,877 cm. of inductance.
$D = 12$; $M = 1$; $N = 6$; $T = 12$.

Example 2:—Find inductance of "doughnut"-shaped coil 1 in. long, $\frac{4}{5}''$ in. deep, $4\frac{1}{2}$ in. diameter and 100 turns.

$$\frac{(5 \times 4\frac{1}{2} \times 100)^2}{1\frac{1}{2} + 1\frac{1}{2} + 1} = \frac{(2{,}200)^2}{4} = \frac{4{,}840{,}000}{4}$$

= 1,210,000 c.m. of inductance
$D = 4\frac{1}{2}$; $M = 1$; $N = \frac{4}{5}$; $T = 100$

If it is desired to express the inductance in microhenrys instead of centimeters, divide the result given by the formulas by 1,000, and if milhenrys are desired, divide by 1,000,000.

Owing to the failure of Mr. A. Frederick Collins to furnish the tenth installment of his series on "Instruction in Wireless Telegraphy," we are unable to publish it this month as promised, and are thus obliged to disappoint the subscribers to "Collins' Wireless Bulletin," who are now receiving ELECTRICIAN AND MECHANIC.

HERE AND THERE

Saved the Day

The brakeman was a novice, and on his first run here there was a steep grade mount. The engineer always had more or less trouble to get up this grade, but this time he came near sticking. He almost lost his head. Eventually, however, he reached the top.

At the station that crossed the top, looking out of his cab, the engineer saw the new brakeman and said, with a sigh of relief:

"I tell you what, my lad, we had a job to get up there, didn't we?"

"We certainly did," said the new brakeman, "and if I hadn't put the brake on we'd have slipped back."—*Washington Star.*

No Wasted Power

One of Washington's capitalists, who is very rich and very stingy, finally put a revolving storm door in one of his buildings. He had held out a long time, but had been forced to it.

The innovation caused much comment. A day or two after the door was installed another real-estate man was discovered by a friend standing on the sidewalk gazing intently at the door.

"What's on your mind?" asked the friend.

"I was just noticing that revolving door."

"He had to come to it at last, I see."

"Yes," said the first observer, "but I'll bet he didn't do it until he found some scheme for hooking it up so that when the people go in and out it furnished power to run the elevator."—*Saturday Evening Post.*

We put hobbles on a horse to keep him at home, but the hobble skirt is not intended for any such purpose.

Small Girl (of twelve): "Is this a library?"

Librarian: "Yes."

Small Girl: "I want something wicked and excitin' and bad."

Librarian: "I wouldn't let you have any book like that, little girl."

Small Girl: "It ain't for me,—I've read 'em. It's for my younger sister." *Life.*

EDITORIAL

It is with a full measure of gratitude that we express our appreciation to our readers for the magnificent response they made to our subscription offers during the month of December. We believed that we were offering them a considerable privilege in permitting subscriptions to be entered for any desired number of years in advance at the old rate, and it is apparent that our subscribers also felt so, as a very large proportion of all renewals have been for two or more years. The extent of the confidence thus placed in us is amazing. One subscriber at least has paid up to the close of the year 1924, and many others for periods of from five to ten years in advance. The knowledge of this confidence will be an inspiration to us, and we will press forward with new enthusiasm in the task of making a better magazine.

One thing has become clear to us, that we did not offer the new readers of the magazine a sufficient opportunity to appreciate the merits of the enlarged edition before the price was raised. Owing to the Christmas season, the distribution of the magazine was necessarily slower than in average months, and a great number of our readers did not get the magazine until Christmas or after. This left very little time for deciding to send in subscriptions before the closing date, and we received a number of letters saying that the readers were sorry that the offer closed so soon. Under the circumstances, therefore, we have decided to give all our readers a last chance to subscribe at the old price. This issue will be published on January 15th, and we shall allow a full month during which subscriptions may still be entered at the old price. Full details of this offer will be found in our advertising pages. We simply call attention here to the fact that absolutely the last chance to enter your subscription at the old price of $1.00 for the new $1.50 magazine will expire at midnight, on February 15th, 1911. All subscriptions mailed before that date will be received, and the postmark will be sufficient evidence of the fact of mailing. Of course, subscribers in Australasia and other distant countries will be given the benefit of any reasonable doubt, and will be allowed sufficient time, after the receipt of this magazine, to send in their subscriptions.

Please contribute your ideas to the department "Practical Hints." We want interesting ways of doing things, little known. Sketches are advisable, and we can re-draw these if not satisfactory for publication in the author's form. For every short article, not to exceed 400 words, accepted and published, we will give a year's subscription to the magazine.

