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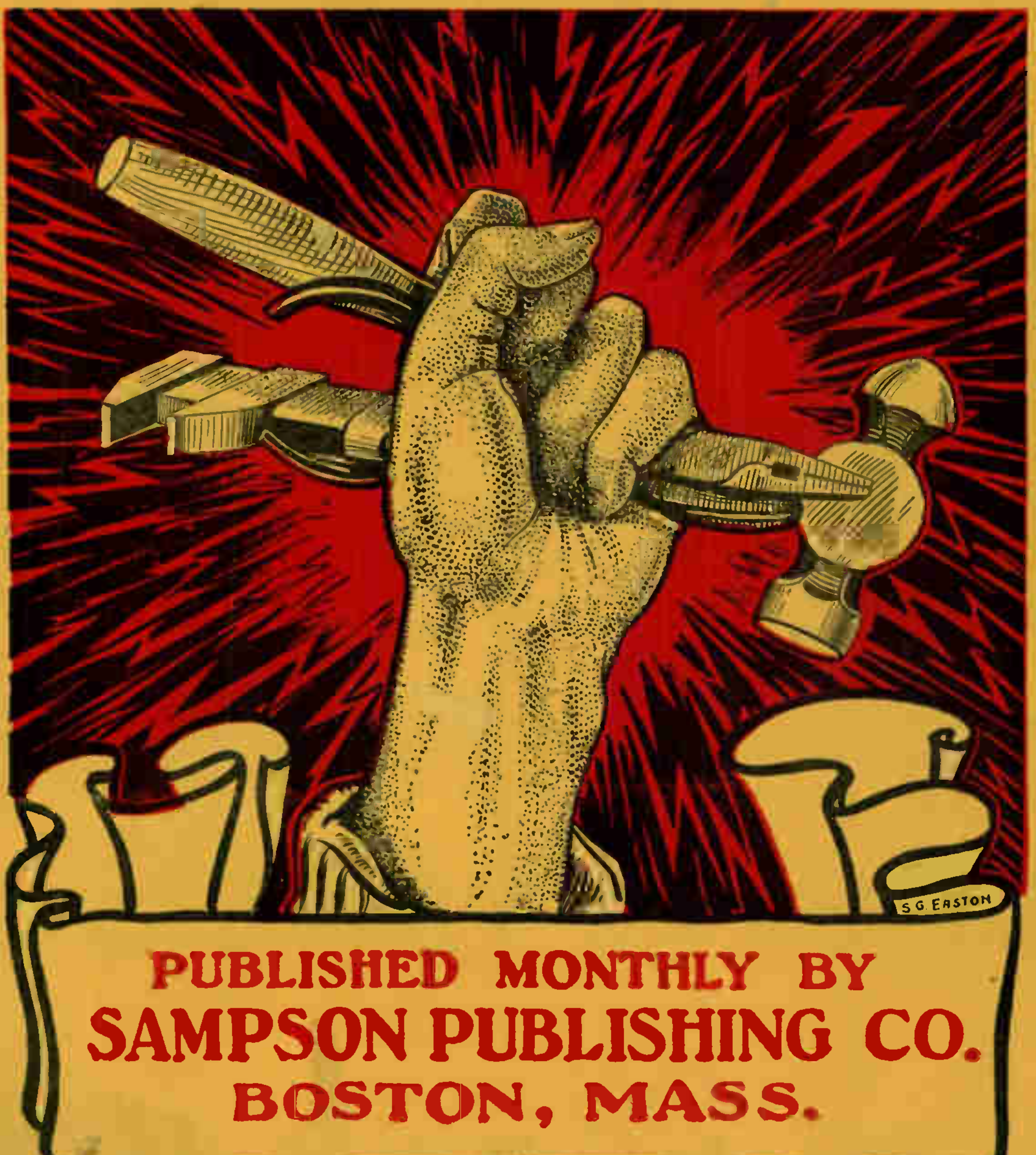
ELECTRICIAN & MECHANIC



ELECTRICIAN & MECHANIC

INCORPORATING

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BUILDING CRAFT, ESTABLISHED 1908 THE COLLINS WIRELESS BULLETIN, ESTABLISHED 1908

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TABLE OF CONTENTS

ELECTRICIAN & MECHANIC

VOLUME XXII | MARCH, 1911 | NUMBER 3

LATHE WORK: MILLING ATTACHMENTS

"SIGMA"

The present series of articles are intended primarily for the beginner and those, who while more advanced, have had no previous practical experience in the proper use of metal working tools, and perhaps not having the ready advice and help of a mechanical friend, will appreciate any little suggestions and "kinks" that will help them through their difficulties. With these thoughts in mind, the writer has gone into the details of many operations concerned with the layout and machining of the work, in the belief that the class of readers referred to may not be entirely familiar with them, or that they may suggest an easier way of doing the work than the reader has been accustomed to.

I have attempted to submit such designs as have proved strong and practical, but yet easy of construction, rather than the more elaborate and refined designs, that might only serve to discourage him from attempting their construction, or in any event would necessitate a large amount of outside work and expense. If any of the designs described are new or available to the needs of the experienced worker, he should have no trouble in elaborating them to his particular fancies.

The fitting of a Milling Attachment enhances the value of any lathe beyond measure, as it permits of a great variety of operations otherwise impossible of execution with the lathe alone. Among the many possibilities might be mentioned the facing of recessed flat surfaces, such as the valve seat in the steam chest of an engine cylinder; cutting the steam ports of same; splining shafts, etc.; cutting gear wheels; slotting (commutators for example); and a host of operations incident to the construction of models of all kinds.

There are three general types of milling attachments as usually fitted to the amateur's lathe. The most simple of the three is known as the Plain Milling Spindle and consists of an elongated sleeve or bearing containing the *milling spindle* proper, which has a chuck at one end to receive the tools and a driving pulley at the opposite end, and the whole device is held in the tool post or by the tool rest.

Frequently the spindle is "back-geared," that is, intermediate gears are interposed between the drive wheel and the spindle, just as is done on a lathe, thus permitting of a higher belt speed when taking heavy cuts or using large cutters. The sleeve is held direct, or by means of a projecting shank in the tool post, or may be bolted to the tool rest by providing a proper lug on one side.

The second type consists, to all intents, in mounting the above device on a slide having a vertical movement, and attaching the whole to the tool rest slide, thus permitting of three distinct motions of the cutting tool and making possible the maximum variety of operations with a single attachment.

The third type is in all respects similar to the above type, except that a small "machine" vise takes the place of the spindle, and in which the work is held while the machining is done by standard milling cutters inserted in the lathe spindle, or held on arbors between centers. This Elevating Milling Slide as it is termed is quite as useful as any of the other attachments, and is particularly useful where light manufacturing is done, as the cost of a large, expensive machine may often be saved by its use.

THE PLAIN MILLING SPINDLE

Fig. 8 represents a Plain Milling Spindle of suitable dimensions for a lathe of 11 in. to 13 in. swing, and for smaller lathes the essential dimensions may be reduced in the proportions to be stated later. The sleeve bearing is best made of cast iron, a simple pattern being made in wood, and a casting obtained at your nearest foundry. As the sleeve will be too large to enter the narrow slot found in the tool post of most small lathes, a projecting shank can be added, and this made to fit the tool post slot, or if preferred, for either large or small lathes, a lug can be cast on the side of the bearing to bolt to the tool rest, dispensing with the tool post, and such an attachment is shown in Fig. 19.

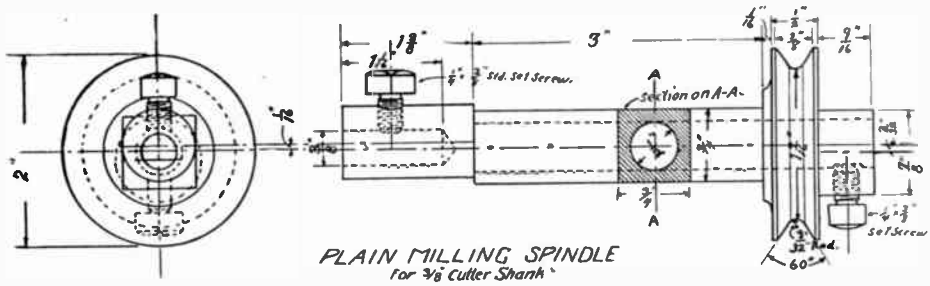
Have the casting a trifle longer than necessary, and after filing the ends up as nearly square as possible, carefully center, and center-drill and ream the centres with a combined centre drill and reamer. Note:—If the casting has not been "pickled" at the foundry, thus softening and partially removing the hard outer skin, it should be done before any tooling is attempted, by soaking the casting for a couple of days, say 40 hours, in equal parts of sulphuric acid and water. Never pour water into the acid but pour the acid slowly into the water. After taking it out of the pickle, scrub with hot, or lye water.

Put the centred casting in the lathe and face off the ends with a side tool set square with the work. Leave the lathe dog on and put a 31/64 in. drill in the lathe chuck, place the back centre in one centre hole of the casting, and, starting the drill in the other, proceed to drill out the hole for the spindle, feeding the work with the tail spindle hand wheel. I should have stated that the dog was to be turned around, so that by putting a bar between the projection and the casting and letting the other end slide along the lathe bed, the casting would be prevented from turning. Feed slowly and evenly and a true hole will result.

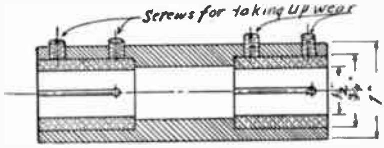
Replace the drill with a ½ in. reamer, having a threaded end so as to be self-feeding (driving it with a dog from the face-plate and entering the centre in the centre hole of the reamer) and using a slow speed, carefully feed the casting to the reamer as you did with the drill, though very little persuasion will be needed; rather watch that you don't feed too fast. After reaming, the drilling of a small oil hole at each end completes the bearing.

Now, taking up the spindle and chuck, it will be noticed that it is made of a solid bar ¾ in. diameter, and a piece of cold rolled shafting answers nicely. It will also be noted that the spindle is turned eccentric to the chuck body, and this is done for the purpose of securing a greater length of thread for the setscrew, without unduly increasing the diameter of the chuck. Cut off, between centres, the exact length from a bar of cold rolled shafting, so as to insure the ends being square, and centre each end carefully (this is best done with the "centre head" of the very useful and convenient—I might say necessary—"combination squares" of B. & S. or Starrett make). If a surface plate is not available, secure a piece of ½ in. or heavier plate glass about 12 in. square, and clamp the centred bar to one side of this improvised surface plate, so it cannot roll or be accidently moved. Now set your surface gauge exactly on the centre of the bar and lightly scribe a line across the end, and moving the gauge to the other end, do likewise. Each of these lines are of course parallel and pass through the centre of the bar, so from the centres previously found we measure off 1/16 in. (= ½ the eccentricity of the spindle—see drawing) along these lines and with a small centre punch, carefully centre these points just found, after which they are drilled and reamed for the lathe.

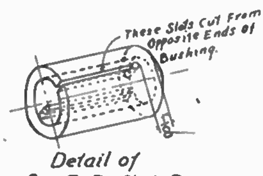
Put a lathe dog on the chuck end of the piece and turn down the portion intended for the spindle proper, and when ready to take the final cut, set the calipers from the cutting edge of two opposite "lands" of the reamer, or as accurately as possible from a steel rule, should your reamer not have an



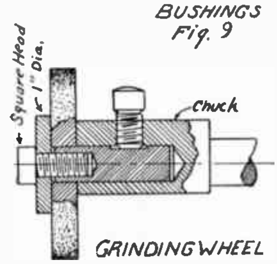
PLAIN MILLING SPINDLE
for 3/8" Cutter Shank
Fig. 8



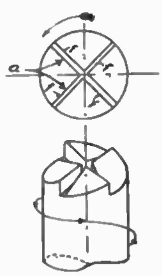
BEARING WITH SPLIT-BUSHINGS
Fig. 9



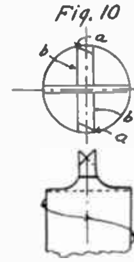
Detail of SPLIT-BUSHING
Fig. 10



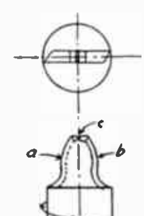
GRINDING WHEEL ARBOR
Fig. 11.



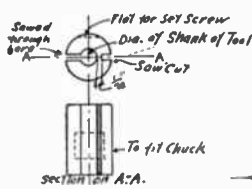
END MILL
Fig 12.



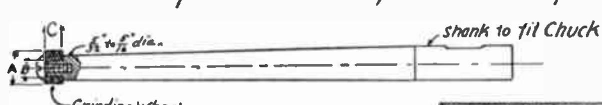
SLOTTER
Fig. 13



GEAR CUTTER
Fig. 14



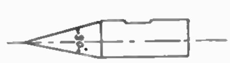
COLLET FOR SMALL SHANKS
Fig. 15



INTERNAL GRINDING ARBOR
Fig. 16

Landis Tool Co.			Brown & Sharp		
Shape	A	B	Shape	A	B
No. 30	3/16"	3/32"	No. 80	1/4"	3/32"
" 31	1/4"	1/8"	" 81	3/8"	"
" 32	5/16"	3/16"	" 82	1/2"	1/4"
" 33	1/2"	1/4"	" 83	5/8"	"
C = 1/4" All Nos.			" 84	3/4"	"
TABLE OF STANDARD WHEELS			" 85	7/8"	"
			" 86	1"	"
			C = 1/4" All No's.		

Fig. 17.



CENTRE FINDER FOR SETTING CUTTERS
Fig. 18.

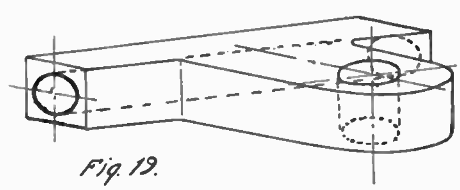


Fig. 19.

even number of flutes. If you use the reamer for a gauge, carefully note the "feel" of the calipers, and when testing the spindle, start a number of light cuts, testing after each until you can reproduce the same "feel." Note:—never caliper work while revolving, or you may have to "scrap" it, when later you come to fit it and find it "way off" in size.

Supposing the turning has been completed and the shoulder next the chuck been squared up nicely with a side tool set "square" with the work, you are ready to take the grinding and polishing of the spindle in hand. If a grinding attachment cannot be had, secure a *flat* piece of steel or hard wood, and glue or wrap *once* around the block a piece of emery cloth and apply to the work, with a firm, even pressure from end to end of the spindle. If the turning has been properly done, the tool marks merely need be removed, but if it is slightly too large, judicious application of the emery block will probably make a fit. If it has been turned too small—well, don't say anything but just "saw wood;" also be sure you hold your calipers perfectly square with the work next time, and see that your finishing tool has a sharply-honed edge.

The proper finishing tool is the broad flat nose tool, or a tool having a broad, round nose is perhaps the best for light lathes, and either must be used with shallow cuts and a fine feed, while the work is revolved rapidly.

If these broad nosed finishing tools give trouble through chatter, look the lathe over for looseness and failing to cure it that way, look to your tool angles, as by changing the angle of top rake or clearance, or both, you may be able to obviate the trouble.

After the spindle has been properly fitted, put a 3/8 in. drill in the chuck and centring the spindle between the back centre and the point of the drill, bore the hole to receive the cutters 1/16 in. deep. Next locate the hole for the set screw, 1/2 in. from the front of the chuck, and if your setscrew has the sharp "V" thread, use a No. 14 Wire Gauge Drill, or for United States Std. thread use a 3/16 in. drill. Tap out with a 1/4 in.-20 thread "V," or U.S.S. taper tap and follow with a plug tap. The drive pulley can be turned from a solid block, but a casting from a simple pattern is more suitable, and in making the pattern, leave the groove to be turned out. This design of face will take all sizes of belts from 3/16 in. to 3/8 in., and the groove is roughed out first with a tool having its nose ground to a radius of 3/32 in. After roughing out, the tool is set central with the work and the curved portion of the groove turned out to a diameter of 1 9/16 in., after which the sides may be turned up to the proper angle. Of course the 1/2 in. hole for the shaft would be drilled out first, so the pulley may be driven on an arbor for turning. It will be noticed that the boss for the setscrew is set 3/32 in. off centre for reasons previously stated, and in attaching the pulley, have its setscrew and the one in the chuck come on opposite sides of the spindle, so these eccentric parts will be in running balance.

An alternative method of making the sleeve bearing is shown in Fig. 9, making use of adjustable, split bushings for the bearings. In making a bearing of this type it will be advisable to first drill out the 3/4 in. holes to receive the bushings and then run a 9/16 in. drill right through, to provide clearance for the spindle. Tap out and fit the small gib screws, and from a 3/4 in. bar of bronze or hard brass, cut off two pieces to make the bushings and secure these blanks in place with the gib screws. After centring, drill and ream, as suggested for the solid bearing, using a *spiral* fluted reamer instead of one having straight flutes and a threaded end as suggested for the solid bearing, for these often chatter when used on the softer metals.

Now scribe a light mark across the end of the casting and each bushing and about in line with the gib screws, so that when replacing the bushings later, they can be located exactly as they were when reamed. Having done this take the bushings out and slit them with a hack saw on two opposite sides and from opposite ends, to within 1/8 in. of the ends, as shown in Fig. 10, locating the cuts in such a position, that when the bushings are replaced, the screws will bear midway between the saw-cuts. A simple form of arbor for carrying a small carborundum wheel, is shown in Fig. 11, and should require no further description.

This will prove very useful for grinding cylindrical surfaces between centres and in this connection the internal grinding attachment, shown in Fig. 16, will also be found useful for internal grinding. I append a table, Fig. 17, of such small grinding wheels as are standard and can be bought in the open market.

Three of the most useful types of cutters are shown in Figs. 12, 13 and 14. The end mill, Fig. 12, as well as the others, is made from a piece of 3/8 in. drill rod, having one end turned down and filed to shape and several sizes of each can be made at once or as they are required, if preferred. The end mill is made by first making a couple of saw cuts across the end as at *a*, and then "backing-off" with a file to form cutting edges, as seen in the projection.

The slotter is used for key-seating and similar work, where it is necessary to cut into the work and move along to form the slot, therefore both the edges *a* and *b* are cutting edges, the latter doing the cutting while drilling into the work and the former when cutting the slot, so both these edges must be backed-off as shown. The gear cutter, Fig. 14, is formed with a file to the profile of the tooth space it is desired to cut, and backed-off on opposite edges, as shown at *a* and *b*, and a small groove cut at *c*. To use this form of cutter, it is started revolving at one side of the gear blank and moved across the face, several cuts being necessary on the larger cast iron or steel gears, the blank being moved one tooth space at a time by means of a dividing plate, but of this I will have more to say later.

The collet, Fig. 15, will explain itself, and while one of these will be necessary for each different size of drill or small cutter shank, they are so easily and quickly made of 3/8 in. drill rod, and only as required at that, that no objection will be found against their use. The centre finder, Fig. 18, is very necessary when it is desired to set the spindle in line with the lathe centres and this operation is performed by running the back lathe centre into the centre hole in the pulley end of the spindle and the attachment is then adjusted so that the "finder" will coincide with the point of the head-stock centre, at which position it is clamped. As an illustration of its further use, suppose it is desired to mill a recess in a piece of work, the centre of which would be located with a centre punch mark. The work would be clamped to the face-plate and by revolving the latter and also moving the milling attachment by means of the feed screw of the tool rest, the work and the finder can be brought central, at which point the work can be held by locking the lathe spindle in some suitable manner, as inserting a piece of soft wood between the gear wheels, etc.

The same method is pursued when milling flat surfaces, providing a single cut across the work will suffice, but where several cuts in width is necessary, the face-plate is held by the hand or a short wooden lever is attached to it, and the face-plate pulled around while the cutter revolves, the latter being moved in toward the centre for each successive cut. While this may not appear as a very satisfactory method, nevertheless it is all right in practice, though when using an elevating milling spindle, such as will be described later, this is unnecessary, as all movements are positively controlled by screw feeds. In the next issue, and before taking up the other two types of milling attachments, I will describe a few good "overheads," that is, arrangements for driving the milling spindle.

To Prevent the Steaming of Envelopes

ROBT. E. BRADLEY

Steaming of envelopes can be effectively detected by moistening one flap with a strong solution of yellow prussiate of potash, and then coating with mucilage and allowing to dry. The other flap is moistened with a solution of ferric alum, and dried. If steamed, after sealing, the water will saturate the paper and bring the two solutions into contact, causing a bright stain of Prussian blue.

Another device is that in which alternate lines are ruled on the lower flap with solutions of the yellow prussiate of potash and with ferric alum. Steaming will moisten the salts on these lines causing bright lines of Prussian blue.