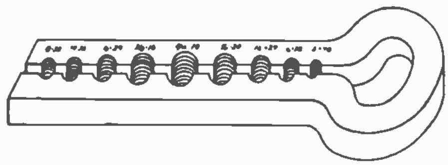
We find it necessary to say a few words in regard to a certain class of questions with which we have been flooded since wireless telegraphy has become so popular with electrical experimenters. From its inception, ELECTRICIAN AND MECHANIC has been recognized as the leading authority upon this subject, and one of our pleasant tasks has been to give reliable information in reply to queries. The question "How far can I receive," with certain specified apparatus is one to which it is utterly impossible to give even an approximately correct reply. Estimates have been given from time to time where the data furnished was particularly complete in details, but even then the answer is necessarily on the order of a guess. So much depends upon local conditions and the efficiency of the individual instruments that it will readily be seen how difficult it is to form an estimate. Mr. W. C. Getz, in an excellent article on "Working Distances of Wireless Stations," in the February, 1910, issue, takes up this subject in a clear and concise manner, and gives several excellent examples which would assist those who desire such information. Readers interested in wireless, who anticipate asking questions on their sending and receiving radius are strongly advised to consult this article, which will clearly show them how difficult it is to correctly answer such queries.

PRACTICAL HINTS

Holder For Cutting Off and Filing Screws

CHESTER L. LUCAS

It is a simple thing to cut off a long screw and file up its point; but, to cut the screw off and file it up without bruising the thread on either piece is quite another matter. For doing just such little jobs as these and doing them quickly, a piece of ¼ in. square machine steel may be bent as shown in the illustration and while the two ends are clamped together with a piece of cardboard between, holes may be drilled and tapped for the standard sizes of screws, half of each hole being in each



piece. If the sizes are stamped above each hole it will make the holder still more convenient. When the holder is placed between the vise jaws, there is spring enough to the holder to hold the two sides slightly open if the vise is not closed tight. The screw to be cut or filed is then turned into the proper hole to the distance it is to be cut to, and the vise closed tight and the cutting or filing done. As the gripping surfaces of the hole are tapped to fit the thread of the screw being held, it is impossible to bruise the thread. When not in use the loop at the end is convenient to hang the holder up by.

Squaring-Up the Angle Iron on the Planer

JOSEPH BARRY

A good method of squaring an angle iron on the planer and one which I have never seen tried before, is to clamp a pair of micrometers to a tool held in the tool-post, and using the thimble or back end of the micrometers, move the bed up so that the front end of the angle iron comes opposite the micrometer, screw them out and take your reading, then move to the back end of the angle iron and do the same. In this way an angle iron may be squared to within one thousandth of an inch, and is much better and quicker than squaring it with a tool. In testing to see whether the spindle of a lathe is square with the shears, a mandrel is generally placed between the centres which has a hole drilled in it on the face plate end. A wire which is bent at right angles at the end is placed in the hole and the mandrel is revolved to see whether the wire touches the face-plate on four points. As the wire is apt to spring more or less it is not very accurate. By putting a piece of steel in the mandrel say a piece ⅛ in. x 1¼ in., and clamping the micrometers to it and using the thimble end, move the mandrel to one point and read how many thousandths on the micrometer, then move them to the next point and so on all the way around the face plate, it can be readily found out how many thousandths the spindle is out of square with the shears.

Hard Soldering

The following method for hard soldering may be of value and interest to some readers. Take some water and dissolve in it all the cyanide of potassium (Caution—POISON) it will take. Keep this in a glass jar with lid on it. Brighten your joint with a file and make it a good, close fit, then wash with soap and water and a stiff tooth brush to scrub with, and then dip in alcohol and dry with a clean dry cloth. Heat job over spirit lamp until it makes a steam when plunged in solution. Heat and plunge a third time, or you can put it on with a borax brush, if you have your job fastened to asbestos. Apply solution all over job.

For the flux use a lump of cyanide

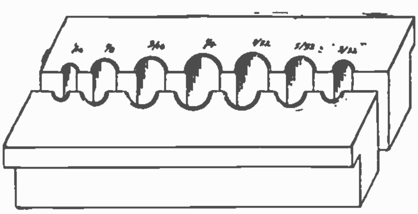
(the size of a pea to a job like a plain band ring, for instance) and place over joint with solder, which you should have previously dipped in solution, too. Blow your flame so as to heat up job equally all over and continue this until you see that the lump of cyanide is dry and beginning to melt; then direct the flame upon the joint until the solder melts and flows; then dip in solution again immediately and it will come out bright and clean and need very little polishing except right at the joint. When you dip in solution the last time let it not remain there but remove and wash at once.