Steaming may be wholly prevented by making the gum of isinglass dissolved in acetic acid, and soaking the paper against which this presses with a solution of bichromate of potash and copper sulphate with a few drops of sulphuric acid. This soon changes the gum, when it comes in contact with it, to a hard, insoluble substance, proof against water, steam, or alcohol.

To state the other side of the case, it may be mentioned that the contents of a letter may often be read by dipping it in gasoline, making it transparent. When the gasoline has evaporated no trace of the treatment will be left.

FOR THE LABORATORY

CONSTRUCTION OF A SIX-INCH INDUCTION COIL—Part II

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.*

The important separating discs which insulate each section from its neighbors may be made of micanite, ebonite or waxed paper. For reasons given in the preceding article, ebonite is not much better, if any, than suitably prepared paper. Micanite is excellent in this case, as it is entirely sealed in and is protected from the action of ozone. However, its cost is likely to prove prohibitive in the case of the average builder. Paper, thoroughly dried and impregnated with beeswax or even paraffin, will stand up splendidly. One or two thicknesses of blotting paper may be used and it absorbs a large quantity of wax. It is doubtful, however, if the blotting paper possesses any advantage over several sheets of the manila paper which was used for increasing the insulation of the tube separating primary from secondary.

The paper is cut into 5 in. squares, preferably on a "photo trimmer," and most carefully dried. This process should take several days. If the paper is weighed before and after drying, the amount of moisture it contained will surprise the builder. Emphasis must be laid upon the fact that it is absolutely useless to wax the paper without thoroughly drying it, for the wax in that case would merely confine the moisture, which would cause a speedy breakdown of the insulation.

It may appear that the author is laying too much stress upon the subject of insulation, but, in nine cases out of ten the failure of an amateur-built coil is due to lack of care in insulation. Nearly every amateur-made coil, if properly proportioned, will show excellent results at the start, but after a few weeks of operation the good or poor workmanship will inevitably show.

Some 300 squares of the paper, having been cut and dried, should be immersed in good hot wax and allowed to remain for 4 or 5 hours. By means of a pair of tweezers, six sheets may be lifted out of the wax at one time and laid upon a clean pane of glass, care being taken to press them closely together with the warm spatula before the wax is cold.

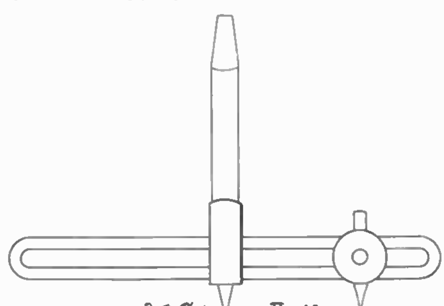


Fig. 10

For cutting out the discs, the author uses a Goodell-Pratt "washer cutter," a sketch of which is given in Fig. 10. This tool may be purchased from any hardware dealer for $1.00, and the investment will prove worth while, even though the builder only anticipates making one or two coils. The tool is supplied with two cutting knives, which may be adjusted to any radius from ½ to 3¼ in. In use it was found easier to use only one knife, cutting the outside of the disc first, and then the centre aperture. By placing the point of the cutter in the centre of a pile of 4 or 5 squares, with the knife set at 2½ in. radius, a slight and uniform pressure on the spindle will suffice to produce a

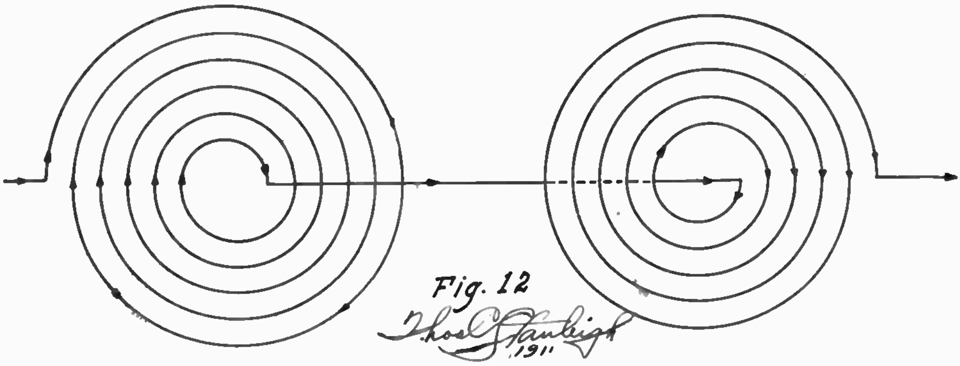


Fig. 12

clean cut edge if the paper is turned under the knife. Any attempt to cut the paper before waxing will result in failure but no difficulty will be experienced in getting out the required number of discs of perfectly uniform diameter if the above method is followed. The central aperture of the disc is to be 2 1/16 in. in diameter, so that it will slide easily over the outside of the insulating tube. If 300 squares of paper are provided and made up into 50 discs of six thicknesses each, there will be sufficient for extra protection at the ends.

The wire sections are to be assembled in pairs having the same internal and external dimensions. A small, sharp-pointed jeweler's soldering copper, well tinned, is provided, together with wire solder, a small bottle of rosin dissolved in alcohol, brush to apply rosin, spirit lamp, spool of strong silk thread which has been soaked in paraffin, a rather sharp small-bladed pen-knife, a coarse needle, supply of insulating discs and a warm smoothing iron should be close at hand. A receptacle containing hot paraffin and large enough to contain several pairs of sections standing upright is also to be provided. The entire assembling operation should be performed in a warm room and upon a firm, clean table.

Having arranged the sections in rows of pairs, take up a pair of the centre ones, *i.e.*, those having an aperture 2 1/8 in. in diameter, and place them side by side, so that the windings run as shown in Fig. 12. If correctly placed, the *outside* wires will point in opposite directions. If incorrectly placed, they will both appear to run in the same direction. The idea is to have the current flow around the core in the same direction in both coils as indicated by the arrows in Fig. 12.

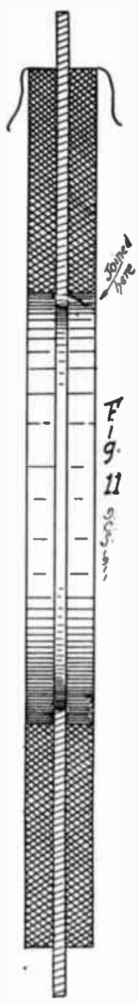
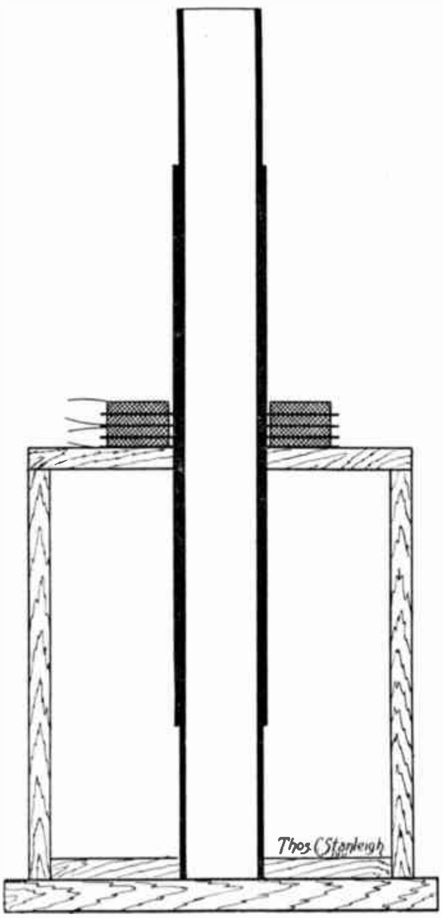


Fig. 11

An insulating disc is placed between the two sections and a hole punched through the paper with a needle. One of the ends of wire is passed through this hole and drawn up tight.

Before attempting to join the wires, the warm iron should be pressed down on the sections which are then bound tightly together with waxed silk thread. The insulation is now carefully scraped from each of the inside wire ends down close to the hole in disc. These ends are now to be twisted together, brushed over with alcohol-rosin solution and then carefully soldered.

Fig. 11 shows a full-sized cross-sectional view of one complete pair of sections. The double sections are to be immersed in the hot wax edgewise and permitted to remain therein until no more air bubbles rise. A receptacle large enough to hold four or five pairs will be sufficiently large, as the impregnated sections may be replaced with fresh ones as soon as they are connected. A stand, similar to the one shown in Fig. 13, should be made before attempting to build up the secondary. The drawing is self-explanatory and needs very little description. The opening in the top is 2 in. in diameter, to allow the insulating tube to be slipped through.



Assembling sections on tube.

Fig. 13

From the inside of the bottom to the outside of the top of stand or box should measure 9 in., so that just one half of the tube projects. The sketch shows two pairs of sections in position.

While assembling the sections a supply of good hot wax (preferably beeswax, but paraffin will do) should be kept close at hand.

Having stood the tube upright in its holder and arranged the double sections in groups according to their size, place an insulating disc down over the tube and on this place one of the double sections. Fold a small piece of waxed silk ribbon over the joint between the sections and see that this joint is pressed snugly up to the inside turns of the winding. By means of a spoon or ladle, run the space between section and tube full of hot wax. As the wax cools and contracts, add more until the space is full of soft wax. When the wax has cooled, but before it is entirely hard, place an insulating disc on top of the first pair of sections and on this place the second pair. Before sealing this pair, separate the layers or sheets of the insulating disc near the edge and make small holes with the needle. The outside ends of the two adjacent sections are passed through from either side and the insulation scraped. The second pair may then be run full of wax and a third insulating disc be put in place. This order is followed out until one-half of the total number of sections is in place. A square piece of heavy wood, having a 2⅛ in. hole in the centre, should be provided to slip down over the tube as the building-up process progresses to press down the sections while the wax is soft. The warm iron is also useful here, but care should be taken to avoid having one side pressed down more than another.

By passing the outside ends of the wire through the discs as the building-up proceeds, the two ends are held in place between the layers of each disc and are all ready to connect when the building-up is finished.

Several extra discs are now to be be passed over the tube and pressed into contact with the end section and finally one of the paraffined wooden ends (see Fig. 16) pressed in place.

Reverse the tube so that the unfinished portion is exposed and make sure that the supporting stand is fastened down to the table or it may tip over. Assemble the remaining half of the double sections on this portion of the tube. Make sure that the space between section and tube is well filled with wax and is free from air bubbles or a breakdown is likely to result.

After completing this end and putting the wooden disc in place, support the secondary on a rough stand, as shown in Fig. 15. Separate the layers of the first insulating disc, through which the outside ends of the winding project, and twist the wires,—which have already been bared of their insulation,—together and solder. Clip the ends down close so that the joint is barely ⅛ in. long and be sure to throw the scrap of wire away, so that it cannot fall into the

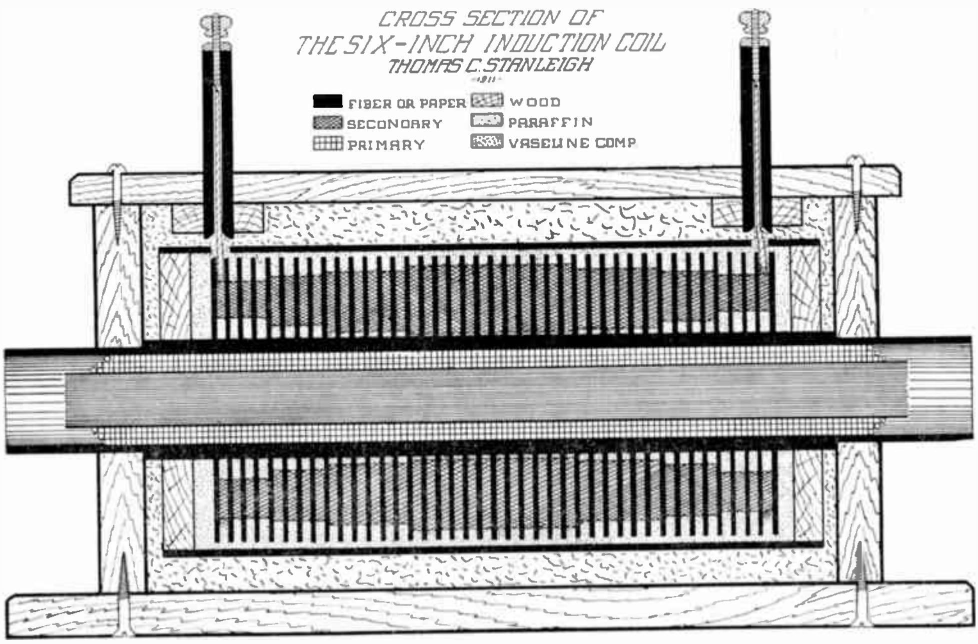


Fig. 14

secondary. Keep the work table scrupulously clean and free from dust or scraps of wire, insulation, etc. After joining the wire press it down between the layers of paper so that it is about ⅛ in. below the edge of the disc, and then press the layers of disc together after placing a drop of melted wax between them. The joint is thus effectively sealed up in the insulating disc.

Connect all of the sections together in this manner, joining the outside end of one to the outside end of its neighbor. As each double section is put in place on the tube, see that the ends of the winding point in opposite directions, as they will if the pairs have been properly connected. Connect ends of the fine wire of the first and last sections to pieces of silk-covered incandescent

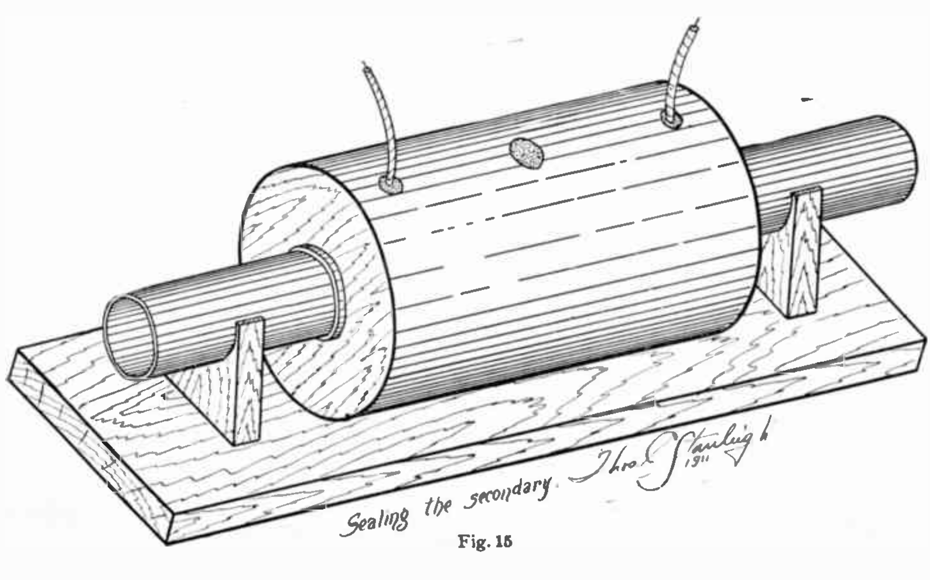


Fig. 15

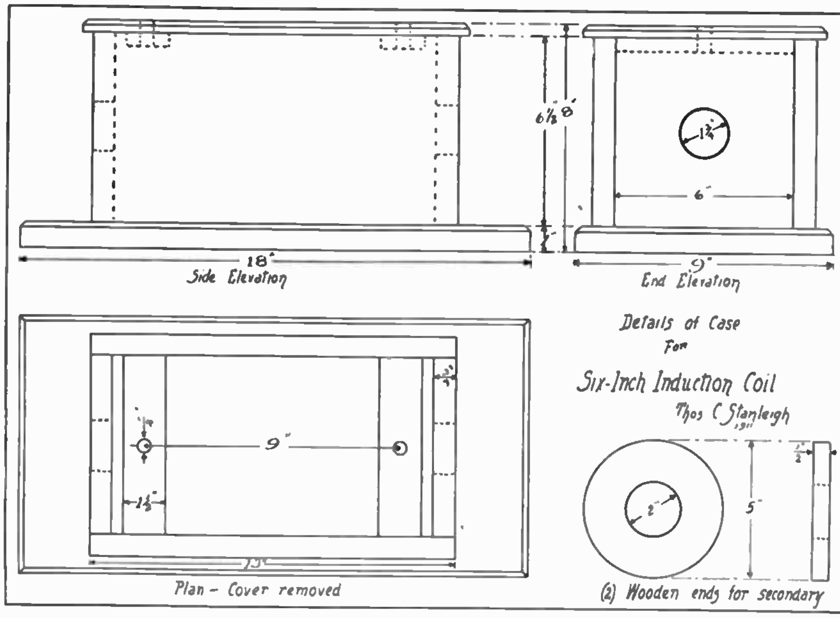


Fig. 16

lamp cord. Bring the cord around the section in one turn and bind down with waxed silk thread.

Secure a piece of pasteboard tubing, such as is used in tuning coils and which can be obtained from advertisers in this magazine, having an internal diameter of 5 in. and a length equal to that of the secondary. Describe a centre line down the cylinder and cut three openings, as shown in Fig. 15. Cut through the centre line with a sharp knife, so that the tube may be slipped over the secondary with the lamp cords projecting. Bind the ends of cylinder firmly to the wooden discs with strong cord. Hot wax is now poured into the centre opening until the space is full up to the top. As this cools and shrinks, pour more in until the secondary is entirely sealed in with wax. The secondary leads should be supported so that they are in an upright position when the wax hardens around them.

Details of the containing case are given in Fig. 16. This box is constructed of dry oak or mahogany, and the stock should be soaked in paraffin in a large tray, which can also be used for impregnating the paper for the condenser. This waxing is not absolutely necessary, but it materially reduces the "brush" leakage from the secondary to the case. The case should be put together with screws and the holes for insulating tube and secondary insulators carefully located.

The general arrangement of the complete coil is shown in Fig. 14. The insulators for the secondary terminals are made of fibre or hard rubber rod, ½ in. in diameter and about 4 in. in length. A ⅛ in. hole is drilled clean through the centre of each to within ½ in. of one end, which is drilled and tapped for an 8–32 screw. The other end is counterbored.

These insulators are firmly secured in the wooden cross pieces which support them in the top of the case while cover is off. The holes in the cover should be made a full ½ in. in diameter, so that the insulators will pass through easily.

Place the finished secondary in position in the case, pass the lamp cords through the insulating pillars and secure their wooden supports by passing slim screws through the sides of the case into them. The insulation should previously have been removed from the ends of the cords, so that a long brass 8–32 screw may be screwed down into the pillar beside the wire. The ends of these screws should be filed to a taper, otherwise the wire will be cut. After inserting the screws and making sure they are tight, cut off the heads so that a knurled nut may be passed over the ends to connect discharger wires to the secondary.

The case may now be filled entirely with a mixture of two parts vaseline and one part paraffin, melted together and poured while hot. Make sure that the lower ends of the insulators are well covered with the mixture. This compound forms a jelly-like substance on cooling and is easy to remove in case of a breakdown. Indeed, the only reason for sealing up the secondary in a removable unit as described is on account of the ease with which it may be removed and a defective section replaced after running the wax off. When the jelly has cooled the cover may be fastened in position, and we are ready to take up the construction of discharging stand, condenser, several types of interrupters and other accessories which will receive due attention in the next article. *(To be continued)*

SOME NOTES ON ELECTRICAL DISTRIBUTION SYSTEMS

J. A. S.

It is only by experience that a considerable portion of the "mains" engineer's practical knowledge is developed. Although his work is based on the elementary principles of electrical engineering, its practice includes a large amount of trouble of various natures which it takes previous experience and a certain amount of originality to overcome. For this reason it may be worth while collecting a few notes upon practical problems connected with the distribution of electrical energy and pointing out the peculiar lessons which were learned from each incident.

Perhaps one of the commonest troubles, in connection with street boxes for the junction or inspection of cables, is the fact that unless ample precautions be taken the connections become loosened in course of time owing to vibration. In a case of this sort, the nuts on the middle wire link in a distributing net-work box, which was situated at the corner of a busy main thoroughfare, had gradually slacked back owing to the vibration caused by the passing of heavy traffic. The result upon the supply given was shown by frequent complaints which were received from consumers in the area affected, who complained of large fluctuations in their light, and in several cases this was followed by the sudden blowing of their circuit fuses. The trouble was not located until several of these circuits had been overhauled by the consumer's department and found to be perfectly in order, and this led for a search for the fault further back. The above defect was then discovered, the loose connections being located. The nuts were retightened by a special insulated box spanner used for this purpose, and after this occurrence it became part of the regular routine to examine frequently the boxes situated near heavy traffic, and, indeed, at longer intervals, every box upon the system was overhauled.

Another difficulty, which is incidental to street boxes, is the accumulation of water, particularly in marshy or low-lying districts. In some instances it may also be due to the fact that, owing to heavy rain, the flush of water becomes too great for the sewers to cope with and neighboring channels become affected. A case occurred of a fault due to water in a straight-through link box, which, although provided with the ordinary "diving bell" lid, was situated in a low-lying district draining adjacent fields. During very heavy wet weather water got in between the cover and the turret and partly filled the box, with the result that electrical troubles ensued. In attempting to render the box immune from further trouble of this nature, it was dried out and resin oil was poured in on the top of the compound to the level of the top of the box. It was, however, found that this was not entirely effective, as further trouble ensued when another series of heavy rains was experienced. Moreover, the presence of the resin oil made it inconvenient to disconnect links and this method was, therefore, abandoned. The box was taken out altogether and replaced by the type of junction box which would be ordinarily used in a mine or other place where gas was likely to accumulate, in which the joint between the lid and the box was made by screwing down the lid on to a rubber band or grummet. This was found to give perfectly satisfactory results over a long period.

A very common cause of trouble on a net work of the three-wire distribution, is the local out-of-balance of an interconnected system, and it has frequently been advised that such a system should be highly sectionized, and if interconnected at all, this should be done through fuses. Whether or not this is the correct practice will not be discussed in this article. The point that should be borne in mind is that too much attention cannot be paid by the mains superintendent to the proper balancing of the net work. Each service as it is put on to the system should be checked to see that it has been put on to the proper side. This is especially the case where metallic filament lamps are being used by the consumers, and, at the present time when such lamps are practically universal, the point needs special attention. In one case of this nature bad light or over brilliance, and consequent injury to the metallic filament lamps, was experienced at one particular area of the net work, although the volt meters in the station showed perfect balance. It was therefore decided to take voltage and load tests on the terminals of various consumers in the area affected, and these showed considerable out-of-balance currents. It was therefore decided, as a temporary measure, to run the station voltages out-of-balance, as the area affected was a particularly important one. The effect of this was an improvement in the faulty area but slight unbalancing in the remainder of the supply. In order, therefore, to effect a permanent change for the better, a considerable number of link box connections were changed over to the opposite polarity, where this was possible, and in other cases the services were dug up and changed in polarity. This involved considerable expense, as these services were buried and laid solid in bitumen, but the trouble was sufficient to teach the lesson that in future all services connected should be noted in a log book, giving the particular side of the system to which they were connected, and efforts were made to balance as far as possible the probable loads between the two sides of the system.

Occasionally the fluctuation in voltage on a section of net work is due to an entirely special cause, such as the switching on and off of an electric sign or the operation of a piece of heavy machinery, and in such cases special means have to be adopted to get rid of the trouble. For example, in a particular case, a laundry was equipped electrically, two of the motors being each of 30 h.p. and running at 200 volts pressure. When these two machines were switched on during heavy load hours, it was found that the voltage of supply on the area immediately surrounding the laundry dropped very badly, in one or two instances dropping as much as 8.12 volts. The consequence was that all the lamps in the area were badly affected and many complaints were received from consumers. The trouble was so bad that it was found necessary to lay a special cable from the supply sub-station in the immediate vicinity to the laundry, and later on to increase the transformer capacity of the sub-station in order to diminish such voltage drop. Another alternative which in this case was also tried was to obtain from the consumer an understanding that he would not switch on the two motors simultaneously and would as far as possible keep off the heavy peak load. The latter stipulation cannot as a rule be arranged unless the supply company is willing to make a certain concession as regards price of current supplied.

Some of the troubles which afflict the mind of the mains engineer are not due to plant but to the human element; the "navvy" with a pick is of course a well-known character and one more feared than beloved by the mains engineer. When, however, the navvy is in the employment of a Water Board which opens up the road without notifying the electrical authority, interesting developments may be expected, and in one such instance one of these men put his pick right through the earthenware duct in which lead-covered cables carried current at a high pressure. Fortunately for the navvy and also for the Water Board the cable was only dented rather badly, and no rupture was caused. A new duct had, however, to be put in and in order to reduce any danger to a minimum the cable was cut and repaired at this point. In order that electrical engineers may not think that all the blame as regards emergencies should be placed upon other shoulders than those of the electric light concern, it may be well to balance this last incident by another in which the electric light authority showed up to some disadvantage. In one system it had been found necessary occasionally to interrupt the supply in certain areas during the day time when the jointers were at work. It is, of course, advisable to notify consumers when such an interruption is to take place, but in the lapse of time it had become the custom to regard this precaution rather carelessly in the case of very short periods of interruption, and perhaps this is not to be wondered at, when having regard to the trouble which is involved. The rule of notifying consumers has, however, been strictly observed since the supply authority was compelled to pay a large sum in damages to a book binder for the alleged spoiling of material due to the stoppage of his motor.

THE WORLD'S LARGEST STEAMER

Launch of the White Star Line's Triple Screw S.S. *Olympic* at Belfast, Ireland

The White Star Line's triple-screw steamer *Olympic* exceeds by nearly 100 ft. in length and 13,000 tons any other ship afloat. Her principal dimensions are:

	Ft.
Length over all	882½
Breadth over all	92½
Breadth over boat deck	94
Height from bottom of keel to boat deck	97
Height from bottom of keel to top of Captain's house	105½
Height of funnels above casing	72
Height of funnels above boat deck	81½
Distance from top of funnel to keel	175
Number of steel decks	11
Number of watertight bulkheads	15

The gigantic measurements of this vessel are best appreciated when it is known that in length the *Olympic* overtops the height of the Metropolitan Tower in New York by 182 ft., is twice as long as the height of the dome of St. Peter's at Rome, and equals in length the total drop of the famous Bridal Veil Fall in the Yosemite Valley. Indeed, if the *Olympic* and her sister-vessel *Titanic* (soon to be launched) were placed end to end under the Brooklyn Bridge, they would completely block the East River, and extend over the shore 100 ft. on each side. It is also interesting to note that the length of each of these ships is four times the height of Bunker Hill Monument.

In each ship 3,000,000 steel rivets, weighing in all 1,200 tons, have been employed to bind the massive steel plates, insuring the greatest stability; and the rudder of each vessel weighs 100 tons, yet will be moved by electricity almost as lightly as a feather.

These monsters of the deep will each accommodate 2,500 passengers, carrying a crew of 860, and because of the enormous size of the ships the accommodations, both as regards the several public apartments and the passenger staterooms, will be exceptionally spacious, while the beauty and luxury of the appointments will surpass anything hitherto attempted. Special attractions, such as Turkish and electric bath establishments, swimming pools, tennis courts, sun parlors, sports decks and palm courts, will be provided in addition to restaurants, dining saloons, lounges, smoking apartments, elevators, etc., all of which will add much to the pleasure of a voyage on these marvels of marine achievement.

The *Olympic* and *Titanic* will be propelled by a unique combination of reciprocating engines with a low-pressure turbine, such as the White Star Line has employed so successfully on its Canadian Service steamer *Laurentic*. By this ingenious system vibration is eliminated and *mal-de-mer* conquered. A speed of 22 knots per hour will be maintained.

Since the advent of the *Great Eastern* in 1858 no steamer has created such general interest as the *Olympic*, not only on account of her surpassing size, but also because of the immense forward steps thus marked in other lines of marine accomplishment, the outcome of many centuries of conflict with the sea.

The *Olympic* will join the White Star Line's mail service between New York, Plymouth, Cherbourg and Southampton next summer, followed by the *Titanic* in the early fall.

Advantages of Electric Heat

Few housewives know that even with the very best cook stoves more than 90% of the heat energy of the coal either escapes up the chimney or makes the kitchen insufferably hot; only from 4 to 7% of the heat is actually used in cooking. When Edison's dream of electricity direct from coal is realized, if ever, then will this extravagant waste of heat energy cease.

Electricity, except for its present cost, is an ideal source of heat, as there is absolutely no loss in the change from electricity to heat. But to change the coal energy to electricity is a laborious process, as 50% of the coal energy is wasted in changing it to steam, while nearly 90% of the steam energy is lost in securing mechanical energy, of which 10% is lost in changing to electricity,—to say nothing about the enormous cost of furnàces, boilers, steam turbines, electric generators and other machinery used in the process.

It seems practically certain that new and better ways of obtaining the heat so necessary for our lives and comfort will be found in the years yet to come, but certain it is that unless some such discovery is made before many years the water powers will have to be harnessed to secure electrical energy, and this energy transmitted to various points and turned into heat.

Electric heat can be had on the instant, for electricity travels at the rate of 186,000 miles a second, and in any degree desired, from a warmth that is barely perceptible to the touch to the carbon-melting heat of the electric furnace in which tungsten, platinum, diamonds and firebrick itself melt and run like water. Electric heat can be carried anywhere about a building and applied just where wanted without serious loss through radiation. Consequently the electric kitchen and the "wooden range" can be operated all day long to cook and bake without raising the temperature of the kitchen to any considerable degree.—*American Review of Reviews*.

Heating Power of Wood

Contrary to a widespread belief that hard woods give more heat in burning than soft varieties, the scientists at Washington are contending that the greatest heating power is possessed by the wood of the linden tree, which is very soft. Fir stands next to linden and almost equal to it. Then comes pine, hardly inferior to fir and linden, while hard oak possesses eight per cent. less heating capacity than linden, and red beech ten per cent. less.—*Domestic Engineering*.

EXPERIENCES IN A SUBMARINE

D. R. BATTLES

Assistant Naval Constructor U.S. Navy

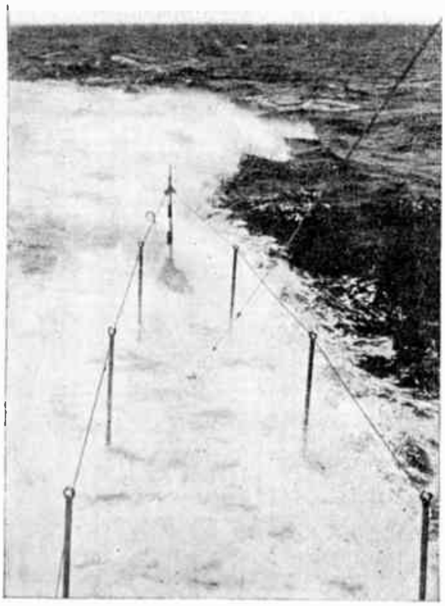
There seems to be a general impression that going down in a submarine is something spectacular, perhaps like going up in an aeroplane. It is not, at least to the persons on board. Imagine yourself on a small deck, about 6 ft. wide and 75 ft. long, only 2 or 3 ft. above the water. In front of you is a small round hole, some 2 ft. in diameter, with a metal ladder leading down to the interior of the boat. You climb down the ladder and find yourself in a compartment just high enough for a person to stand erect in the centre, the shell plating above rounding down at the sides. Forward, if the submarine is one of the later types, are two more compartments, and aft is a fourth, in which is the propelling machinery. All along the sides of the compartments are msyterious looking machinery and pipes, large ones for water and smaller ones for air. If you are not familiar with submarine boats it would be of little use to try to explain the use of all this machinery, even if it were permitted.

A man climbs up into the conning tower. Others begin to pass down the life lines and stanchions through the hatch through which you entered. When all is below, the men close the hatches and the ventilators; the boat is sealed up and no air enters or escapes. Except for the small amount of light that comes through the lenses in the conning tower, the light of day is excluded. The boat is lighted by electricity and the crew breathes the air in the boat. All is very quiet, as no sounds from the outside can be heard, except perhaps the gurgling of the water about the boat's sides.

The man in the conning tower gives an order. All the men are at their stations. The men at the valves open the vents through which the air from the ballast tanks escapes, and other men open the sea valves. Water enters the tanks, but there is no sound. If you watch the depth gauge, you may see the hand very slowly travel around, 1 ft., 2 ft., and so on, up to 8 or 10 ft. The ballast tanks are full, and water runs from the try cocks. The sound of water splashing over the decks can be heard, as the waves pass by. Other men open other valves, and water is admitted to bring the boat to just the depth desired, and to give it the proper trim. Then the man in the conning tower signals to the engine room, and


Bridge of U.S.S. *Salmon* at Bermuda

the motors are started. The boat is now under way under the water with only part of the conning tower exposed, in the awash condition, it is called. The man at the diving rudder, at a signal, gives the wheel a few turns, and the boat inclines down a little by the bow. The gurgling sound,

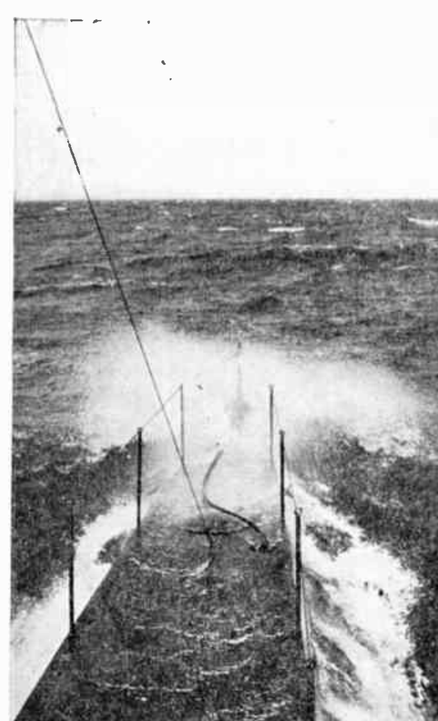


U.S.S. *Salmon*
Stern from bridge

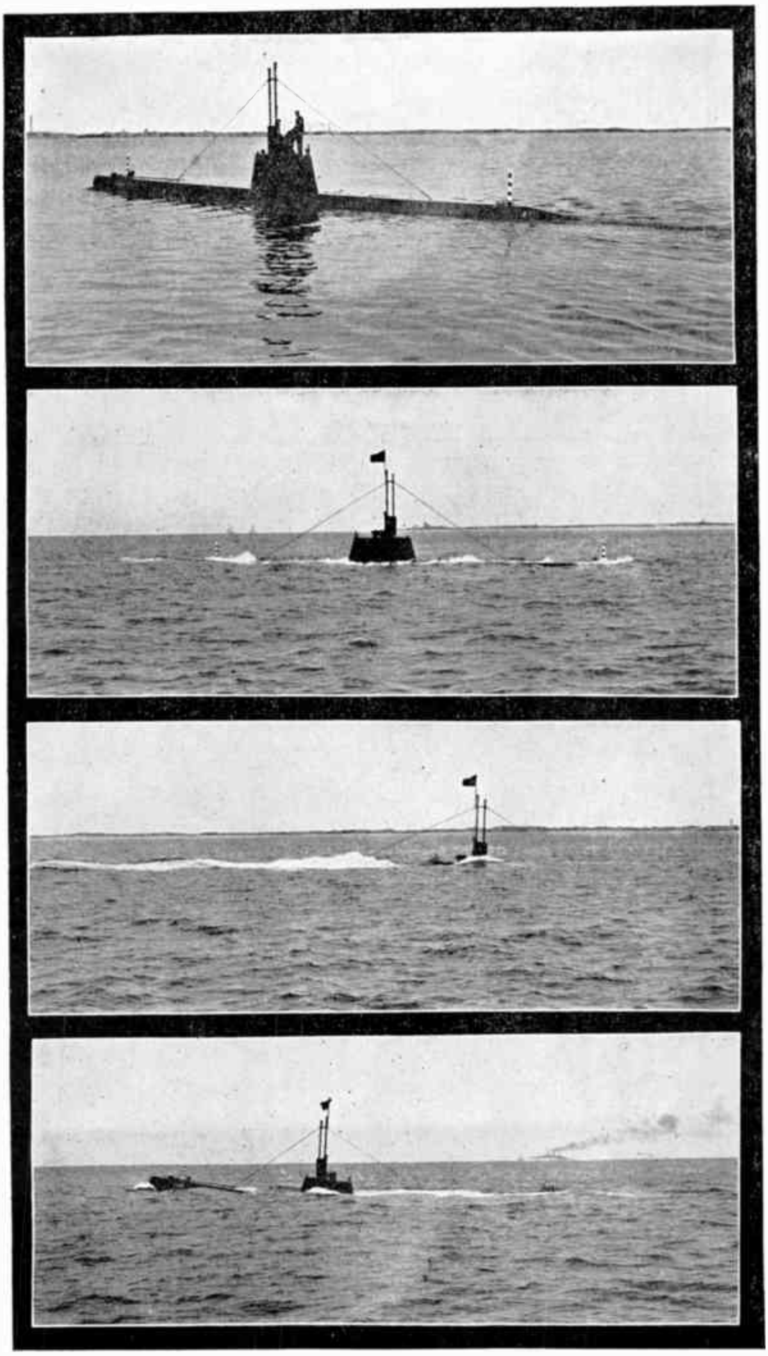
which was more noticeable as the boat gathered way, ceases, and we are fully submerged. But the only way you can tell it is by the depth gauges, which register 15 or 20 ft., showing that only the tops of the periscopes are out of water. You can hear nothing except the hum of the motors; you can see nothing, except through the periscope a much reduced picture of the sea, which seems strangely far away. The crew sit still at their stations. It is not very exciting. Presently the man at the diving rudder again spins his wheel around; the boat inclines up a little by the bow, and soon there is the gurgle again. That is all the change, but we are back on the surface.

That is all there is to going down in a submarine if everything goes all right, and fortunately everything almost always does go all right, as we have been very free from accidents in our service. One day while the boat was at rest in the water submerged, from a mistake in operating the valves, the stern sank, until the boat had an inclination of 12 degrees by the stern. Probably she would have gone farther, if the water had not been shallow. It was rather startling, but it did no harm.

A submarine does not, however, always operate submerged. More often she proceeds on the surface, and then, unless the sea is very rough, she is operated from the bridge. This is a tiny portable structure about 12 ft. above the water. The buoyancy of a submarine is not great, and the form of the boat is not very suitable for surface work. Consequently, if there is any sea running, she sticks her nose under the waves pretty badly. She also rolls, and is not a comfortable boat for a voyage. But she is safe enough. When the sea becomes too rough for the use of the bridge, the boat is sealed up as for submerging, and is navigated from the interior. This is even more uncomfortable than navigation from the bridge, but it is safe, for the boat bobs around like a bottle with a cork in it. When



U.S.S. *Salmon*
Bow from bridge



United States Submarine *Salmon*

From top to bottom—Running light; Awash; Diving; Rising to surface.

the *Salmon* made her trip to the Bermudas, it was necessary to navigate in this fashion one afternoon in the Gulf Stream, while the sea was quite high.

This voyage of the *Salmon*, undertaken prior to her delivery to the United States by her builders, the Electric Boat Co., was at the time the longest trip that had been made by a submarine under her own power, and it still remains the longest sea voyage that has been so made, as most of the long trips of submarines have been made along the coast, where harbors were available in case of breakdown. For that reason the voyage remains probably the best example of the powers of endurance of this class of boats. An account of the trip appeared in the September number of the *Rudder*, and with it were shown some interesting pictures of the sea conditions encountered on the way.

Pictures of the *Salmon* have been chosen to illustrate this article, as she is the most recent type of submarine in our Navy. Most of them were taken during her official trials at Provincetown, Mass., during May and June of last year. They may give a good idea of the appearance of the boat at different stages in her manoeuvres.

WOODWORKER

HOW TO BUILD A CAMERA OBSCURA

Camera obscura is a familiar object at every seaside resort, and is still considered as a more or less mysterious object by the younger population.

The apparatus is very simple and a glance at Fig. 2 will lay bare the mystery to those who do not understand its action. At the top of the wooden building, there is a moveable cowl which has an opening in one side. Behind the opening is a mirror, set at an angle of 45 degrees, which deflects everything within range onto a lens fixed directly below, and set also at an angle of 45 degrees to the mirror. The lens, which has a focus of 6 ft., is that distance from a horizontal table, on which, when the room is in darkness, the view is projected. The action is similar to that of the view finder fitted to every hand camera.

THE CONSTRUCTION OF THE DARK CHAMBER

The most conveneint shape for the chamber is circular, but octagonal or hexagonal shapes are equally suitable; the latter probably will be the best, as it means only six sides. The room when finished may be taken apart, for it is built in sections and bolted together.

We shall first require six sides each 4 ft. wide and 6 ft. 6 in. high; these are made of ½ in. match-boarding, nailed on to a framing of 2 in. by 2 in. quartering. Two uprights, each 6 ft. 6 in. long, are planed on one side to a bevel of 60 degrees, as shown at Fig. 4. The rails, top and bottom, and in the centre, are tenoned in, glued and screwed up. In one section allowance must be made for a door, two upright posts being tenoned into the top and bottom rails and the middle rails tenoned on each side. The door should be 2 ft. 6 in. wide, framed up with 2 in. by 2 in. stuff with a diagonal piece running from the top outside corner to the bottom inside corner.