You may think that this would be a formidable task, but it can all be done in much less time than it takes to tell it, and any one who has been accustomed to using borax for a flux will be surprised at the ease with which he can solder in this way.—E. G. Cumby, in *The Keystone.*

Riveting Jaws For the Bench Vise

CHESTER L. LUCAS

These riveting jaws for the bench vise are made of tool steel, hardened and drawn to a very dark straw color. Located half in each jaw are about a dozen holes ranging from 1/16 in. to 1/4 in. Along the outside edge of each jaw the stock is planed away leaving projecting edges to catch on the vise jaws proper. Before drilling the holes a thin piece of brass was clamped between the pieces; this keeps the jaws far enough apart to allow the pressure to come on the piece of wire that is being riveted.



These jaws were especially designed for making odd sizes and lengths of rivets used in model making, etc.; but, they are useful in heading over small punches for die work; for cutting off pins and rods when it is essential that the pins or rods shall not be marred; and for squaring up or doing other filing on the ends of such pieces.

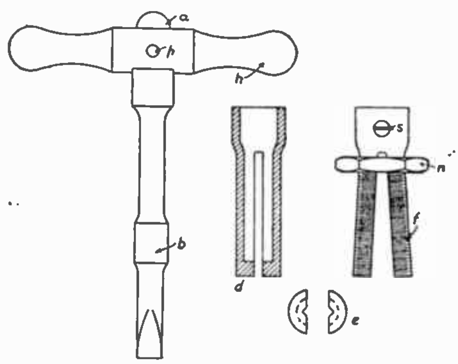
In using these jaws it is only necessary to place one on each vise jaw, place the rivet in the proper pair of holes, and with enough of the stock projecting to make the head, squeeze the vise up hard and rivet in the usual manner.

Powerful Grip Screw-Driver

JOHN HEYES

The common type of screw-driver sometimes fails to extract a screw, owing to insufficient leverage. The screw-driver shown here not only has a far greater leverage, but to ease a fast screw the top *a* of the blade can be tapped with a hammer, whilst the end of the blade is in the screw slot. This rarely fails to start the most stubborn screw.

The handle *h* is made of mild steel, a 1/2 in. hole being drilled for the blade, which is secured by a cast-steel pin *p*. The blade is turned from tool steel, and the end filed to go into the screw slots—about 1/32 in. thick. It must finally be hardened and tempered—from blue at the top end *a*, down to deep brown at the slot end.



To make the grip attachment, turn a piece of tool steel 2 3/16 in. long to 11/16 in. diameter for 1/2 in., and to 9/16 in. for 1 11/16 in. Carefully drill a 3/8 in. hole for 2 in. through the centre from the thick end, leaving a 3/16 in. piece, which, later, must be filed to form jaws, as shown in end view *e*. The 3/8 in. hole must be enlarged to 1/2 in. for 1/2 in. in length, to fit tightly on the part of the blade *b*. A setscrew *s* and a corresponding hole in the blade must be provided. The part *f* is screwed with a fine thread, and a suitable hexagon nut *n* made to fit.

The part *f* is then split in two by using two hacksaw blades in the frame together; section shown at *d*. The nut is then screwed on as far as possible, and whilst in this position the grip is made bright red hot, and whilst red hot a pointed 5/16 in. rod is driven in the jaw end to force them apart, after which the whole is immediately quenched in cold water. Whilst the rod is fast, grip it in a drill chuck in the lathe and polish all over, afterwards tempering blue all over, except the jaws, which must be left brown. A small ring gas stove is very useful to temper small articles over. Care must be taken when fixing the position of the set-screw *s* to have the slit in the jaws of the grip in line with the end of the screw-driver.

—*Model Engineer.*

Drawing Keys

W. MUNCASTER

The possession of proper appliances has a good deal to do with the quickness and easiness of drawing a key which has been tightly driven into a wheel or pulley on a shaft. The methods of drawing keys are various, the usual one being to wedge two flat chisels behind the head of the key and driving them towards each other with a hand hammer. Sometimes this method is successful; but more often ends in bending the key or otherwise damaging it to such an extent that, should it eventually be drawn, it will not be in a fit condition to replace.

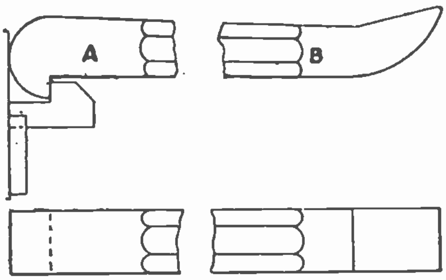


FIG. 1.