Each section should be bolted together as shown at Fig. 5, the holes for the bolts being bored before the matching is nailed on the framework. The roof should be framed up in sections, as shown at Fig. 3; each side of the frame should be 4 ft. 3 in. long, the lower rail, 3 ft. 9 in., and the top rail, 9½ in. long. The rail is shaped inside to a curve of 6 in. radius. The outside edges of the long rails are planed down to a slight bevel; this may be easily marked off by placing one section on the ground pro-

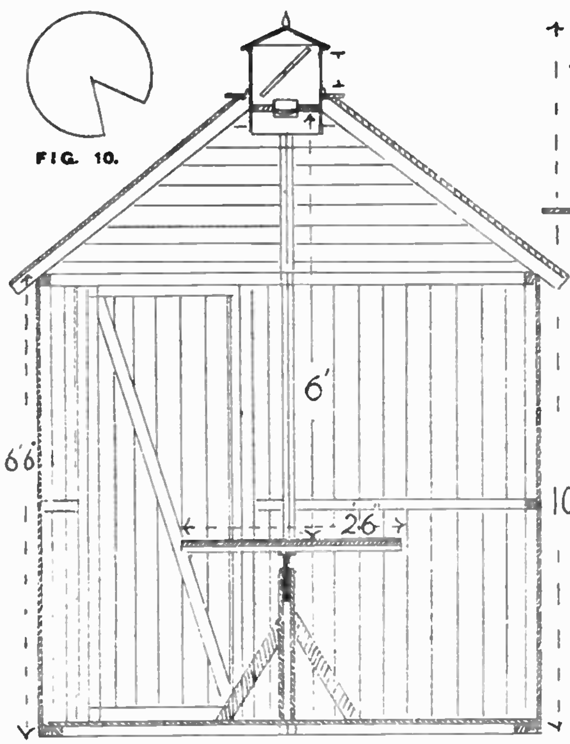


FIG. 10.

FIG. 2.

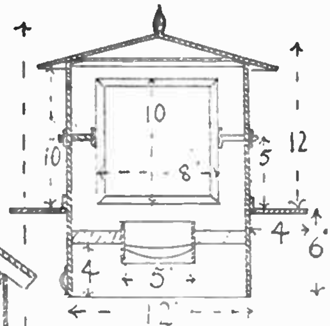


FIG. 9

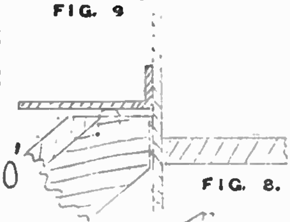


FIG. 8.

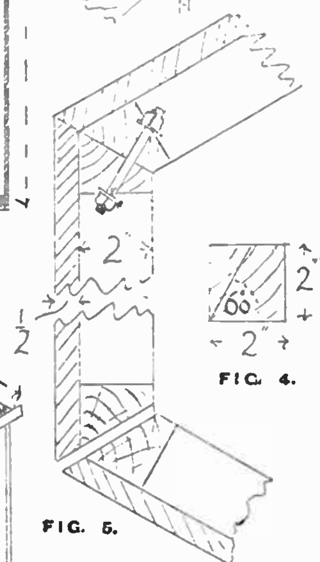


FIG. 4.

FIG. 5.

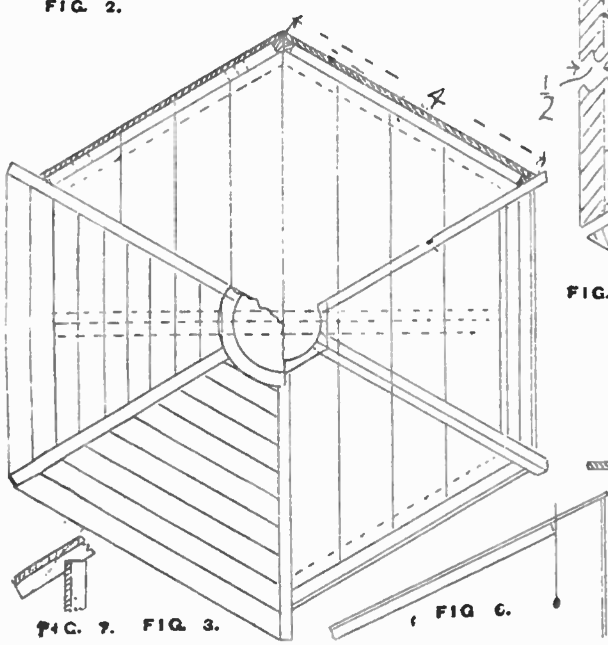


FIG. 7. FIG. 3.

FIG. 6.

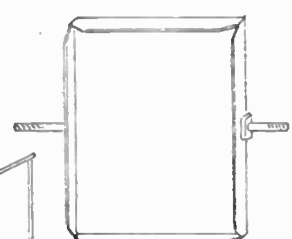


FIG. 11.

ducing the end to the apex of the triangle and raising it 3 ft. 5 in. above the ground. By placing a plumb line, as shown at Fig. 6, the angle may be marked directly on the wood. The roof timbers should be shaped, as shown at Fig. 7, to rest on the sides.

In the top of three sections, a ball

caster should be let in so that the top projects about 1/8 in. above the surface, as shown at Fig. 8. This is to allow the cowl at the top to run easily.

The floor is made in two sections; the frame is shown in dotted lines at Fig. 3. Each half is covered with 9 in. by 1 in. floor boards.

The sides may now be put together, the roof put on, and the whole bolted together, painted a dark color inside, and any suitable color outside. The roof may be covered with felt or the corners covered with strips of wood as suggested in the plan, Fig. 3.

HOW TO MAKE THE COWL—Fig. 9

This is the most important part of the camera obscura. It is made so that it may easily revolve on the ball casters already fixed in the top of the roof; it contains the lens and mirror, which have to be fitted in very accurately. A fairly stout piece of sheet zinc or copper should be bent to form a round tube of 12 in. outside diameter and 15 in. long. Allowing for an overlap of 1 in. for soldering, a piece of metal, 3 ft. 1 5/8 in. long and 1 ft. 3 in. wide, will be required; this should be most carefully bent, so that an even cylinder is produced. The edges to be joined should be tinned, and the joint very carefully soldered. As this is rather a big job for an amateur to tackle, it may be advisable to get a tinsmith to join up the metal. Inside the tube, with the lower side 5 in. above the lower edge, fit in a round piece of wood 1 in. thick, having a hole 5 in. diameter in the middle. This should be attached later on to the sides by screws driven in at intervals. On the outside of the tube, 6 in. up, a flange 4 in. wide is soldered on. The flange should be of stout metal, as the weight of the tube is carried on it. Take a piece of metal 1 ft. 8 in. in diameter, and cut out a circular hole in the middle, 10 in. diameter. Snip a series of 1 in. cuts all around the inside, and then bend up these pieces so that they form a good surface, by which the flange may be soldered to the tube. The inside of the projections should be tinned, and in soldering care should be taken that the joints are all tight.

The top of the tube should be turned in 1 in. at the top to the same slope as the roof. It will be necessary to cut out some triangular snips to get an even bend.

Cut out a piece of metal for the top, allowing for an overlap of 1/2 in. or so. Fig. 10 shows the best way of setting out the cone-shaped top. This piece is bent, soldered up and then soldered to the tube, but it will be more conveniently done when the opening has been cut out; this is 7 in. each way, commencing 1 1/2 in. up from the flange. We may now fit up the mirror. This is a piece of ordinary silvered plate glass 10 in. by 8 in., fitted in a zinc case, made as shown at Fig. 11. The metal should be cut out, and the corners cut to an angle of 45 degrees, so that they may be evenly folded over the edge of mirror and hold it tightly. On the sides of the frame solder on two bolts, long enough to go through the outside of cowl and be screwed up as shown. Care must be taken that the soldering is well done, for although there is no particular strain on the bolts, they should not be weak. When the mirror is fixed up, place inside the cowl, and screw the nuts over suitable washers on the outside, and tighten up when set at an exact angle of 45 degrees with the horizontal. The piece of wood previously prepared may now be screwed in, and the lens fitted in so that it is adjustable up or down. About 3 in. up on the outside of tube, solder on a loop of wire so that a cord may be fixed to it, and then when the lens is properly adjusted to a distance of 6 in. from the mirror, the cowl may be fitted in the space and should, on being turned round, move easily. A length of cord should now be fastened in the middle to the loop on the lower end of cowl and the ends passed over two pulley wheels screwed in the roof; another pair of pulleys should be fixed on the sides, and then on pulling the strings, the cowl may be turned in any desired direction.

HOW TO MAKE THE TABLE

Another very important part of the work is the table on which the picture is projected. It should be 2 ft. 6 in. diameter, and painted a flat white, that is, a white without a brilliant surface. The top, which should be of matchboarding, is nailed to three battens, one in the middle and two towards the outside of the circle. In the middle fix on an ordinary piano stool screw. The support is made of 1 in. strips of wood nailed together to form a hollow of 1 in. square between them and should be 2 ft. 2 in. high. Screw to the top the plate belonging to the screw, and then secure the support by struts screwed to the floor and upright. The top of the table should be covered with card-board, or it may be formed of plaster of Paris, carefully shaped to the same curvature as the lens.

When the door is closed, the surrounding scenery will be seen on the table top, and a few turns one way or another will bring the picture into sharp focus. The distance of the lens from the table should be exactly 6 ft., but a little adjustment is necessary to get a sharply-defined projection.

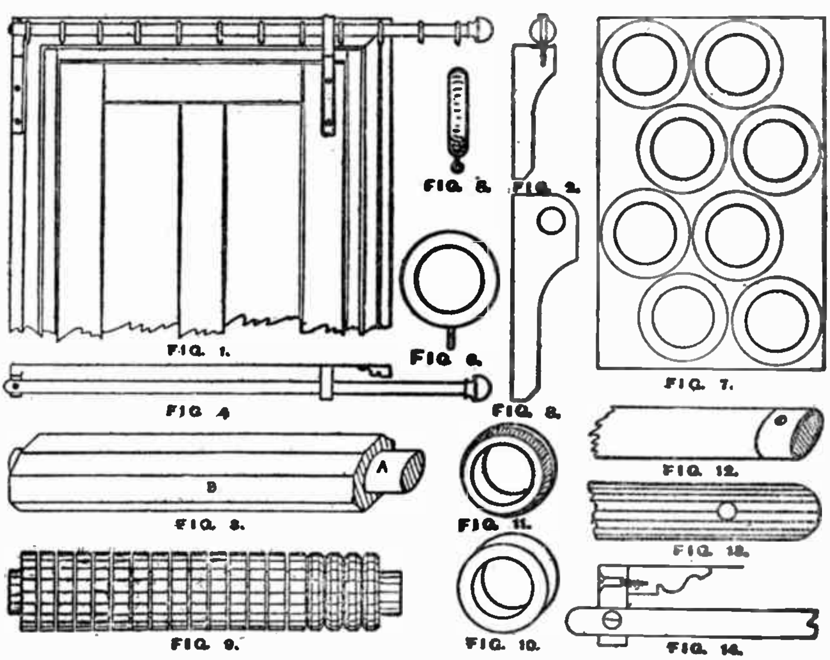
HOW TO MAKE A SIMPLE PORTIERE ROD

The time is at hand when curtains over the door will be appreciated, and the portiere rod shown fixed in Fig. 1 will be found to be perfectly satisfactory.

The rod itself may be made of soft or hard wood, or a good straight broom handle may be used, cutting it to the length required, which is about 9 in. longer than the width of the door to which it has to be fixed.

Two brackets will be wanted, one shaped as Fig. 2, to screw to the architrave at the hinged side of the door, on which that end of the rod is pivoted with a screw, as shown. The other bracket is shaped as Fig. 3, and is screwed on to the front stile of the door, the rod passing through it. The hole must be of such a size that the rod will slide freely, and should be made smooth, so that there is no friction.

The brackets must be of such a width in relation to each other that when the door is closed, the rod will be parallel with it (as in Fig. 4); and it must be far enough away from the architrave at the top of the door as to allow the rings on which the curtain is suspended to slide freely, without coming into contact with anything.



The rod may or may not be fitted with an ornamental end (as shown in Figs. 1 and 4), as preferred. If so fitted the end must be removable, so that the rings can be taken off when required.

The brackets must be fixed well up (as in Fig. 1), so that what draught comes in over the curtains is turned towards the ceiling.

Wooden rings (as in Figs. 5 and 6) should be used, and though they may be purchased cheaply, our readers may prefer to make their own, either by cutting them out of fretword (as in Fig. 7), or by turning them in a lathe (as in Figs. 8 and 9). By the former method they simply require cutting out and the corners glass-papered off to be passable, though with a file and a chisel they may be made much better.

The rings may be turned in the lathe, by first turning the mandril *A* (Fig. 8), then boring a hole to fit this through the piece of wood *B*, and driving it on, as shown. This can now be mounted in the lathe and turned first as on the left in Fig. 9, then the corners taken off, as on the right, finally cutting each through into the wood mandril.

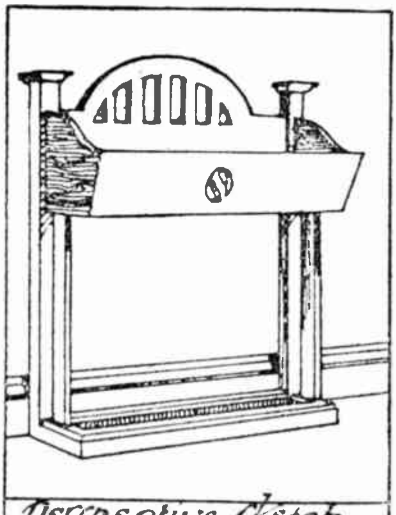
It is not necessary for the rings to be round in section; they may be square (as Fig. 10), or octagon outside and square inside (as Fig. 11), though they can easily be turned to the round section on the outside, and worked by hand on the inside.

A stronger rod is formed if the pivoted end is shod with brass or iron (as Fig. 12), or failing this, the screw hole may be brought further from the end to gain strength (as Fig. 13), and the bracket screwed to the outside of the architrave instead of on the face (as Fig. 14), this giving the end of the rod room to swing round.

Small screw eyes fixed in the rings form the means of attachment for the curtain, and to get the most strength these should be screwed into the side grain of the wood.

DESIGN FOR AN UMBRELLA STAND

This piece of furniture is of simple construction, suitable for making in almost any wood, and will be found convenient in most homes. The sizes given could be reduced a little if desired.



Perspective Sketch

No more seasonable piece of furniture could be started at the present time and in style it is thoroughly up-to-date and effective. One of its chief characteristics is its sloping front rail, which gives it considerable distinction.

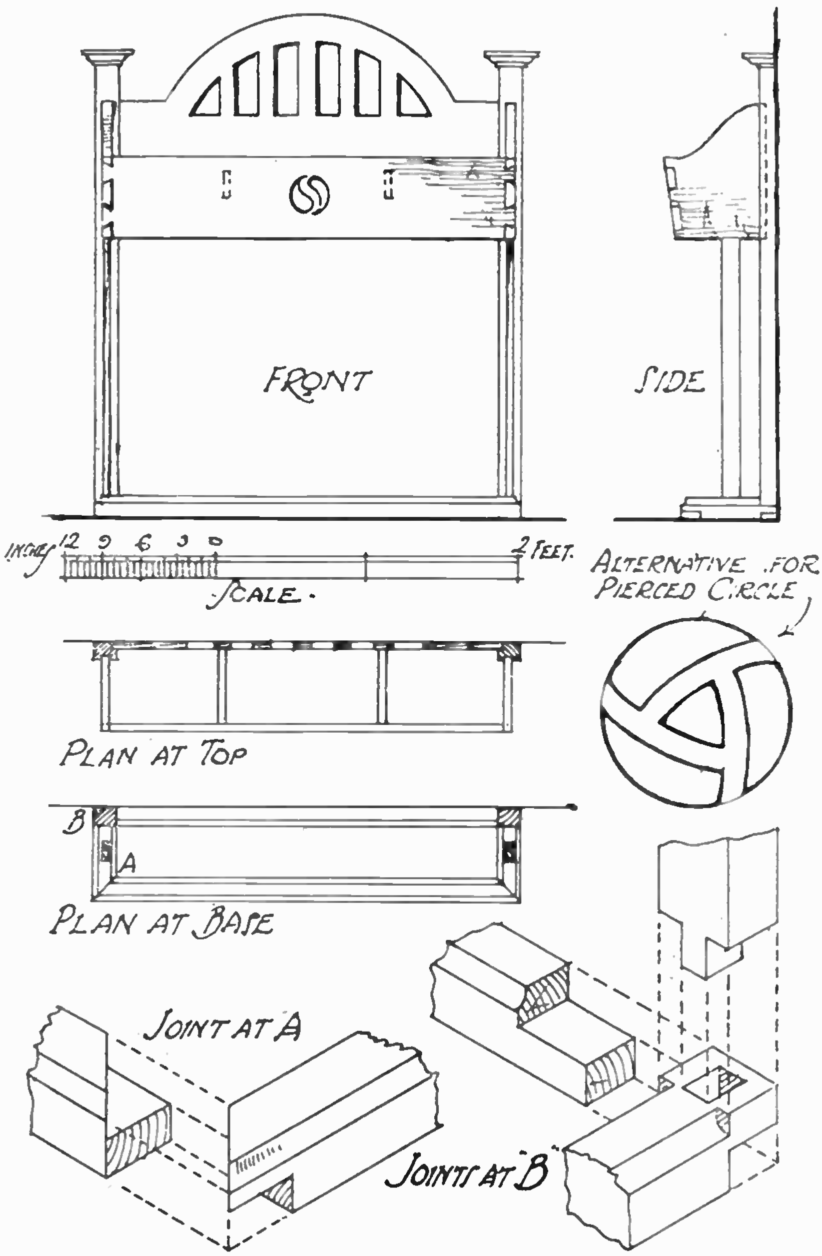
DETAILS

It consists of a rectangular base of 2 in. by 2 in. stuff, halved and mitered together, and having a hollow chamfer along the upper edges, all as shown by the enlarged details at *A* and *B*. Into the back corners of this base are tenoned a couple of 2 in. by 1½ in. uprights, having neat moulded caps as a finish to their tops. The back consists of two 9 in. by ⅝ in. boards (the top one cut to the pattern shown) either dowelled or simply glued to each other, and fixed into rebates at the backs of the upright. The six piercings should go right through the board.

FRETTED FRONT ORNAMENT

The remaining portion of the stand comprises two ⅝ in. shaped ends, housed into the uprights and dovetailed to a 7 in. by ⅝ in. inclined front, having some simple circular ornament 3 in. in diameter cut through the centre.

AN UMBRELLA STAND



Under the end pieces are fixed thin uprights, say 1½ in. by ⅜ in., and light strips are fixed where dotted on the drawing of front, in order to form three compartments. The fretworker can, if he chooses, introduce a more elaborately fretted panel in the front with advantage.

A zinc tray with wire handles should be obtained to fit loosely into the base.

A WOOD FINISHING KINK

C.W.M.

The following short article describes a method used by the writer in finishing a large amount of Georgia pine, hemlock and cypress, which, for simplicity, cheapness and excellence of results, is hard to beat.

The stain is composed of burnt umber, preferably the dry color, although the color as sold in cans, ground in oil, may be used; this is mixed with turpentine, using enough burnt umber to make a heavy stain, in fact, heavy enough so that when put on the wood with a brush, it will cover the grain entirely, much the same as a dark brown paint.

In using the stain, apply with a paint brush in any manner to cover the surface, as it will make no difference with the result whether it laps or not; as soon as the surface looks dull in spots, rub hard with a piece of burlap, rubbing with the grain where possible, and removing all the surplus powder; this will bring out the grain of the wood in a most gratifying manner. If the grain does not show up with good contrast, continue the rubbing until the desired effect is obtained.

When the stain has thoroughly dried, apply a coat of shellac; when dry, rub lightly with very fine sandpaper, and finish with a thin coat of good varnish.

A word of caution may not be out of place in regard to putting stain on more surface than can be rubbed before drying; this, of course, will depend upon the temperature of the workroom and character of the work; also bear in mind that there is more danger of getting the stain too thin, than too thick; be sure it is thick enough before commencing.

It is understood that this article may not be of value to the professional wood finisher, but is intended for the every-day handy-man, who has no special knowledge of wood finishing, and perhaps cannot afford the high-priced preparations which are upon the market.

It can be used successfully by anyone capable of using a brush, bringing out the natural beauty of the above-mentioned woods, which, when finished, will closely resemble black walnut.

DEVICE FOR HOLDING POLISHED FIXTURE PIPE TO PREVENT MARRING

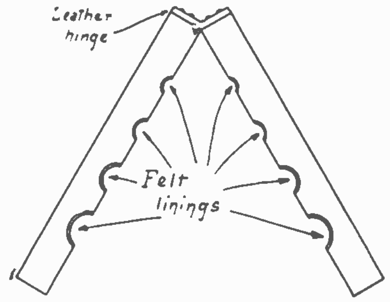
W. M. KISHPAUGH

A very useful device for holding polished fixture pipe of different sizes while threading, cutting off, etc., is shown in the accompanying illustration.

It is quite important that the polished pipe used in ornamental gas and electric fixtures should not be marred while working on it.

The device consists of pieces of oak, 1½ in. x 2 in. by 12 in. long. These are placed in a vise with the broad faces together, and holes from ¼ in. to 1½ in. bored in them, using the line between the two pieces as the centre line for the holes as shown. Half of each hole will be in each piece.

A hinge consisting of a piece of leather is placed at one end joining the two pieces together, and soft felt is glued tightly on the inside of the strips. The pipe is placed in the hole in the block best suited to its size, and the block placed in a vise and the latter tightened down.



Any amount of work may be done on the pipe without danger of marring it.

This little wrinkle is used by one of the largest electrical contracting firms in this city.

THE MOTION PICTURE—Part V

STANLEY CURTIS

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

An inexpensive and thoroughly reliable rheostat for use on 550-volt circuits may be constructed by almost any operator, providing the work is carefully done. Particular attention must be given to the insulation of such a rheostat, however, or trouble may be expected.

The rheostat to be described will carry a current of 25 amperes for over an hour without overheating, and for short runs of twenty minutes or so it will pass 35 amperes without danger of burning out.

In calculating the amount and size of wire necessary to give us the proper resistance for any circuit we make use of Ohm's law, which reads as follows: "The strength of a continuous current in a circuit is directly proportional to the electromotive force acting on that circuit, and inversely proportional to the resistance of the circuit." That is, the current is equal to the volts divided by the ohms; or, as it is expressed, $I=\frac{E}{R}$. For instance, an ordinary 110 volt, 15 c.p. carbon filament incandescent lamp has an approximate resistance of 220 ohms. If this lamp is connected to a circuit, having a pressure of 110

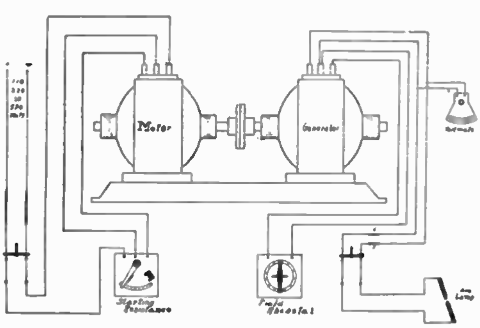
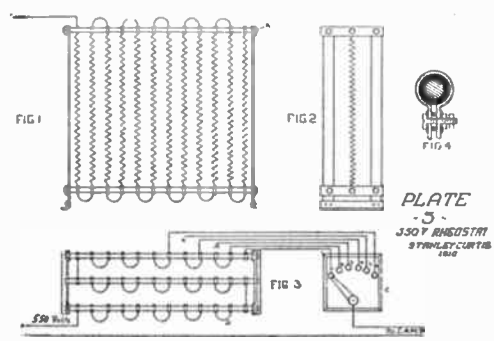


PLATE 2-MOTOR-GENERATOR

volts, the current passing through the lamp would be 110 divided by 220 or .5 of an ampere.

From the formula $I=\frac{E}{R}$, we may take two others: $\frac{E}{I}=R$, or the volts divided by the amperes equals the ohms, and $I\times R=E$, or the amperes multiplied by the ohms equals the volts.

In designing the rheostat for use in series with a single arc on a 550-volt circuit, we must first determine the amount of current we shall have to use in order to produce a sufficiently powerful light. As 25 amperes will, in most cases, give the desired result, we will use that as the minimum amount of current



the resistance in question will pass. By applying the formula $\frac{E}{I}=R$ and dividing 550 by 25, we find that we shall have to have a total resistance of 22 ohms in the circuit. Now, the resistance of the arc, when the carbons are separated $\frac{3}{16}$ in., is about 1.6 ohms; and the resistance of carbons, connections and wire may be put at .4 of an ohm. Therefore we must have about 20 ohms' resistance in the rheostat in order to pass the desired amount of current.

German silver wire may be used for the resistance coils. This wire, in a 30 per cent. alloy, has twenty-eight times the resistance of copper, and has a resistance of 17.95 ohms per 1,000 ft. in the No. 8 size. The safe carrying capacity of No. 8 German silver wire for continuous duty is 17 amperes, but for intermittent duty the capacity is doubled. For projection work we may safely "split the difference" and figure on this size as the one to use, as the machine will seldom be used for any great length of time on the 550 volt circuit with a rheostat, owing to the enormous waste of current and resultant expense.

As this size of wire has a resistance of

17.95, or practically 18 ohms per 1,000 ft., we shall have to use about 1,110 ft. of wire to give the desired 20 ohms resistance. The wire may be wound in coils over a wooden mandrel 1½ in. in diameter. If eighty turns are put on for each coil, the turns will be somewhat less than ⅜ in. apart when the coil is pulled out to 28 in. in length and fastened in the frame, as shown in Plate 5, Figs. 1 and 2. There will be about 31 ft. of wire to each coil, and in 36 coils, therefore, we shall have 1,116 ft. of wire.

The frame or support for the coils is best made of ¼ in. strip and angle iron, as shown in the cut. The rods from which the coils are supported are pieces of ¼ in. gas pipe. Fig. 4 in Plate 5 shows the method of clamping the ends of the coils. A strip of ⅛ in. brass is bent as shown, and is insulated from the gas pipe by sheet asbestos. After assembling the spirals, they are all connected in series. The controller shown in Fig. 3, Plate 5, enables the operator to cut out from one to six of the coils, thereby increasing the current when necessary. This will be found very convenient, if the current is taken from the railway feeders, as the voltage lowers when a car passes.

As mentioned above, a rheostat is very wasteful of current, especially on circuits of from 220 volts upward. For example the arc requires about 25 amperes at 45 volts, or 1,125 watts to furnish light. Therefore we use up 25 amperes at 505 volts on a 550-volt circuit in the rheostat. It will be seen at a glance that 13,750 watts are wasted in the resistance, and only 1,125 watts are actually used to produce the light. Practically the only means of avoiding this enormous waste of current is to use a motor-generator set, a diagram of which is given in Plate 2. Here we have a motor, wound for the line voltage, direct-connected to a low-voltage dynamo. The dynamo is usually shunt wound and the voltage may be varied by turning the handle of the field rheostat. The dynamo terminals are connected directly to the arc lamp, with little or no resistance in the circuit. A voltmeter is generally used across the generator terminals to show when the proper voltage is obtained before striking the arc.

Such a set requires practically no attention, except cleaning and oiling, and will soon pay for itself in the amount of current saved, if the arc lamp is required to burn for any great length of time.

Direct current has been almost entirely replaced with alternating current in the outskirts of nearly every city and town; in fact, in some of the more recent central station installations, alternating current is the only kind generated for use on power and lighting circuits. The principal reason for this is the fact that alternating current may be generated at a comparatively high voltage at the plant, then "stepped up" to a far greater voltage by means of "transformers," and finally sent out over a transmission line of comparatively small copper wire to the centre of distribution, perhaps many miles away, where it is "stepped down" to the usual 110 or 220 volts for use in the stores, residences, factories, etc.

A high tension current may be sent over a comparatively small wire without undue loss or heating, whereas the same amount of energy, at a pressure of 110 volts, for instance, would require many times the cross-section of conductor to carry it to the consumers. Therefore, the alternating current system means a great saving of copper in long transmission lines.

On an alternating current circuit we may make use of a type of the "transformer" above mentioned, to cut down the usual 110 or 220 volts to the 40 or 50 required for the motion-picture arc, and at the same time save the extra current that would be wasted in a rheostat, if one were used.

Before taking up the use and connections of the transformer, let us understand the principle on which it operates. This principle is based upon a property of electricity known as "induction." If two wires are laid side by side, but insulated from each other, and an alternating current is passed through one, a similar current will be "induced" in the other wire, even though they are not connected in any way. Now let us wind, say, five turns of rather heavy insulated copper wire around one end of a bundle of soft iron wires, perhaps ½ in. in diameter by 6 in. long. Then, on the remaining space on the iron "core" we wind, say, fifty turns of somewhat finer insulated wire. The two ends of the fine wire may then be connected to the terminals of an 8 c.p., 110-volt lamp. If we connect the ends of the heavy wire to the terminals of a rather powerful battery having a pressure of about 6 volts, the lamp will flash up brightly every time the connection to the battery is broken. This is due to the higher voltage induced in the fine wire, the inductive effect being greatly enhanced by the presence of the iron core. While, in the above example, an "interrupted direct current" was used for sake of convenience, the effect would be the same with alternating current. The reversals of current would come so rapidly, however, that there would be no "flashing" of the lamp and it would burn steadily.

The current induced in the fine wire will be greater in potential and less in amperes than that of the heavy wire. This ratio is almost entirely dependent upon the relative number of turns existing between the large and the small wires. Thus, if we connect the ends of the fine wire coil to a 110-volt circuit, an electromotive force of 10 volts will be induced in the coarse wire coil. It is upon this principle that the "economizers" for motion-picture arcs are constructed. A glance at Fig. 2, Plate 3, will make this clear. The current passes through the primary coils *P*, around the core *C*, at a voltage of 110 or 220. This induces a current of twice the amperes but only about half the voltage, in the secondary coils *S*. The secondary terminals are connected to the arc *L*.

If an alternating current is passed through a solenoid or hollow coil of wire, secondary currents will be induced in each neighboring turn. These currents tend to oppose the flow of the main current, and constitute what is known as an "inductive resistance." If a mass of laminated iron is placed inside the solenoid, this retarding effect is greatly increased and we have what is called a "choke coil." Choke coils are often used on motion-picture arcs, and the connections are shown in Plate 3, Fig. 1. A small choke coil is introduced into the primary circuit of the transformer in Plate 3, Fig. 2, at *R*. By means of this coil the voltage and resultant current in both primary and secondary may be increased or diminished as required.

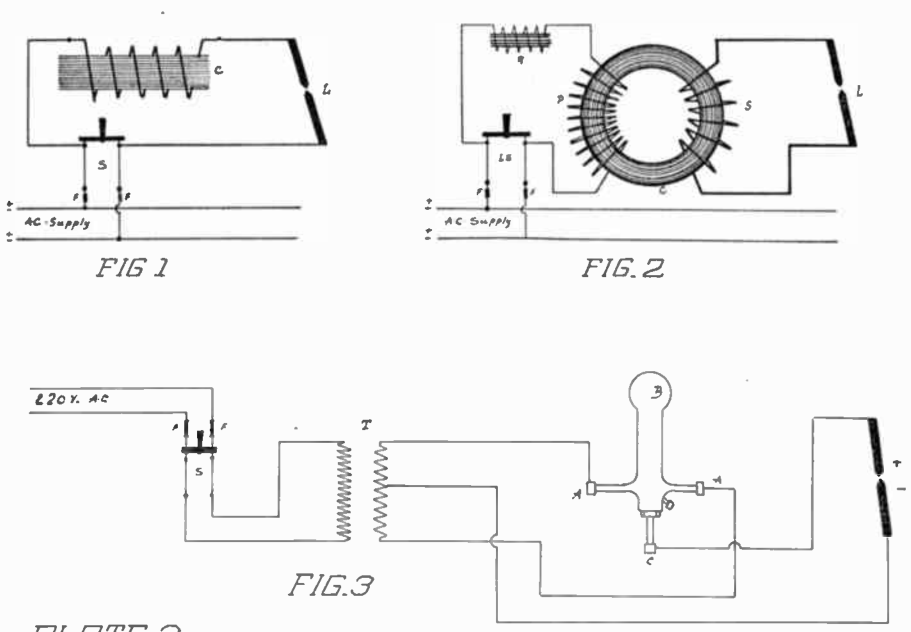


PLATE 3 STANLEY CURTIS 1910

Thinking that perhaps some reader of an experimental turn of mind might like to try his hand at the construction of an inductive resistance to replace a rheostat on an alternating current circuit, the writer will describe a choke coil, built by him several years ago and which gave excellent service on a 60-cycle, 110-volt circuit. The coil consists essentially of a solenoid of insulated copper magnet wire *A*, Fig. 10; the fibre support or bobbin, *B*; the laminated iron core, *C*, which can be partially withdrawn from the solenoid by means of the rod, *D*; the whole mounted upon a slate baseboard, *F*. Figs. 11 and 12 give the end elevation and plan, respectively; in Fig. 12 the core is shown drawn out to the fullest extent.

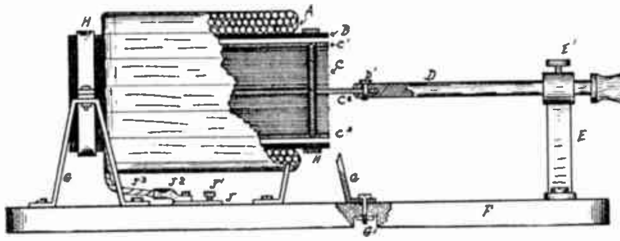


Fig. 10

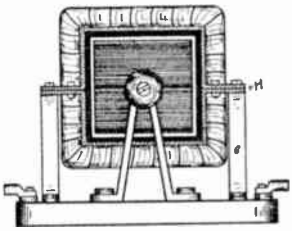


Fig. 11

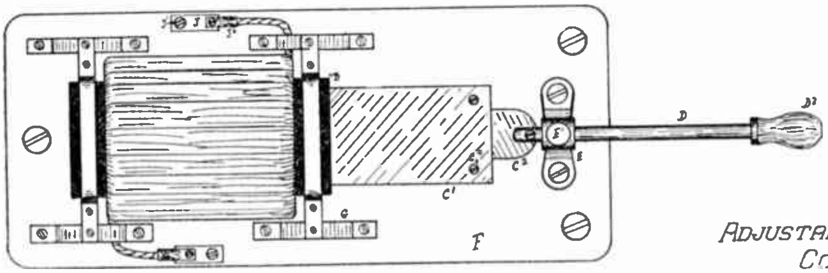


Fig. 12

Adjustable Choke-Coil
Stanley Curtis 1910.

We will first take up the construction of the core, which consists of a pile of very thin sheet-iron plates cut 8 in. long by 3 in. in width. There must be enough pieces cut to make a pile $2\frac{11}{16}$ in. high when tightly clamped together. We shall also need two pieces of $\frac{1}{8}$ in. iron plate cut to the same size, and a piece of $\frac{1}{16}$ in. sheet-iron cut to this size, but having a projecting tongue, C^2, Figs. 10 and 12, on which to fasten the rod, *D*.

After cutting the laminations of thin sheet-iron (the writer used "stove-pipe iron"), each piece should be coated with shellac varnish. A quick and effective method of doing this is to dip the sheets in a shallow tray containing the shellac, holding the sheets of iron by the edges and afterward standing them on edge to dry. The insulation of one piece from another in this manner materially reduces the quantity of heat which develops in the core, after long use. When the iron is dry, divide the mass into two piles and place the $\frac{1}{16}$ in. plate with projecting tongue between the piles. (See Fig. 10.) The $\frac{1}{8}$ in. plates are then placed on top and bottom and the whole bundle squared up. Clamp the bundle firmly together with a hand-clamp and drill a $\frac{3}{16}$ in. hole down through the pile, in each corner of the plate, to take the clamping screws, C^4, Fig. 12. These holes should be drilled down to the bottom plate, but not through it. In this plate holes should be drilled and tapped for the long 8-32 screws, one of which is shown in Fig. 10. The heads of these screws must be countersunk in the top plate and the body of the screws insulated from the core by wrapping paper around them, before inserting in the holes. If the work has been carefully done, we now have a compact mass of laminated iron 3 x 3 x 8 in. with a projection, to which we secure the $\frac{3}{8}$ in. brass or iron rod, *D*.

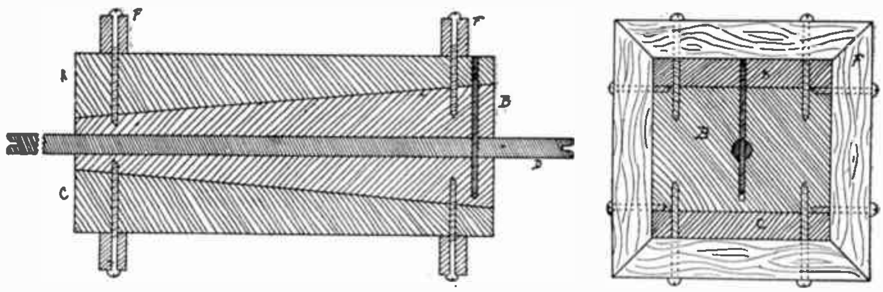


FIG. 13
Stanley Curtis 1919

A wooden handle, D^2, is drilled to slip over the end of the rod and fastened by means of a screw in the end.

The winding of the solenoid or coil is best done in a lathe, as the heavy copper wire is most difficult to handle. The "former," on which the coil is wound, is made as shown in Fig. 13. It consists of three oblong blocks of wood, each having surface dimensions of 3⅜ x 8 in., and tapering in thickness, so that when the three are placed together the total depth is 3⅜ in. A glance at Fig. 13 will make this clear. The tapering construction is used so that the centre piece, *B*, may be driven out after the coil is wound, thus collapsing the form. A 12-in. length of ½-in. soft steel or iron rod is centered in the block, *B*, and prevented from turning therein by the insertion of a 5/16 in. pin into a hole drilled through block and rod. Small blocks of wood, *F*, may be fastened by screws to the body of former and spaced 6 in. apart. These will prevent the turns of wire from separating when the second and third layers are put on.

The former may then be placed between the lathe centers and secured to the face plate by means of a dog, as shown in Fig. 14. A piece of friction tape about 16 in. long should be placed on each of the four sides of the former, so that the coil may be held together while being removed from former. The tape will readily adhere to the wood while the

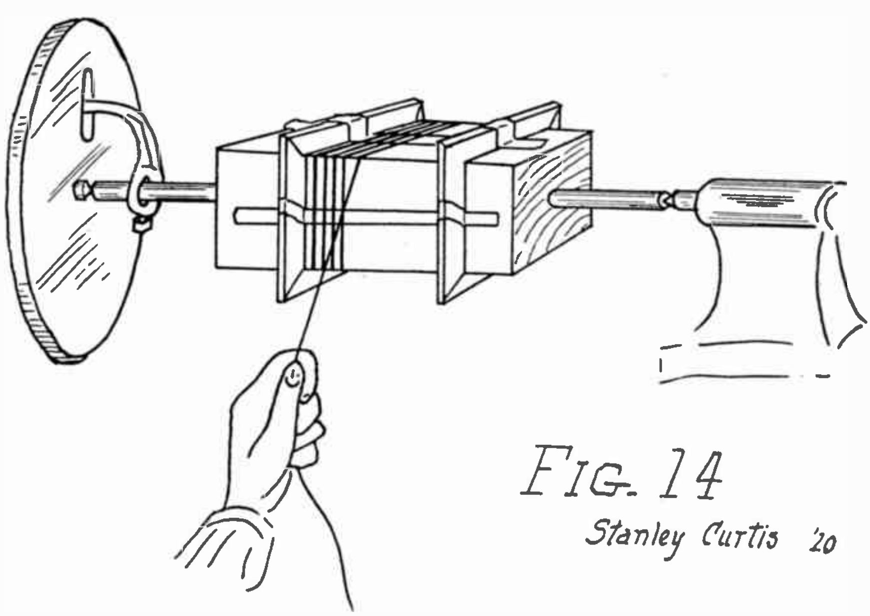


FIG. 14
Stanley Curtis '20

winding is being done. About 8 lbs. of No. 6 double cotton-covered magnet wire will be required. If carefully wound, 32 turns may be put on in each layer, and the winding is three layers deep. The starting end of the coil should be securely fastened, as shown in Fig. 14, by passing it through a notch in one of the retaining blocks, when by tightening the screws, the wire will be firmly clamped. The lathe should be turned in the direction of the arrow and at the slowest speed. The spool of wire is placed on a spindle to the left of the operator, who should wear an old pair of heavy gloves, as otherwise his hands will be burned by the friction of the wire as he guides it onto the former. A small wooden mallet will assist in flattening the turns, especially on the first layer. In winding the second and third layers the operator will have no difficulty in guiding each successive turn into the channel formed by the turns beneath it. This is clearly shown in Fig. 10.

After the winding is finished, the ends of the tape previously mentioned must be brought up tightly over the coil and stuck together. After removing the former from lathe, the center block may be driven out, the former collapsed, and the wire, now in a solid coil, removed ready for taping.