Three methods of extracting a key are shown in the accompanying sketches, all of which will be found, on application, to answer their requirements. The first consists of a good stout steel bar, about 2 ft. long, with a projecting lug at one end and tapered to a wedge at the other, as shown in Fig. 1. *A* represents the lug end, and *B* the wedge end. To draw a key, place the lug end behind the gib head of the key (if the key is properly fitted there should always be sufficient room between the head of the key and the boss of the wheel to allow for this), and pull the other end of the bar in a direction away from the key, using the bar as a lever, the rounded

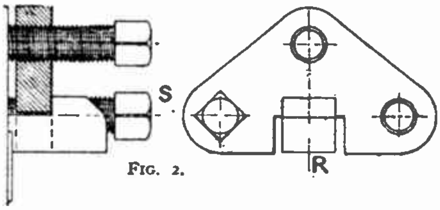


FIG. 2.

end acting as the fulcrum. Keep a good pressure on with the bar, and strike the key on the underside with a lead or copper-headed hammer. This should give the key the necessary start, the rest of the operations being easy, as the bar can be followed up by pieces of packing of various thickness, as the distance between the head of the key and the face of the boss increases. The wedge end is used when the key is fitted too far in to allow for the lug end being inserted.

Fig. 2 shows a key-drawer made from a piece of ½ in. steel plate, with three ½ in. setscrews fitted to it (for keys up to ¾ in. wide). A recess *R* in one side of the plate allows it to drop over the key and by tightening the screws *S* against the boss of the wheel or pulley, the plate is forced against the head of the key. The centres of the two bottom screws should be in a line with the top of the recess, these screws taking most of the strain; the top screw being used to follow up and keep the plate square.

Another form of drawer is shown in Fig. 3. This will be found more simple to operate than the one shown in Fig. 2, although it may be a little more expensive to construct. It consists of two parts: *A* the bridge piece, and *B* the drawhook. The former is made from a piece of flat mild steel, with a hole drilled in the top of the bridge, through which passes the screwed portion of the drawhook *B*. The drawhook would require to be forged, the slot to fit over the key being drilled out and then filed up square. With the foot of the bridge against the boss of the wheel from which

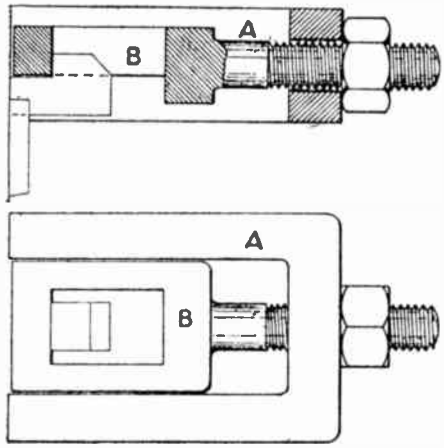


Fig. 3.

the key is to be drawn, and the slot hooked over the head of the key, it will be possible to extract by tightening on the nut with a spanner. There is only about an inch of draw allowed for, which should be ample to give the key a good start. If it is not easy enough to draw out by hand, after being pulled that distance, the nut may be eased back and some packing placed under the foot of the bridge.

—*Model Engineer.*

Anode Surface

It is quite common for platers to err in the use of too small a number of anodes, particularly in the case of nickel solutions in which a greater anode surface is necessary than in any other in common use. The economy is followed simply on the score of cost, but it is false economy, as the metal deposited must come from some source, and if it does not come from the anodes, the solution is robbed.

In the case of a nickel solution, the anodes do not give up their metal freely and as much surface as possible must be employed. Theoretically, were there no secondary reactions, an anode surface equal to that of the cathode would be all that is required, and in the case of silver this proportion answers. With nickel, however, it is not true, and there is always a certain amount of passive surface exposed, that which is inert and that which has become coated with a deposit which masks the reaction, so that a large excess of surface is required. Let it be said that too much anode surface cannot be obtained in a nickel solution, and those who are successful in maintaining it see that there is an ample number of anodes.

With too few anodes, the nickel is not given off from them as fast as it is deposited; but, instead, the nickel is robbed from the solution and free sulphuric acid left. The balance is thus disturbed and sooner or later, unless remedied, the bath goes wrong.

Drilling a 2¾-in. Hole Through Glass

H. D. CHAPMAN

Having to cut a 2¾ in. hole through a round piece of glass, 12 in. in diameter, I proceeded as follows: I intended to use a piece of brass or copper tubing 2¾ in. diameter on the outside, but not having any that size I turned up a wooden plug 2 9/16 in. diameter and 4 in. long. I bent a piece of 1/16 in. sheet copper around this plug and fastened it so that the copper projected over the end about 9/16 in. I then flattened out the shank of a broken bit and drove it into the plug. Through a board 16 in. long and ¾ in. thick a hole was bored just large enough to permit the plug to turn in it; the glass was then fastened to the board concentric with the hole with short nails.