The ordinary cotton tape sold in rolls is most suitable for our purpose. The insulating tape known as "friction tape"

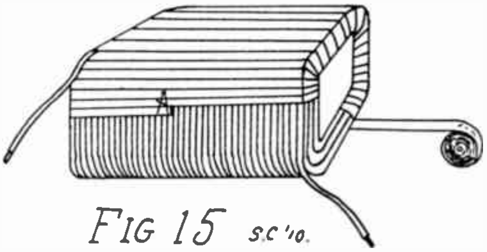


FIG 15 S.C. '10.

should not be used, as it will emit a most disagreeable odor if the coil becomes warm in use. After selecting a width of cotton tape,—the ¾ in. width is just about right,—the end is secured to the coil with shellac varnish, as at *A*, Fig. 15, and the roll passed through the center of the solenoid, first removing the piece of friction tape at this point. The cotton tape is wound tightly over and through the coil, each turn of tape overlapping its neighbor for about half the width, until the entire mass of wire is neatly covered from end to end, with the starting and finishing ends of wire projecting from their respective corners. The starting and finishing point of the tape will be at the bottom of the coil, when it is in position. The whole layer of tape should be given two coats of thin shellac, the first coat being thoroughly dried before the second is put on. A final baking for two hours in an oven is desirable but not absolutely necessary.

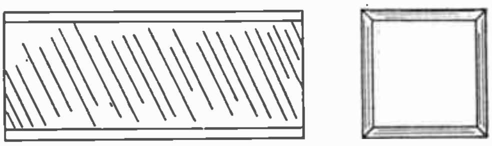


FIG. 16 S.C. '10.

While the shellac is drying, the fiber tube which supports the solenoid may be made. Four pieces, each 8 x 3⅜ in., are cut from a sheet of ⅛ in. fiber and the edges beveled, as shown in Fig. 16, so that when assembled the pieces will form a tube 8 in. long and 3⅜ in. square on the ends.

Before forcing this tube into the solenoid, thick shellac should be applied to the beveled edges of the sheet fiber. When this is dry, the sides of the tube will be firmly cemented together.

The baseboard should be of slate, cut to 8 x 20 in., and about ¾ in. in thickness. The solenoid is secured to it by means of ⅛ x ¾ in. soft iron strip, bent to the shape shown in Figs. 10 and 11. The method of fastening the supports to the slate is shown in Fig. 10 at G^1. Further description is unnecessary.

The starting and finishing ends of wire are soldered into copper lugs, which are clamped to the copper or brass plates, *J*, on the base.

The regulating rod, *D*, passed through a rigid support, *E*, and may be held at a given position by setscrew, E^1. The support must be good and stiff, as the current has a tendency to pull the iron core into the solenoid, while coil is in operation. This pull is surprisingly powerful, too.

The coil is connected in the circuit in the same manner as a rheostat, and the current is increased by withdrawing the iron core from the solenoid. The core should be *in* when arc is started and gradually drawn out until enough light is obtained.

The above coil will carry 50 amperes safely and give results far superior to rheostats on an alternating current circuit. On a current of high frequency, such as 125 or 133, it will be necessary to pull the core out farther than on a 60-cycle current, for the retarding effect is greater as the frequency increases. Needless to say that this coil *will not* operate on direct current.

The operator who uses a choke coil or transformer on his lamp will often be annoyed by having the lugs or terminals of the asbestos-covered cable burn off, perhaps in the middle of a reel. This is due to the heating effect of the heavy current, combined with the intense heat of the arc. On nearly all of the new models of arc lamps this mishap is prevented by a solid bronze arm extending back and well away from the arc. To this arm the terminals are fastened. The operator who uses one of the old lamps may improvise an arm of ¼ in. copper rod, flattened at either end, as shown in Fig. 17. One end of

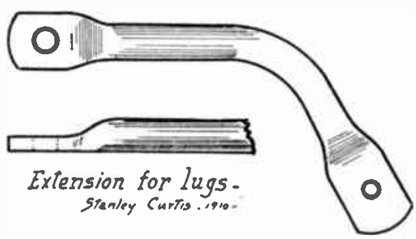


Fig. 17

this is clamped to the lamp terminal and the other extends back for connection to the cable.

Another annoyance to be found on the old lamps is that of having the bronze arm, under which the carbon is clamped, break, thereby dropping the carbon out of the lamp. This may be prevented by using an arm of cold-rolled steel forged to the shape shown in Fig. 18.

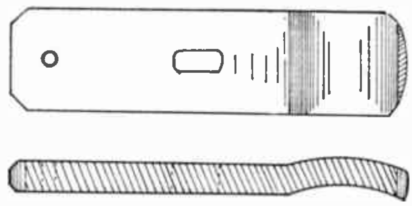


Fig. 18

This will stand the heat and expand without cracking.

As already mentioned, direct current gives the ideal light for projection work, but on account of the cheapness of transmission, alternating current is the only kind used in many places. The "happy medium," and, in the hands of an intelligent operator, the ideal system, is found by the use of a "Mercury Arc Rectifier," a very simple diagram of which is given in Plate 3, Fig. 3. For sake of simplicity the starting coils, magnets, cut-outs, etc., have been omitted, as space would hardly permit of a just description.

The instrument is supplied with alternating current through the switch, *S*, from which it goes to the step-down or auto-transformer, *T*; the alternating current then passes to the rectifier, *B*, which changes it into direct current for use at the arc. By simply closing the switch and touching the carbons of the lamp together the rectifier is started and the lamp supplied with a steady direct current of just the proper voltage without the use of rheostats.

These rectifiers are very economical in operation and, with proper use, will not get out of order.

(*To be continued*)

THE FUTURE OF ELECTROPLATING FROM THE ELECTROCHEMIST'S VIEW

Address by Percy S. Brown before the National Electroplaters' Association.

There seems to be a general impression among platers that the chemist is merely a theorist and they are inclined to smile whenever he attempts to show them some points about plating. This attitude is an unadvised one, as the modern chemist is, as a rule, a specialist and when he becomes interested in plating it is only a matter of a short time before he learns the practical points and becomes equipped to more than compete with the experienced plater.

ELECTROPLATING AND CHEMISTRY

Electroplating is essentially a chemical,—or, more correctly, an electro-chemical process, and, therefore, it is far easier for a chemist who knows the theory of electrolytic action to learn the practice of plating than for the practical plater to learn the theoretical. Eventually the plater will also be a chemist as a matter of self-protection, as otherwise he will find himself being replaced by the younger generation. If you make inquiries among foremen platers, you will find that they are awakening to this fact and are looking into the question of taking up the study of chemistry either in night schools or by correspondence.

If we give credit where credit is due, we will find that the greatest advances in electroplating have been made through the published researches of chemists and metallurgists or platers well versed in chemistry. Such names as Classen, Sang, Cowper-Coles, Watts, Langbein and others should be well known by every plater through their researches in electroplating and similar lines. The improvements in the art of electrodeposition have been so gradual that we are inclined to feel that it is but the natural outcome of a progressive age and not due to the careful work of a few able men. Unquestionably our progressive platers' supply houses have been instrumental in bringing about improvements; but many of these improvements are the result of years of work by chemists and metallurgists either directly in their employ or whose patents and investigations have been considered of sufficient monetary value to receive their financial backing. In the same way the competition between the various supply houses has been a direct means of benefiting the plater, as this competition has caused great improvement in the quality and variety of the various materials used in plating and has aided in the development of new methods and processes. In all of these improvements you will find that the chemists had an active part, and it is certain that the more closely the chemist becomes associated with the supply houses the more improvements will be made.

A KNOWLEDGE OF CHEMISTRY

As an example of how a knowledge of chemistry will benefit the plater, I know of cases where materials are sold under fancy names and when analyzed are found to be commercial material that can be purchased on the open market 100 per cent. cheaper than they can be purchased from the supply houses. This is no exaggeration but an absolute fact, although fortunately it is a severe case and one not occurring very commonly. The fact that platers' supply houses are not immune from taking large profits for commercial material sold under fancy names makes it all the more necessary that the plater should be able to determine the quality of the material that he is buying. The plater who can demonstrate to his employers how he can save them money by his knowledge of chemistry will soon be pushing the so-called practical old-time plater to the wall.

THE OLD METHOD

The old method of mixing solutions by adding a little of everything at hand until the solution works satisfactorily is gradually disappearing, as the plater begins to realize that possibly some of the ingredients are unnecessary. We are all aware that many of the common formulas used today are the outcome of haphazard experiments and that many so-called "trade secrets" are compounded in this manner and are for the most part useless. There are but few of the "trade secrets" that would stand the light of day and many owners of such "secrets" would wonder how they ever had faith in them should they once be submitted for unbiased comment. The chemist is in reality an enemy to trade secrets. He is in a way a detective and on analyzing a secret solution discovers that the secret so jealously guarded is merely some commonly used solution with some inert material added which is useless except so far as it gives the owner of the secret a good excuse for secrecy and an excellent chance to hoodwink others.

The chemist figures theoretically the quantity of different materials, knows their properties and action, whether they will mix without a chemical change taking place, whether they will have a poisonous effect and all the large and small things necessary to the successful outcome of his work. He is like the engineer and other professionals who have a definite object in mind and work on scientific principles to obtain results.

PROGRESS IN ELECTROPLATING

There are many platers today who follow the chemist's line of work and a number of these are well versed in chemistry; but there are also many who are neither the one nor the other and they are the ones who ten years from now will be just where they are today, if not further down the scale. The day of the old-time plater and his secret formulas and methods is passing, and passing rapidly, and modern methods and modern platers are coming rapidly to the fore, and before long chemistry will be the *open sesame* to the best positions offered.

The thing to remember, however, is that success will not come to even the chemist plater unless he realizes that to attain success he must put behind him all the old ideas and distribute his knowledge freely to others. Our valuable trade papers have done much to advance the plater by publicity and if the new plater, benefiting by the knowledge he has gained by reading these papers, will write of his experiments and observations instead of hiding them away in the back of his head, as has been the custom, he will be doing himself and the members of his profession untold good and will gain far more than he would under the old régime.

OPPORTUNITIES FOR PLATERS

The opportunity for the new plater was never so great as it is now that we have an association for the purpose of disseminating knowledge of the profession to the profession. Those who believe in the idea of the new plater should not hesitate to come forward voluntarily and contribute their support to the association. Time will show that those who do this will be the ones who believe in the wonderful opportunities open to the plater who has a knowledge of chemistry and they will be the ones who will contribute their knowledge and state the results of their experiments and investigations the most readily. The main fault with the papers prepared by the old-time plater lies in the fact that his arguments are seldom convincing; he lacks the necessary knowledge of chemistry that would not only clinch his arguments, but would also give him the feeling of confidence in his results only obtained by those who have accomplished their end by careful scientific investigation and not by hearsay or by careless methods.

STUDY CHEMISTRY

There is no doubt that the plater is beginning to realize the advantages that chemistry holds for him, and there are many today who are spending their days hard at work and their evenings poring over chemical text-books or in classes at night school. Many of these men are middle-aged and have families and they realize that their earning capacity will be increased by a knowledge of chemistry, and therefore do not hesitate to sacrifice their evenings to study in order better to provide for the future. These men and the younger generation who are studying chemistry while they are learning the practical part of plating are the ones to whom the greatest credit is due, and their success is certain. The future will see the electroplater a chemist with absolute certainty, unless he be so short-sighted as to neglect the psychological moment that opportunity offers.

—*The Keystone.*

Ferro-Silicon

This material, now largely used to improve the physical qualities of steel, possesses peculiarities which render it, in some conditions, dangerous. Attention was first drawn to this fact in 1907, when it was discovered that ferro-silicon gave off poisonous emanations and was liable at times to cause explosions. In 1908 the death of five persons on a ship carrying a cargo of ferro-silicon was ascribed to its action. Investigations were then set on foot, and the report of the local government board in England on the subject has just been published. The material is an alloy of iron and silicon, but there appears to be no chemical union. Singularly enough, the dangerous gases are produced most abundantly when the percentage of silicon is about 50, but if the percentage is above 70 there appears to be no danger. The investigators recommend that the transport and storage of ferro-silicon be confined to grades in which the percentage is below 30 or above 70.

FLIGHT

THE "GNOME" AVIATION ENGINE

AUSTIN C. LESCARBOURA

In cross-country, altitude, endurance, distance and every incident connected with successful aeroplane flights, we find the "Gnome" motor was used by the victorious aeroplane driver in most instances. It is a recognized and proven statement that the "Gnome" motor is the leader of all other aeronautic engines. At the Harvard and Belmont Park meets in this country, especially at the latter meet, this engine held its usual prestige over the other entrants. Practically all the world's records are held by this engine today, and even yesterday, for the combination is either the Farman Biplane or the Bleriot Monoplane using the "Gnome" engine. Therefore, in view of the importance of this engine, the writer will endeavor in the succeeding pages to give a description of this wonderful product of French engineering and science.

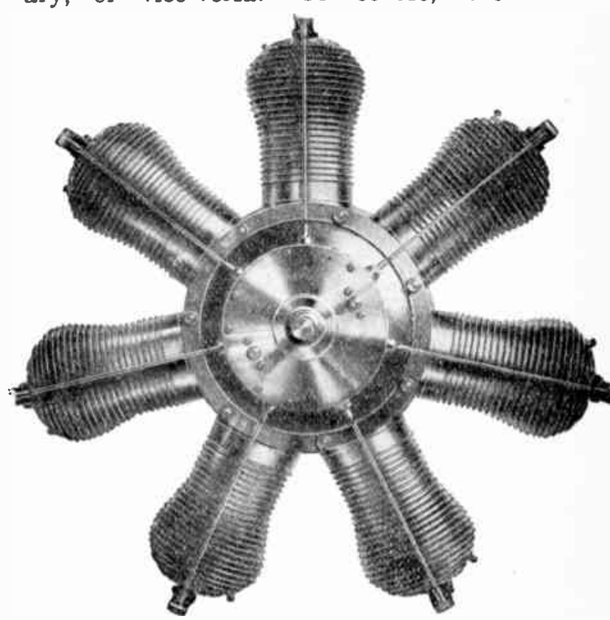
The "Gnome" engine for aeronautic purposes is known as the "Omega type" by the manufacturers. It is built by the "Societe des Moteurs Gnome," Paris, France. It has been constructed, not with the idea of having the parts as light in material as possible, but an engine which is light in design. For this reason, nickel steel is used wherever possible, and aluminun parts are entirely unknown to the construction, for it has been found through actual experience that this metal is unreliable for appliances where life is at stake. This is quite a novel departure from the standard aviation motors which use aluminum in their construction. Furthermore, none of the parts are cast, but each is individually machined into shape.

The engine consists of seven cylinders branching from a common centre which is the shaft. The shaft is hollow, and through this, the cylinders are fed the explosive mixture and the lubricating oil. For lubricating, castor oil is used at the rate of 2 liters an hour. This is also one of the characteristics of the motor, and the burning oil always leaves a long trail of smoke in the wake of the flying aeroplane. Owing to the fact that the shaft is stationary and bolted solidly to the aeroplane framework, the revolving cylinders form a perfect fly-wheel, which causes the motor to work very steadily, and in general principle, not unlike that of the steam turbine as compared with the steam engine. For this reason, the motor will work with good efficiency with one or more cylinders missing, owing to the momentum of this fly-wheel inertia. Through this feature, alone, the motor has advanced to the front rank of aviation, and obtained its renown for smooth running qualities. Another point: the cooling, is accomplished by the cylinders themselves. As each is supplied with cooling flanges, the engine is cooled to perfection by its own movements. It might be interesting to remember that M. Henri Farman, after remaining in his aeroplane four hours and a half, while flying for the Michelin Duration prize, in November, 1909, at Mourmelon, France, on landing, discovered that his "Gnome" motor was perfectly cool, which proves its effectual cooling properties.

The cylinders are turned at present from solid steel bars about 5 in. in diameter, until a tube is obtained with walls of 1.2 m.m. thickness. The wonderful feature of possibly the entire construction is in the thickness and strength of this wall of the cylinders, which withstands the tremendous internal and centrifugal strains. The consumption of petrol is 300 grammes per h.p. per hour. The speed of the motor can be readily throttled from 200 to 1,300 revolutions per minute.

The inlet valves are arranged in the centre of the pistons, and while they are automatic in action, they are of a very delicate nature, in the arrangement of the valves. The piston has a single iron piston ring. Surrounding this piston ring is a brass strip which is bent over. This brass strip is kept expanded by the pressure of the piston ring, and the explosion pressure still further tends to expand it and keep it tight. The piston like the cylinder is of steel. The inlet valves are of the ordinary type, but their stems are engaged by a pair of levers terminating in counterweights. These counterweights are acted on by a flat spring which constitutes the valve closing spring as the engine rotates; the valves tend to fly radially outwards and consequently to open under the centrifugal action. The counterweights exert a centrifugal force in the opposite direction, tending to keep the valves closed, so the effect of rotation neither tends to open or close the valves. The only active effect to which they are subject is that of the spring holding the valves closed and that of the suction opening the valve on the suction stroke. For this complicated description of the intricate inside working of the engine, the writer is indebted to the "Automobile Dealer & Repairer," of England, where the "Gnome" engine has caused quite an interest among the automobile trade.

The magneto is of the well-known "Bosch" type. This is driven by gears of a ration of 4 to 7, and the current is distributed to the seven spark plugs of the cylinders through an ebonite distributor with seven brushes, and from these brushes the current is conveyed to the spark plugs by bare wire. The oil pump is placed on the opposite side of the magneto and is a perfect mechanical pump with two cylinders and two distributors. The reader will note that the magneto, oil pump, carburetor, and the other necessary accestories are at the extreme end of the ssationary shaft of the engine where same is rigidly bolted to the aeroplane frame-work. At the other end of this shaft is the revolving member and the propeller directly bolted to same. The carburetor, as before stated, is placed at the end of the hollow shaft. It has an automatic air valve, and will work satisfactorily under almost any condition found in the art. The spark plugs of the engine cylinders likewise are specially designed to resist the conditions to which they may be subjected, as, for instance, the lubricating oil which forces its way to them. The motor may either be used with the shaft rotating and the cylinders stationary, or vice-versa. Of course, the



most widely used method is as a rotary motor, *i.e.*, with the rotating cylinders and fixed shaft. In the former case it would be practically the same operation as the "Anzani" 5-cylinder motor, and would lose its claim to the class of rotary engines.

Coming to the question of weight it might be interesting, and a marked contrast to compare the "Gnome" engine with an ordinary automobile engine. The 50 h.p. "Gnome" weighs 167 lbs. An automobile engine complete with radiator, fly-wheel and necessary accessories would mean for the same weight, an installation of a 6 h.p. engine.

The 100 h.p. "Gnome" motor which was used by M. Alfred LeBlanc and Mr. Grahame-White in the International Cup Race at Belmont Park, proved to the defenders what a remarkable, unexcelled speed could be derived from the Bleriot-"Gnome" combination. On the straight-away flights M. LeBlanc made speeds in excess of 70 miles an hour and nearer to the 80-mile an hour mark, thereby becoming the speed champion of the world's aviators. A well-known American in aviation circles predicted the victory of these machines in the month preceding the meet, and, furthermore, claims that this type will hold its own for time to come, excepting possibly the "Baby Wright." This machine came within the shadow of Mr. Grahame-White's speed during the contests, but far from equalling that of the little Frenchman.

The 100 h.p. "Gnome," roughly speaking, consists of two 7-cylinder 50 h.p. units connected on the same shaft and bolted together. The cylinders are so arranged that looking from the front, the cylinder of the rear engine will be half-way between the cylinders of the front unit, therefore allowing every cylinder to be seen from the front, the reason being to allow each cylinder to receive the full effect of the inrushing air and thus get the maximum cooling effect. The pessimists who predicted that the 100 h.p. would not remain cool during the one-hour flight required to cover the 65 odd miles of the race were keenly disappointed in their prophecy, for the engine of Mr. Grahame-White was sufficiently cool at the finish to very probably go quite a little distance beyond that required. He readily finished, and barring the unfortunate accident of M. LeBlanc, he would also have finished the single mile that barred him from the victory.

As to the size of the 50 h.p. "Gnome," the writer will tell of a little incident at Mineola Aviation Field, while recently watching Mr. Clifford B. Harmon preparing for a flight. The "Gnome" on the "Henri Farman" biplane was still at rest. One of the spectators turned to the writer and asked if Harmon was going to fly. On being answered that he was, the spectator asked where was Harmon going to get power. I pointed to the "Gnome," much to the surprise of the man, for, he told me, he had taken that for another "monkey-business," but never would call that a motor. Compared to the 7-ft. propeller which is connected onto it, it is difficult to see where such a small machine can do the work, so I fully assured the man in a serious manner.

As a final word, not only is the "Gnome" motor a wonderful machine as a piece of machinist's work, and also in regard to the design and science which brought it to a commercial success, but its name, the "Gnome," has been well chosen, for in its use aviation has become a more substantial sport. A reliable motor was the missing "link" in the aeroplane flights of the early pioneers, and today this problem has been well overcome. The next problems to be solved will be those of better construction and better designs in the aeroplane proper. As to the American and European engine manufacturers, who are at present embarking new rotary engines on the market for aviators, let us close with the old proverb, "Imitation is the sincerest flattery."

M. Lepine, the prefect of police in Paris, has had the question of regulating aerial circulation under consideration for some time, and has now drawn up a code which will be put into force at an early date. The chief provisions are:

1. The new regulations will apply to the three following classes of machines for aerial locomotion: aeroplanes, dirigible balloons and free balloons; all three classes will be included under the general denomination of aeronefs.

2. Landing at any point within the city of Paris or the communes of the Seine Department is forbidden.

3. Apparatus circulating above Paris and the chief towns of the department must keep at such a height that a landing can be made at a point free from collections of buildings.

4. Pilots of dirigible or free balloons may not throw overboard any form of ballast but fine sand.

5. No aeronefs, if compelled to land unexpectedly, may make a new start from the place of landing. All apparatus must be taken to pieces and removed to the nearest fixed starting grounds.

THE MODELMAKER

E & M

75-WATT BIPOLAR DYNAMO WITH WROUGHT IRON FIELD MAGNET

WM. C. HOUGHTON

Part II.—Winding and Assembling

The armature may be first taken in hand. The core slots, heads and shaft for 3/4 in. at each head should be thoroughly insulated. The writer has found that a special grade of tough cotton paper about .008 thick, put on with shellac, is best for this purpose. It should be obtained with the other materials for the machine. Micanite, Empire cloth, thin muslin, etc., may be used if the cotton paper cannot be had. Thin press-board will do for the slots, but takes up rather more room than is desirable.

If the cotton paper is used, proceed as follows: Cut one strip 2 in. wide and about 16 in. long, two strips 3/4 in. wide, 2 1/2 in. long, and four discs 1 5/8 in. diameter with 1/2 in. hole. Each disc should have one radial slit.

Prepare twelve soft pine strips 7/32 in. thick, 3/8 in. wide and 2 in. long. These should be carefully planed out to accurate dimensions, particularly the thickness. It is best to plane out in one or more long strips and then cut to length. Shellac the armature core, heads and shaft for 3/4 in. nearest each head. Rather thick shellac is best for this purpose. When dry enough to be tacky, mount between lathe centres or otherwise hold it conveniently. Shellac 2 or 3 in. at one end of the 2 in. strip of paper, on one side only. Fold the end around three sides of one of the pine strips. Push firmly into one of the armature slots. The shellac side should of course be toward the armature, not the strip. Indeed, great care should be used to keep the strip and the outside of the paper clean, otherwise it will be very hard to take out the wood for winding the coil. The wood should go in hard enough to hold the paper securely in place, but not hard enough to cut it or break it at the corners. Care must be taken to put the paper in the first slot squarely, so that it will go straight around the armature. Do not cut the paper, but fold down into the next slot and secure with another strip. The paper should not only lie smoothly in the slots, both bottom and sides, but on the tops of the teeth. Be sure to push sufficient slack into the slot so that the strip will not break the paper as it goes in. Shellac more of the paper from time to time, and proceed in the same way until all slots are filled. The paper is left in a continuous strip, not cut off until all the coils are wound, shellacked and baked.

Next, put one of the slotted discs on each head, over the conical nut. The slit will allow the ends to be lapped, making the paper fit the surface closely. Both the head and paper are shellacked to make them stick. Put one of the 3/4 in. strips around each end of the shaft, securing it in the same way, and then the other two discs on the heads.

If the above directions have been carefully followed, every part of the armature that the winding will touch, will be insulated.

To those who are inexperienced in the art, armature winding is rather a difficult matter. If, however, the principle of the thing is once understood, success is only a matter of care and neatness. A careful study of directions before beginning will help the amateur.

The winding here described will give 10 volts at 3,500 revolutions per minute. It consists of 12 coils, 10 turns per coil, of No. 18 (B. & S.) double cotton-covered wire. A little less than one pound is required. The spool should be so mounted that the wire may be wound direct from spool to armature, cutting only as each coil is finished.

Mount the armature in the lathe between centres, or with one end held in a chuck, and with the commutator end at the tail-stock. Number the wooden strips in the slots 1 to 12 consecutively. The writer usually numbers them clockwise, looking at the commutator end.

Remove strips 1 and 8 but no others. The first coil will half fill both of these slots; that is, there will be ten turns, making two full layers and half of the third layer. Take the end of the wire, mark it with black shellac, ink or otherwise, so that it may be identified as the beginning of a coil. Fasten the end temporarily to a tack driven in the commutator end of strip No. 9 or 10. Lay the wire in slot 1 from right to left, placing it in the corner nearest slot 12. It will tend to bend up more or less, and must be pushed down to lie snugly in the corner. For this purpose a pusher made of an old tooth-brush handle filed to an edge about as thick as the wire is necessary. Hard wood may be used, but soon batters out of shape and has to be repaired. Metal should not be used as it is likely to cut insulation. The wire is next led across the head of armature (pulley end), keeping a little way from the shaft. Thence it is laid along the corner of slot 8, and across the other head to the point of starting. Three more turns wound in the same way complete the first layer of four turns. Wind the other layer and half layer in the same way, making the ten turns of the first coil. Great care must be taken to make the wire lie flat and closely, both in the slots and on the heads. Bring the wire at the end of the coil to the point where it started in slot 1, cut off, and twist beginning and end of coil together for about 1 in.

Do not twist too tightly and do not twist one wire around the other. Twist the two together and bend back a little in space between slot 1 and slot 12. Note that this first coil is all on one side of the shaft. The second coil is exactly like it but is wound in slots 7 and 2, beginning in 7. The beginning of every coil should be distinctly marked as noted in directions for first coil. This is important. A mistake in connecting the coils will cause the machine to fail altogether. When two coils are wound, compare with drawing to see that all is correct. The third coil is wound in slots 3 and 10 with terminals in 3. The fourth in 9 and 4 with terminals in 9. Observe that the coils come in pairs, one on each side of the shaft with terminals in opposite slots.

The fifth coil is in slots 5 and 12, terminals in 5. Sixth coil, 11 and 6, terminals in 11. At this stage all the slots will be half filled. There will be six terminals in alternate slots beginning with 1. That is, every odd numbered slot will have terminals. The even numbers will not. At this stage the winding should be tested for grounds or shorts. A magneto is best, but an electric bell and three or four batteries will do. A low-reading voltmeter or ammeter with batteries is also good, and rather more sensitive than a bell. Fasten one wire to the shaft and touch the other to the bared end of each coil in succession. If there are no grounds, test for shorts from each coil to the others. If either grounds or shorts appear, of course, the defective coil should be rewound. This should not occur, however, if due care has been used.

If there is any difficulty in remembering the number of each slot, the wooden strips should be replaced as each coil is wound.

The seventh coil is wound in slots 2 and 9 with terminals in 2. Eighth coil, 8 and 3, terminals in 3. Ninth, 4 and 11, terminals 11. Tenth, 10 and 5, terminals 10. Eleventh, 6 and 1, terminals 6. Twelfth, 12 and 7, terminals 12.

When the winding is complete, all the slots will be full, and there will be terminals, a beginning and an end, in each one. These terminals will be ends of the *same coil*. A thorough test should again be made for grounds, etc. See that all coils lie flush with tops of armature teeth or below them, and wind a dozen or more turns of strong cord or fine wire around armature to keep them down.

Thoroughly saturate the windings, slots, heads and all with shellac, which should not be too thick. Bake the whole for two or three hours in a very slow oven. Care must be taken not to burn it or even slightly clear the insulation.

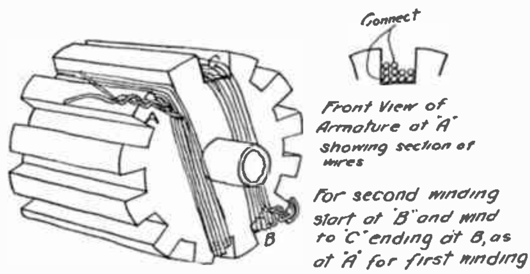
A good way is to place armature in the range oven after the fire has nearly gone and leave it over night.

When thoroughly baked and cooled remove the binding cord, and with a sharp knife, cut away the insulating paper on the armature teeth. Untwist the terminals, at slots 1 and 2, scrape off insulation, and twist the *end* of coil 1 with the *beginning* of coil 1 in slot 2. In the same way go around the armature, connecting the *end* of each coil to the beginning of the next in order. This is just like connecting batteries in series, carbon to zinc, carbon-zinc, etc.

with the fibre disc. A sharp tool must be used, with a fine feed, and high cutting speed. Lubricate the tool with beeswax, or turpentine and beeswax, and a smooth surface will be the result.

FIELD MAGNET WINDING

Make two washers 1/16 in. thick, 2 1/4 in. diameter, with 1 3/8 in. hole. Cut two strips of cotton paper 1 5/16 in. wide and 8 in. long. Slip one washer on each magnet core, and wrap the barrel of each with a strip of the paper secured with shellac. If necessary wind with thread to keep paper in place until shellac is dry.



ARMATURE- FIRST WINDING
MAKE SIX COILS LIKE THIS

Second layer of coils are wound in the same manner as the first; but with terminals in slots which have no terminals from the first layer

ARMATURE - SIXTH WINDING -

Cut the twisted terminals to even length of about 1 in. The commutator may now be forced on the shaft and the terminals soldered to the rivets where they come through the back. Care should be taken to lay the terminals "straight out," that is, each is to be soldered to the rivet (commutator segment) directly opposite.

The whole armature should now be wound with a layer of white linen thread covering the wires in the slots, to keep them from flying out by centrifugal force when machine is in use. Bands of fine brass wire secured by solder are used for the same purpose in larger machines, but the thread is much better for small armatures. Secure the ends neatly, and give the whole a coat of shellac but do not saturate it.

The commutator face should now be trued up and the rivets turned off flush

Mount a 1/2 in. bolt in the lathe chuck and screw on one of the fields. Begin to wind at the left-hand end of core. The wire should be No. 20 single cotton-covered. Lay a piece of narrow tape along each side of the core with the end sticking out at the chuck (left) end. After winding a few turns, double back the loose ends and wind over them a few more turns of wire. Then pull the ends up tightly, thus securing the wire in place, to prevent slipping when the other layers are wound on over it. Wind the wire in even layers back and forth, stopping each layer one turn short at the left end. This will "stack" the coil and prevent the outer layers from slipping down. In this way wind on ten layers, securing the last with tape, the same as the first. One or two layers more or less will not make much difference, but there should be the same number on each coil. Test for grounds with magneto, etc., same as armature coils. When complete the coils should be given two or more coats of shellac.

Bolt the field magnets in place, taking care that no shellac or dirt gets in the joint between core and ring. Connect the inner end of one coil with the outer end of the other, putting the two in series. The other two ends are to be connected to the binding posts on the field ring. It is best to make temporary connections at first and after testing the machine they may be taped, or flexible cords may be soldered to coils and binding posts and the joints taped.

BRUSH HOLDERS

Hold a piece of 5/8 in. brass rod in the lathe chuck with 1 1/4 in. projecting. Turn down to 7/16 in. diameter for a length of 1 in. from the end. At 1 1/8 in. from the end cut in with a parting tool 1/8 in. deep. Knurl the 1/8 in. edge of the head and trim off the rough corners left by the knurling wheel. Spot the centre and drill a little more than 1 in. deep with a 5/16 in. drill. With a No. 15 drill go in 1/4 in. deeper, and then cut off.

Make two holders thus. Insert a 5/8 in. flat head brass screw, 10-24, from the inside and sweat in place with soft solder. Make two knurled nuts 1/4 thick from 1/2 brass rod in a similar manner. The nuts for the field magnet binding post, which are just like them, should be made at the same time. The nuts for both brush holders and field binding posts may be made of 1/2 in. hexagon rod if no knurling wheel is at hand. Turn the part that touches the wire and leaves the "grip" hexagonal. The screws for the binding posts are 1 in. long and should be round head brass 10-24. Insulate each post with two fiber washers 5/8 in. diameter, 1/4 in. hole, and a fiber or paper bushing. Brushes may be made of wire gauze or of graphite. If gauze is used cut a strip about 4 in. long and 3/4 in. wide. It should be cut "on the bias," that is, diagonally from the strip. Roll up very tightly to a diameter of 5/16 in. or a trifle less, making an easy fit in the holder tubes. Secure with a little solder, but take care that the solder does not run in and fill up the gauze. If they are a bit tight they may be eased off with a file. The ends of the rolls should be square and smooth. If graphite is used, saw a piece about 3/8 in. x 3/8 in. x 1 1/2 in. from a larger motor or dynamo brush. Hold in lathe chuck and carefully turn to proper diameter and length as above. The graphite brushes work with less friction than the gauze, but the machine is more likely to bother about "picking up."

The brush holder holes in the bearing bracket may now be laid out and drilled 1/2 in. diameter. This was not done when the frame was machined, because the holes should be laid out equidistant from the centre of the armature shaft and on a level with it. This cannot be done until the shaft is babbited in place. Make two washers of thin hard fiber, 5/8 in. and 7/16 in. hole, and slip one on each brush holder tube next the head. Cut strips of cotton paper 1 in. wide and shellac around the tubes, winding on enough to make them fit tightly in the holes. Shellac the outside of paper and push them in hard, taking care not to wrinkle up the insulation. Wind two open spiral springs of music wire about .020 diameter, on an arbor 1/4 in. diameter or a little less. They should be of the right size to slip freely in the brush tubes, and about 1/2 in. long when not compressed. Slip them in the tubes and the brushes after them. Make two flexible cord conductors with copper terminals long enough to reach from the brush holders to the field binding posts, putting them under the heads of the screws on the inside of the ring.

The armature may then be put in place, the bearings screwed on and the pulley put on the shaft. See that the shaft revolves very freely. Put a wick of thick and coarse felt in the hole below each bearing, and fit and drive in place a short brass plug in the bottom of each. Drill a small hole through the babbit in the top hole, and fill the bearings with oil. The wicks will keep the shaft oiled for a long time.

It is best to test the machine as a motor first. From three to five or even six storage cells may be used if at hand. If not, dry batteries will do, but they must not be kept in circuit more than a few minutes. The machine should

(*Continued on page* 195)

MACHINE SHOP PRACTICE—Part V

The Engine Lathe

P. LEROY FLANSBURG

From the very earliest beginnings in machine shop practice the engine lathe has always been considered the most important of the metal-cutting machines. The reason for this is quite easy to understand, for there is no other machine which is capable of doing as many and as varied kinds of work. As time has passed, men have studied the subject more and more fully and many new types of lathes have been invented and developed. Such machines as the turret lathe, the vertical boring lathe, copying lathe, ball-turning lathes, and a great many types of the duplex lathe best show the representative examples of advanced practice, but although for the purposes for which they were designed these machines have proven invaluable, still the old-fashioned type of engine lathe is no less and if anything is more used than it was formerly.

With but the single exception in the case of the milling machine, the principles governing the operation of all the metal-cutting machines and of the tools thereon, are similar to those which govern the operation of the lathe.

In the large drawing the author has endeavored to show an example of a modern lathe, such as will be found in the average machine shop. By referring to this drawing the names of the principal parts of the engine lathe may be readily found.

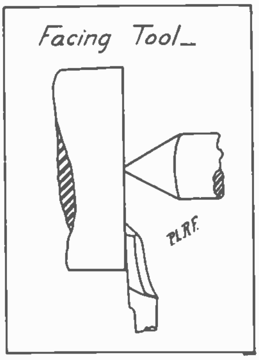
In all of the older types of lathes the dead-centre was the only kind of a headstock used, and the present type of headstock with the running mandrel is a comparatively recent machine.

As a rule lathes are said to be divisible into two classes, namely, those used for hand turning, and those which are used for either screw cutting or automatic turning.

Of course the hand turning machines can only be used for light work, and success in the use of them is dependent upon manual dexterity alone. They are largely used for wood turning, but are seldom used for metal turning, although by driving them at slow speeds and using proper tools, they may be used for light metal work

FACING TOOL

When considering the tools used on a lathe, we first notice that all tools are in reality but wedges and that they act and operate as such. They enter the work by means of a keen edge and then divide or separate the material into parts. In the case of metal turning, if the angle of the tool is too acute or if the edge is too keen, the contact with the hard metallic body, which is being turned, soon completely wears or breaks off the keen edge of the tool.



In the case of the more fibrous metals, care should be taken to give quite a large amount of top rake to the cutting tool. For wrought iron the top rake should be between 35 to 40 degrees, but for cast iron or cast steel only about 25 degrees of top rake is necessary. Any more than that would give the tool the tendency to dig into the work, thus spoiling the surface which is being formed.

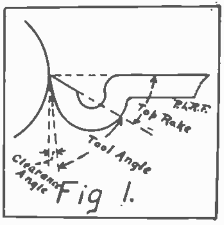


Fig 1.

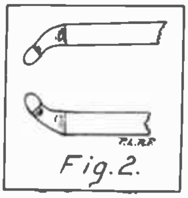


Fig. 2.

By referring to Fig. 1, one can see the names of the various tool angles.

The tool used for this drawing being an ordinary roughing tool used for plain traversing and surfacing.

When one needs to turn tapered or curved pieces of work it is then necessary to use tools known as "side roughing tools." Examples of these are shown in Fig. 2.

Side roughing tools are also used for the boring of holes and for similar work.

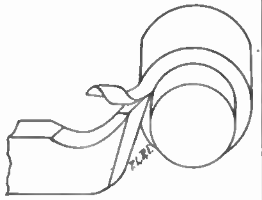
Many types of tool-holders are now on the market, and these are fast superseding the use of solid tools for cuts up to ½ in. in depth. By using tool-holders material is saved, weight and cost are minimized and a much smaller quantity of steel is required for the tool.

The definition of cutting speed means the number of feet of cutting performed by the tool in the given time. The feed is applied only to the tool and regulates the thickness of the shaving taken by the tool. It has been found in practice, that a maximum of tool feed gives much better results than does a maximum of lathe speed.

CUTTING TOOL

In order to calculate the surface speed of the piece of work which is being turned proceed as follows:

Make a chalk mark on either the face plate or the piece of work and count the number of revolutions per minute. Multiply this by the diameter of the piece of work (in inches), and multiply this result by 0.262. Your result will be the speed of cutting, in feet per minute. For instance, suppose your work is revolving 45 times per minute, and that its diameter was 3 in.; then 45 x 3/12 x 3.14 or 45 x 0.262 gives 35 ft. per minute as the speed at which the shaving is being run off.



Cutting Tool.

PARTING TOOL

In the case of the average machinist, he seldom calculates the speed at which either the work or the tool should be run, instead, making use of the knowledge which he has gained by experience. However, the novice should always calculate his speeds.

For ordinary rates of feed and depths of cut, using a good grade of carbon tool steel, the speed at which the work may be turned is about as follows:

Tool steel	20 ft. per min.
Machine steel	25 ft. per min.
Wrought iron	30 ft. per min.
Cast iron	35 ft. per min.
Brass	70 ft. per min.

While this table will probably prove useful for general practice, still it cannot be made exact because the cutting speed is of necessity dependent upon the following things:

First—On the toughness and density of the metal from which the piece of work is made.

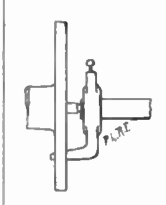


Fig. 3

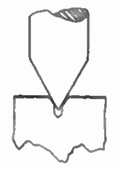
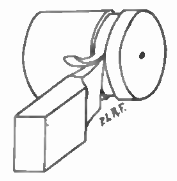


Fig 4.

Second—On the number of surface feet which are to be dressed with each setting of the tool.

Third—On the shape and form of the tool employed.