With No. 60 emery and turpentine I began to cut the hole, using the board as a guide for the plug and with a brace to turn it. This worked fairly well, but when we used the emery dry better progress was made. Of course I neither bore down hard, nor turned fast, as I did not want to generate any heat and crack the plate. The plate was cut through in about 20 minutes' time.

Convenient Hammer Attachment

DONALD HAMPSON

A rather handy stunt that I have seen machinists use and, indeed, have done myself, is to keep a centre punch in their hammer handle. A hole bored in the handle is closed by a light brass cap which swings on its screw. The centre punch is ever at hand—something to be considered by those who have much use for one and who do not like to carry too great a load in their pockets.

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.

1535. **Mending Rubber Battery Jars.** R. B. F., Jamestown, N.Y., asks: Kindly inform me how I can mend cracked battery cells which are made of hard rubber. How can I vulcanize hard rubber strips or sheets together? Ans.—Plain rubber cement may be used. Dissolve crude rubber in carbon disulphide or benzol. Gasoline may also be used for the solvent. We have obtained good results by softening edges of sheets with hot iron then pressing together; when cold brush over with rubber cement. Hot iron run over surface of crack in cell will seal it up.

1536. **Sending Radius.** R. A. G., Brockton, Mass., asks: What is my receiving distance with the following outfit: loop aerial 60 ft., 2 strands No. 14 aluminum wire with a horizontal stretch of 100 ft. and 1 ft. apart, lowest end 35 ft. above instrument, receiving transformer, primary, No. 22 L.C.C. 100 turns, 2⅞ in. in diameter, single sliding contact; secondary, No. 23 S.C.C. 200 turns, 2⅜ in. in diameter, 3½ in. long, taps taken every 20th turn to a 10 point switch; detector, silicon and sealed point electrolytic, S.P.D.T. knife switch to throw either in circuit; potentiometer, double slide non-inductive, 300 ohms resistance; 2 batteries; variable condenser, five stationary, four movable, 5 by 5 in. 1/16 in. apart. Receiver, 1,000 ohm; fixed condenser, .002 M.F. to shunt phone. (2) Sending distance: spark coil, core ¾ in. by 8 in. primary 208 turns No. 16 D.C.C., secondary 1½ lbs. enamel C.C. Independent Interrupter, zinc spark gap. Helix 26 ft. ½ in. strip brass, ¼ in. apart on winding. Tubular condenser, 4 glass cylinders 8 in. by 2 in. 48 sq. in. tinfoil, made so as to be fixed or adjusted. Telegraph key 12 to 14 dry batteries. Sending antenna, umbrella shape, fourway loop aerial No. 14 aluminum 25 ft. long, 8 leads to instruments, highest height 60 ft. Ans.—See Ans. to R. S. S., Pleasantville Station, N.Y., in January issue. (2) Your sending distance is from 7 to 9 miles.

1537. **Receiving Radius.** P. H. D., Newark, N.J., asks: (1) I would like to know how far I can receive with a set consisting of a small single slide tuner, a silicon detector and a 100 ohm receiver in connection with a loop aerial, consisting of four No. 14 aluminum wires, 50 ft. high and a water pipe ground? (2) How far can I receive with a double slide tuner, 2,000 ohm receivers, a silicon detector, variable and fixed condensers, in connection with same aerial and ground as in (1)? (3) How far can I send with a 1¼ in. coil, a helix, key, 2 pint Leyden jars, using a 6-60 storage battery for current. Ans.—(1) and (2) It is impossible to tell your exact receiving radius. See Ans. to No. 1537. (3) From 6 to 8 miles.

1538. **Receiving and Sending Radii.** C. A. W., Moberly, Mo., asks: (1) Could I transmit and receive up to 300 miles with the apparatus which Mr. Guilford described in your February, March, April and May issues under the average conditions with a flat aerial 50 ft. by 75 ft., the wires 4 ft. apart and 50 ft. from the ground. (2) Would the sending of a 50-word message cost much with such an apparatus? (3) Would a variable condenser made by sliding one brass tube into another be as good as the half circle as the one described in Mr. Guilford's set? Ans.—(1) Mr. Guilford states in the first article of this series, that a 5 k.w. station should be heard at 500 miles and that the transmitting instruments would send a distance of 50 miles. By suitably increasing the size of spark coil, or transformer, you should be able to cover the distance you mention. (2) No. (3) A tubular condenser having the same capacity should give just as good results.

1539. **Induction Coil.** F. J. C., Somerville, Mass., is making a small coil and has ½ lb. of No. 34 s.c.c. secondary wire wound. (1) He wishes to know if he can use the same size of wire with enamel insulation to finish the secondary; (2) Would the telegraph wires of the B. & M. R.R., which run within 50 ft. of his aerial, affect his receiving, and would a loose coupler eliminate the trouble? (3) The name of a manufacturer who could supply him with a magneto having an output of 6 volts and 6 amperes? Ans.—(1) Yes. (2) We do not think you will be annoyed to any great extent. (3) The Voltamp Electric Mfg. Co., whose ad. appears elsewhere in the magazine, can supply you with an efficient little dynamo of this size. The magnetos used on automobiles for ignition and lighting would probably answer your purpose.

1540. **Receiving Radius.** E. L. S., Lexington, Mass., asks: (1) His receiving radius; (2) for suggestions on improvements in his set; (3) Is Electro Importing Company's ½ k.w. transformer capable of sending 100 miles? Ans.—(1) and (2) See answer to J. K. H., McComb, Ohio, in this issue. (3)

The sending radius of any transformer depends upon local conditions and the efficiency of the transformer itself. As we have not had an opportunity to give the one in question a trial, we would not be justified in expressing an opinion. See Mr. Getz's article in this issue.

1541. **Sending and Receiving Radii.** J. K. H., McComb, Ohio, asks the radius of his station with 1 in. coil. (2) With ½ k.w. open core transformer? (3) How to improve his set? Ans.—(1) and (2) we refer you to article by Mr. Getz in February, 1910, issue. (3) See article by Mr. Kerr in October, 1909, magazine.

1542. **Loop Aerial.** R. H., Brooklyn, N.Y., asks questions regarding his receiving radius, and on the construction of a loop aerial. Ans.—We refer you to an article on "Working Distances of Wireless Stations," by W. C. Getz, in the February, 1910, ELECTRICIAN AND MECHANIC for answers to your questions.

1543. **Buzzing in Phones.** J. D., Waltham, Mass., asks: (1) How can he overcome the buzzing in his phones? (2) For dimensions of glass plate condenser. (3) Would it be all right to connect a finer wound coil to his tuning coil so as to get better results, so one would condense the other? Ans.—(1) Have you tried a loop aerial and variable condenser? Refer to Mr. Getz's article in February, 1910, issue. (2) As you do not state what size coil or transformer the condenser is to be used with, we cannot very well give you dimensions. See article by Mr. Getz in this issue. (3) We do not quite understand your question. If you are thinking of something on the order of a loose-coupled tuning coil, Mr. Cole's article in the September, 1909, issue would help you.

1544. **Positions of Primary and Secondary.** W. L. R., Mitchell, Ill., asks: "Why is the secondary of the transformer, described in the January issue, wound on first?" He understood that the "primary should go next to the core." Ans.—No doubt you are confusing the closed-core transformer with the open-core or induction coil type. If you will again examine the cross-sectional drawing of this transformer (Fig. 2), you will notice that the core is built up and around the winding so that, indeed, the primary is "next to the core." Practically just as good results would be obtained if the positions of the winding were reversed, although the difference in the length of wire would have to be considered.

1545. **Connections of Transformer.** J. C. J., Montreal, Quebec, asks: Should not the second layer of secondary be connected to posts 2 and 3 instead of 3 and 4 in transformer described in January issue? Ans.—You are right. That is a typographical error in the text. Connections should be made as shown in the diagram, Fig. 12, page 11, in January number.

1546. **Wireless Hookup.** H. D. K., Erie, Pa., sends sketch of wireless system and wishes to know what improvements can be made in the "hook-up." Ans.—In your transmitting circuit you have your spark gap across your transformer and your condenser in series with the helix. Better regulation would be obtained by having your condenser across the transformer and the gap in series. You also have a portion of your helix short circuited by the branch from the ground lead. This will form a local oscillating circuit which will be of no use, and at the same time cut down the efficiency of your set. Then, you have arbitrarily fixed the position of your ground and aerial connections to the opposite ends of the coil, which will give you extremely tight coupling, and will not permit tuning in proper manner. The receiving side is provided with too much apparatus, as while it would probably work, the same result could be accomplished with a loosely coupled tuner or variometer alone. It is doubtful if the coherer device will give satisfactory service. You will find out as you experiment further that simplicity is what is most desired in wireless work. An operator who has five or six switches and several pieces of apparatus to manipulate generally has too much to do to get the signals. We would advise you to model your transmitting side after the diagrams of recent transmitting stations given in the recent issues of this magazine.

1547. **Sixteen-Mile Set.** C. E., Garden City, Kans., asks: (1) I have an aerial which is composed of four No. 18 copper wires 100 ft. long, strung between a mast 73 ft. high to a windmill 30 ft. high. The lead-in wire is weather proof No. 12 copper wire. I have a 100 A. ground switch and a ground wire No. 4 running to 6⅛ in. gal. rods 6 ft. in ground. The receiving set is composed of one set of telephone receivers, total resistance, 2,400 ohms, one tuning coil made of D.C.C. No. 18 wire for primary wound on a core 15 in. by 4 with a secondary of No. 32 S.C.C. wire, one layer wound for 3 in. on the outside of primary, one slide contact on primary. Have potentiometer of 400 ohms and a fixed condenser. Sending set 1 in. coil, sending helix wound on cage, composed of 25 ft. of No. 8 copper wire. Spark gap, fixed condenser, and fine large key. What I want to know is, what improvements will we need with two stations almost identically the same to be able to talk 16 miles over sand hill with the one station on the north side of the Arkansas river and the other about 15 miles south of it in the hills. (2) Have been using home-made detectors to talk around town. I had an electrolytic and a No. 1 one not at all good, so I used a carbon one composed of two carbons with a needle across. Tell what cause of trouble. Ans.—With the exception of the detector you have a fine set that you should be able to work at least 20 or 30 miles, if your transmitting apparatus is properly tuned. For a good detector, see article by Mr. W. C. Getz, in December issue of this magazine. You should have no difficulty in also receiving the government wireless stations at Fort Riley and Fort Leavenworth, Kans. The carbon steel detector is an inefficient form, and is not adapted for good sensitive results.

TRADE NOTES

Correspondence School Instruction

There are various methods of giving Correspondence School instruction, as in various other lines of educational work. The natural supposition is that a correspondence school is organized for the purpose of "giving individual instruction by means of correspondence." This presupposes something more than merely furnishing the student with printed lessons, which he studies, writes answers to the questions, sends them to the school, where they are marked as right or wrong and his standing in this particular lesson determined thereby.

The ideal correspondence school, the real correspondence school does much more than this. The method is to first determine the particular kinds of work or the positions of responsibility that the pupils are to be fitted for. This gives the general subjects of the proposed courses of instruction. The next step is to formulate the subject matter of the lessons necessary to cover the special subjects that the pupil should be familiar with, omitting all outside subjects, and carrying the instruction along in the identical lines and under the same practical conditions as are encountered in actual work. This is the method pursued by the Modern Systems Correspondence School, of this city.

Their lesson text books are printed for the sole purposes of instruction of bona fide pupils. Being printed in the printing plant of the school they are not subject to inspection by the public, and are not sold or otherwise distributed.

Each of these lesson text books contains an "Examination Paper," which states briefly the object of the lesson, prescribes such sketching or similar exercise as is required, and gives a series of carefully prepared questions which can only be answered by *a knowledge of the subject*, and not by reference to a line or two of the text. By this means the student's knowledge of the *underlying principles* of the lesson is ascertained. For instance: ten pupils may answer the same question correctly and yet no two of the answers are alike *verbatim*.

The pupil is required to make a report of each lesson, accompanying it by such sketches, charts, calculations and answers to the questions as are required. He also includes any special observations or opinions he may desire, and he is not only allowed but encouraged to ask any question he wishes upon obscure points in the lesson, or upon the subject of the lesson. In this he is given quite a wide latitude. This report is carefully examined by an expert with practical experience in the subject, generally the author of the text of the lessons. He writes a criticism upon the report deciding as to the correctness of the answers, replies to any questions that may have been asked, gives explanations as to obscure or not adequately understood points, and not infrequently solves problems occurring in the everyday work and experiences of the pupil. This is the real correspondence school work, since it is "giving individual instruction by means of correspondence."

With the ambitious man who is seeking valuable and important results from his efforts to qualify himself for a better position and the increased salary which goes with it, there should be no hesitation in deciding that the correspondence school managed on this plan is the best suited to qualify him for the position he seeks.

We are in receipt of a handsome catalog from Henry Disston & Sons, of Philadelphia. It is undoubtedly the finest saw and tool catalog we have ever had the pleasure of reviewing. The book is bound in cloth and the text as well as illustration pages are printed in half-tone on coated paper. The catalog is a fitting messenger of Disston products, which for over seventy-one years, have stood foremost in the markets of the world for high quality, beauty of finish and efficiency.

The book we received is the Hardware edition, covering the complete line; for the Mill Trade the company issues a separate catalog, which is about the first half of the Hardware edition and covers circular, band and cross-cut saws, tools for the mill, files, etc. In addition to these a pocket edition, being a facsimile of the above, is issued.

BOOK REVIEWS

Mechanical World, Pocket Diary and Year Book for 1911. Manchester, England, Emmott & Co., Ltd. Price 25 cents net.

This well-known handbook, now in its twenty-fourth year of publication, contains a most useful collection of engineering notes, rules, tables and data, together with pages for 1911 diary and memoranda.

Mechanical World Electrical Pocket Book for 1911. Manchester, England, Emmott & Co., Ltd. Price, 25 cents net.

A handbook, similar in form and appearance to the "Pocket Diary and Year Book," containing a collection of Electrical Engineering Notes, Rules, Tables and Data.

Construction of Induction Coils and Transformers, compiled by H. Winfield Secor, 1910. New York, Modern Electrics Publication. Price 25 cents net.

A handbook purporting to give detailed instructions and data on the construction of induction coils and wireless transformers. The book contains a large amount of useful information and also a goodly share of practically worthless information. The aim has apparently been to condense into a handbook of 100 pages the information which could easily fill a volume of six or seven times its size. The result is an incoherent mixture of short articles, some good and some poor. The one redeeming feature of the book is a collection of excellent tables of data on the construction of coils and transformers of various sizes, which in the hands of a fairly experienced worker would prove useful.

WIRELESS TELEGRAPHY

In response to many requests, we publish below a list of books on wireless telegraphy, with the prices at which we can furnish them, postpaid.

COLLINS, A. F.
Wireless Telegraphy........................ $3.00

ERSKINE-MURRAY, J.
Handbook of Wireless Telegraphy........... 3.50

SAINT JOHN, T. M.
Wireless Telegraphy for Amateurs and Students.................................. 1.00

SEWALL, C. H.
Wireless Telegraphy........................ 2.00

MASSIE, W. W., and UNDERHILL, C. R.
Wireless Telegraphy and Telephony Popularly Explained.......................... 1.08

MAVER, W.
Wireless Telegraphy...................... 2.00

TESLA, N.
Experiments with Alternate Currents of High Potential and High Frequency. A classic work and the authority on the subject 1.00

FLEMING, J. A.
Principles of Electric Wave Telegraphy. A comprehensive digest of wireless telegraphy in all of its branches. One of the most complete and practical books ever published on this subject.......................... 6.60
Elementary Manual of Radio-telegraphy and Radio-telephony for Students and Operators.................................. 2.00

HOWGRAVE-GRAHAM, R. P.
Wireless Telegraphy for Amateurs........... 1.00

KENNELLY, A. E.
Wireless Telegraphy and Telephony, enlarged and reprinted.......................... 1.14

HARRISON, NEWTON, E.E.
Making Wireless Outfits.—A concise and simple explanation on the construction and use of simple and inexpensive wireless equipments, for sending and receiving up to 100 miles, giving full details and drawings of apparatus, diagrams of circuits and tables. 12 mo. cloth, 50 cents; in paper covers.................................. .25
Wireless Telephone Construction.—How to make and use an inexpensive equipment. cloth, 50 cents; paper, ... .25

TWINING, H. LaV., A.B.
Wireless Telegraphy and High Frequency Electricity.—A most complete manual containing detailed information for the construction of transformers of from 100 watts to 5 kilowatt capacity; wireless telegraph and high frequency apparatus, with chapters on their theory and operation. 1909... 1.50

MORGAN, ALFRED POWELL
Wireless Telegraph Construction for Amateurs.—A manual of practical information for those who wish to build experimental wireless instruments, which can be considered as something more than toys, but are still considerably less expensive than a high grade commercial set. No attention has been paid to the history of the art, the space, instead, being devoted to short but complete explanations of the uses of the various instruments as well as the structural details. 1910.. 1.50

HALLER, GEO. F., and CUNNINGHAM, ELMER T.
The Tesla High Frequency Coil. Its Construction and Uses.—Full and explicit directions for the construction of apparatus needed for experimenting with high frequency currents. This book fills a long felt vacancy in scientific literature. Intended for the advanced experimenter. 1910..... 1.25

ROBINSON, Lieut. Com. S.S.
Manual of Wireless Telegraphy For Use of Naval Electricians. An exceptionally complete and instructive book for the wireless operator....................................1.25

Sampson Pub. Co., Boston, Mass.

Our Special Magazine Offers

We list below our prices on a large number of the most popular technical magazines, alone and in combination with ELECTRICIAN AND MECHANIC, GOOD ONLY UNTIL FEB. 15, 1911. If you do not see the magazines you want listed, write us. We will quote you a price on any magazine published and it will be lower than you can get anywhere else. Write us what you want and we will quote you price by return mail.

TECHNICAL MAGAZINES

Reg. Price 1 year		Our Price 1 year	With Elec. & Mech.
$3.00	Aeronautics	$2.85	$3.50
2.00	American Artisan	2.00	2.85
1.00	American Boy	1.00	1.70
2.00	American Carpenter and Builder	1.75	2.60
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3.00	Electrical World. (Weekly)	3.00	3.85
1.00	Electrical World. (Monthly)	1.00	1.85
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