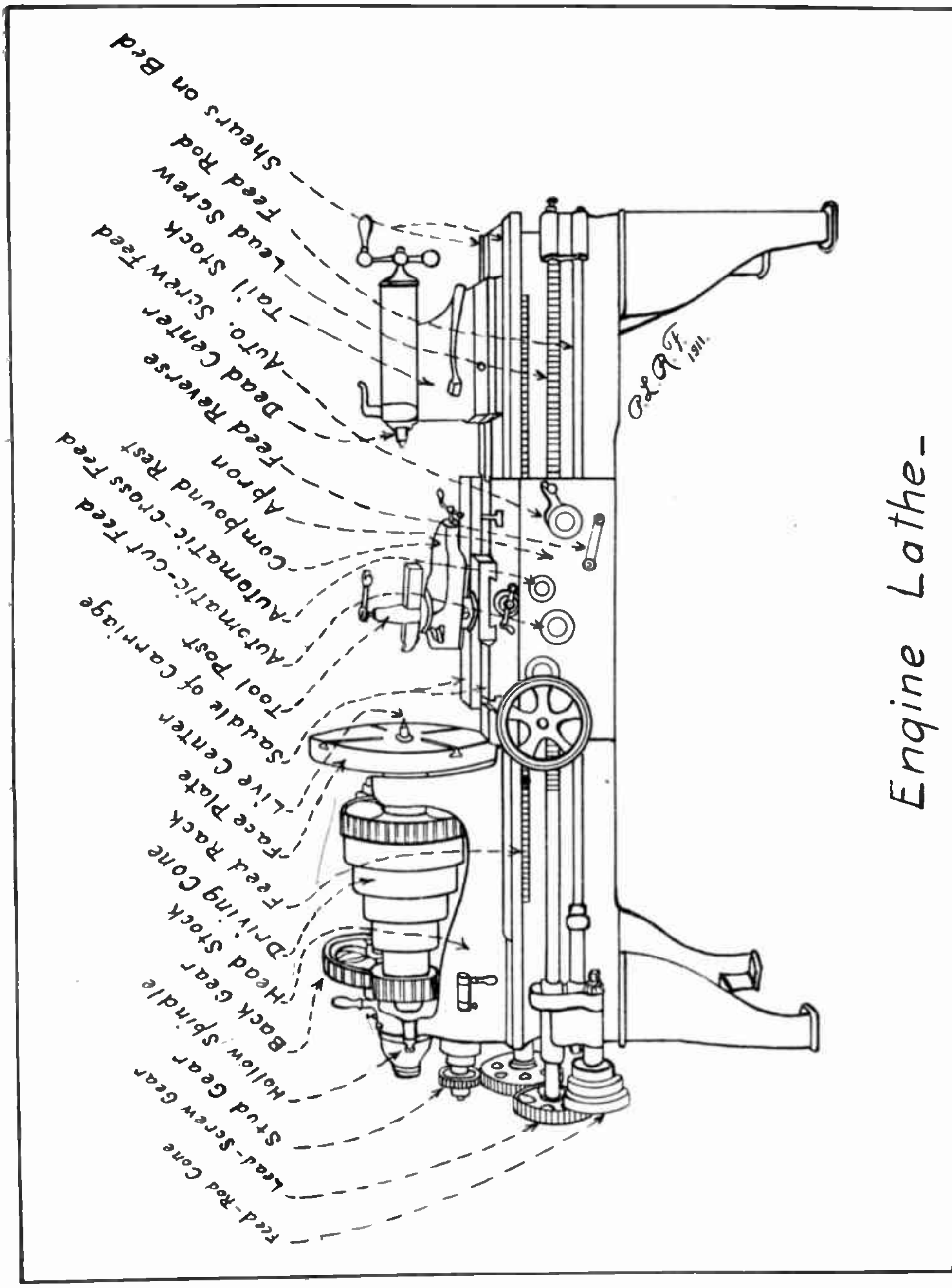
Parting Tool.

Fourth—Whether it is a roughing or a finishing cut which is being taken.

Fifth—Whether the cut is being taken by the tool, on or below the "skin" of the work.

For the purpose of holding a small piece of work in the lathe a "dog," similar to the one shown in Fig. 3, is often employed. The dog is securely clamped on the piece of work which is then mounted between the centres of the lathe. In order to cause the work to revolve, the dog is so arranged that it fits into a slot in the face plate. Thus when the face plate revolves the work is caused to also revolve with it. Sometimes the work is mounted one end in a chuck and the other resting against the dead-centre of the tailstock.

Centres should be carefully hardened, tempered and then ground to the same angle at the point (about 50 or 60 degrees). The reason for the careful hardening of the centres is to make them capable of withstanding the constant wear caused by the work which they carry. One of the centres fits into the tailstock and is called the "dead centre,"



the other fits into the spindle. The one which fits into the spindle revolves with the spindle and is known as the live centre.

In order to make possible the holding of work between centres, a small hole is drilled into each end of the work and then countersunk in the manner shown in Fig. 4.

Although much may be done on the ordinary lathe, still all improvements in chucks, tools, etc., which will facilitate or quicken processes, are not only advisable, but also necessary.

In my next article I will describe some of the other parts of the engine lathe, and will also speak of some of the simpler operations which the ordinary lathe is capable of performing.

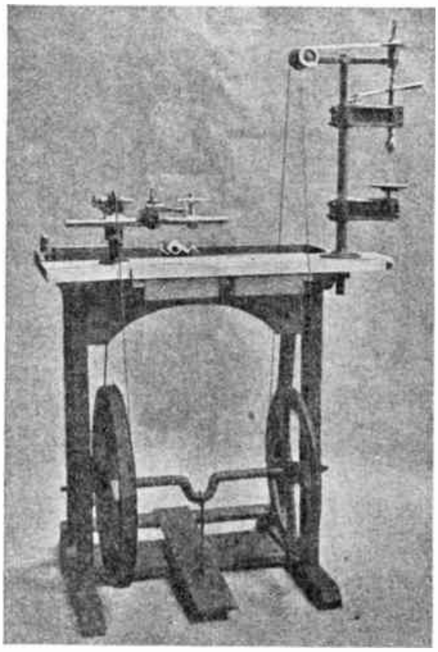
THE WORKSHOP

A SMALL SENSITIVE DRILLING MACHINE

W. S. FARREN

The drawings reproduced with this article show a sensitive drilling machine of novel design. The object of the constructor was to provide an accurate drill for holes under ¼ in., to be made as far as possible from solid material and scrap. Two patterns only were required—one for the bearers (Fig. 4), and one for the table and clamping washers (Figs. 5 and 17). In addition, a steady rest was made for turning the pillar, but this can hardly be included in the drill. The main points about the design are: (1) The bearings for the revolving spindle are coned, adjustable, and dead hard, so that the spindle can never become loose, as is the case with ordinary machines with plain parallel bearings; (2) the sleeve carrying the spindle does not revolve, and the wear on it, such as it is, can be taken up by the split bearer; (3) there is absolutely no side strain on the spindle bearings, the driving pulley being mounted on a separate bearer, and the spindle connected with it by a universal joint and square extension; (4) the method used in boring the bearers ensures absolute accuracy in the alignment of the drill spindle and pump centre in the table. It is thus possible to drill two holes in a piece of metal, such as a clock frame, truly opposite to one another.

To proceed with the description of the drill. The general design is shown in Fig. 1. It will be noticed that the lever is balanced, not by a counterweight, as usual, but by two springs. Fig. 2 shows the driving wheel, which is described later. The pillar was turned from a 2 ft. length of 1¼ in. diameter mild steel. It was found to spring so much in the centre that it was impossible to get it parallel, so operations had to be suspended for the construction of a steady rest, as one was not included in the accessories available. It was decided to make one that would do for other jobs as well as this particular one, and with this end in view the design shown in Fig. 22 was fixed on. The steady consists of two parts—the standard *A* of cast-iron, and the bearing piece *B* of mild steel. The base was first of all faced up square with the upright, and this filed where *B* bears on it. The hole for the bolt by which *B* is attached was then drilled ½ in. diameter at centre height above the



base. To do this the base *A* was bolted on to the carriage in the right position, and the drill held in the chuck. *B* is a piece of ½ in. mild steel, slightly rounded and case-hardened where it bears on the work. The standard is secured to the carriage by a separate dove-tailed piece fitting in the transverse slide. In the case of a ⊥-slotted carriage, as in a Drummond lathe, two bolts through the holes shown will suffice. The drawing is not dimensioned, and to no particular scale, but is of right proportions. The actual dimensions will, of course, vary with the lathe which it is to fit. This steady has been found very reliable, and with its aid the pillar was turned up quite parallel. It was carefully tested at the beginning to ensure it being without taper, and the lathe centres adjusted until no difference could be detected between the ends. A shoulder was left to full diameter of bar near one end for the clamping washer to bear against, and the short end screwed 12 threads per inch for clamping nut. The latter is of ½ in. mild steel. A keyway is cut for 17½ in. ⅛ in. square. This was done by a parting tool fixed sideways in the slide-rest, the latter being traversed by the rack. The angle of the tool needs careful adjustment, and the best position must be found by trial and error. The tool is nearly sure to cut at first as if the metal were cast steel, but when the correct angle has been found the shavings will come off the full length of the work.

The bearers are shown in Fig. 4. Two castings were obtained off the same pattern, and were machined in the following way: they were first filed and scraped up to a surface plate on the two facing bosses at one end (the holes were not cored out), and then mounted on the faceplate in the way shown in Fig. 24. A planed cast-iron plate was obtained ½ in. by 3 in. by 7 in., and fastened to the faceplate by two studs, and a light cut taken over it. A hole 1 in. diameter was bored at one end, and the bearer fixed on to it, the big end in position, and this bored out to 1 in. a good sliding fit on the pillar. The bearer was then removed, and an arc, 5 in. radius, scribed on the plate, a hole with a point in the centre of this arc as centre was drilled for the steel plug *A*, which was an exact fit in the

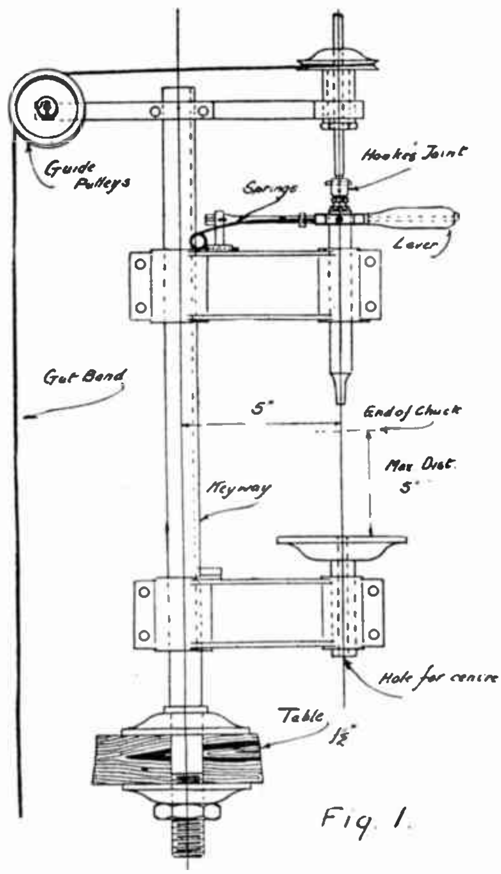


Fig. 1.

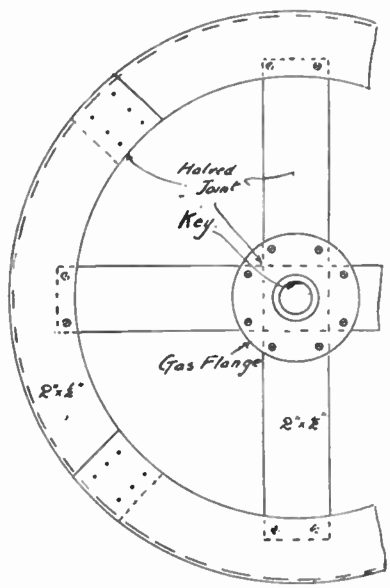
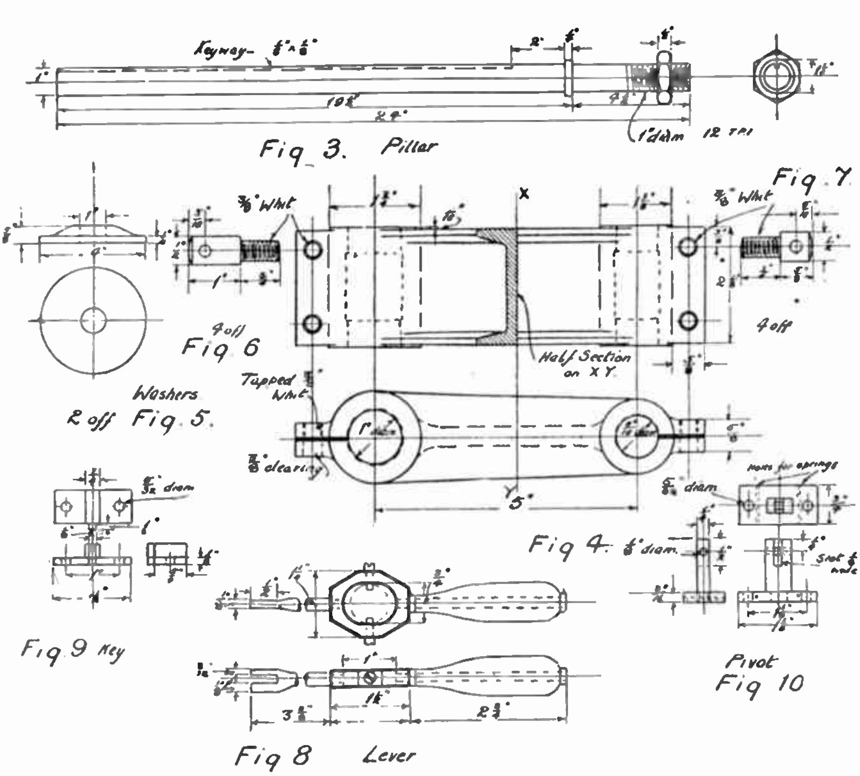


Fig 2.

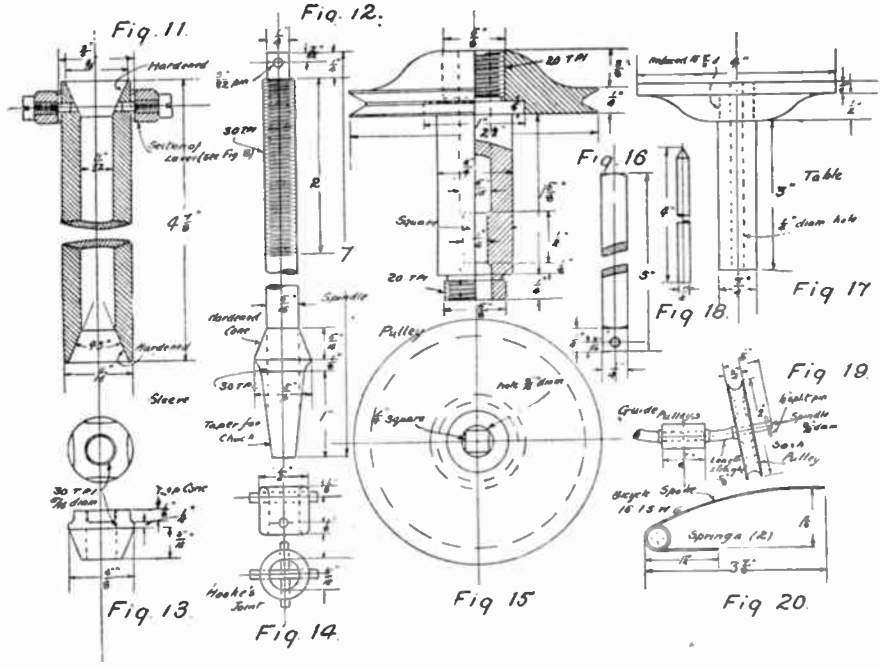
THE DRIVING WHEEL.



DETAILS OF A SMALL SENSITIVE DRILLING MACHINE.

large hole bored in the bearer. The latter was then mounted on the plate again in the position shown in the drawings, and the smaller end bored out to 11/16 in. for sleeve. The centre of each bore was relieved 1/32 in. The smaller hole was lapped out with emery powder on a piece of wood. The other bearer was similarly treated, with the exception that the smaller end was bored 3/4 in. for the table spindle. On the top bearer is fixed a pivot piece for the lever (Fig. 10). This is made of mild steel, brazed together, the pin being of silver-steel tempered brown. Two 5/64 in. holes were drilled parallel with the base, as shown, for the short ends of the springs. Two 5/32 in. screws fix the pivot to the bearer. On the lower bearer goes the keypiece (Fig. 9), which is constructed similarly to Fig. 10. A piece of the surfacing strip is filed away down to the bore to let it come up to the pillar. The width of the projecting piece should be a good fit in the keyway. That this method of machining the bearers is a success may be judged from the fact that a piece of brass wire, when put in the drill chuck and turned to a point in place met the pump centre exactly. The flanges at each end of the bearers were then drilled and tapped 3/8 in. for the clamping screws, split, and one half of the hole enlarged to clearing size. Eight screws were required altogether, shown in Figs. 6 and 7. Those in Fig. 6 are higher, to allow of the tommy clearing the casting when tightening up from the front of the drill. The tommy is of 3/16 in. silver steel, one end being bent over.

For the sleeve a 5 in. length of 3/4 in. cast steel was drilled through 11/32 in. in the chuck. A carrier was then fastened to one end, and this supported on the head-stock centre, while the other was run in a temporary cone plate. This is illustrated in Fig. 25. It was rigged up with an angle plate on a piece of 5/8 in. mild steel. The latter was bored out to a cone, the smaller end of the hole being slightly under 5/8 in. diameter, and the angle of the cone about 60 degrees. Two studs were fastened in one of the slots of the angle-plate, projecting outwards, and this face placed down-



DETAILS OF A SMALL SENSITIVE DRILLING MACHINE.

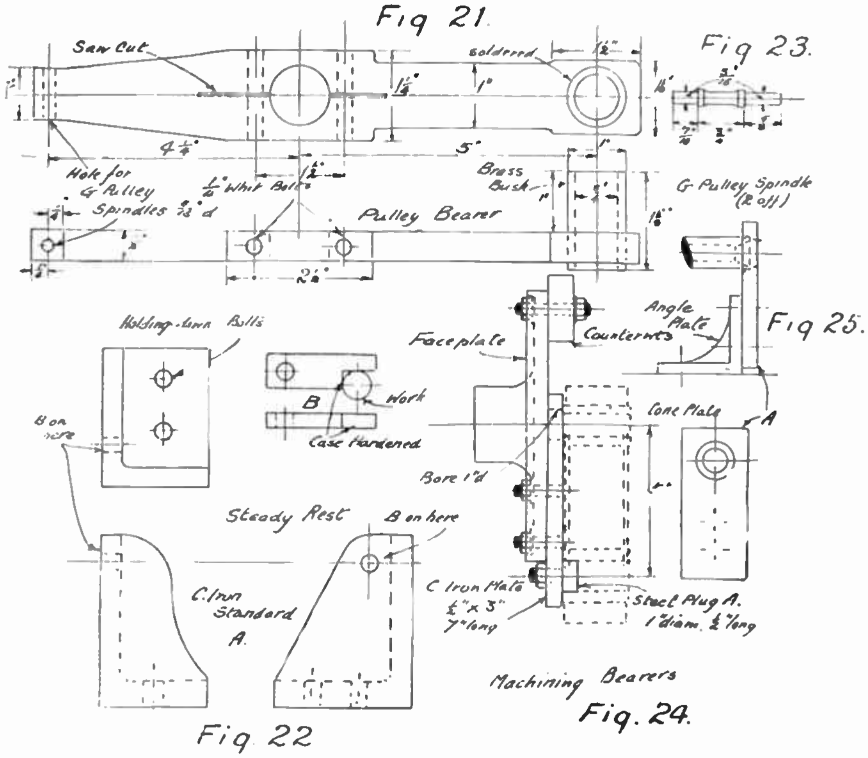
wards on the bed, the studs being filed until when they rested against the inside of the shear of the bed the angle-plate was square across. The cone-plate was then fastened to the vertical face, so that the coned hole was central. The sleeve was bored out with this rig to an angle of 45 degrees at each end, the diameter of the larger end of the cones being 5/8 in., and not 11/16 in. as figured in the drawings. Before boring, the two transverse holes for the lever screws were drilled 3/32 in. These holes are shown too high up in the drawing. They do not cut into the coned part of the sleeve, but into the parallel bore. This gives a better bearing, but slightly less travel.

In the meanwhile the spindle (Fig. 12) had been turned. The body is of 5/16 in. mild steel, 7 in. long, screwed 30 threads per inch, for 2 in. at one end, and 17/16 in. at the other, to fit a pair of bicycle cones. One end is reduced to 1/4 in. for the universal joint. The cone for the lower end of the spindle was a very tight fit on its screw, and the latter was slightly tapered. The cone was heated sufficiently to allow it to screw right up to the end of the thread, but not enough to draw the temper. When cold, it was as if solid with the spindle. A piece of mild steel about 7/16 in. diameter and 1 in. long was similarly screwed and shrunk on, and then turned down, together with the spindle end, to fit in the socket of an Almond drill-chuck. The cones were then ground with the overhead gear driving an emery wheel in the slide-rest, the latter being unaltered from boring out the cones in the sleeve. Of course, in each case (*i.e.*, both for spindle and sleeve) only one end (that nearer the tail-stock) could be operated on. The work was reversed for the other end. This method necessitates the turning of both sleeve and spindle up to the point of finishing the cones, which are then all done at one setting of the slide-rest, and are thus bound to fit. The sleeve was then mounted on the spindle as a mandrel, the cones tightened up, and the outside turned down to 11/16 in. plus about 1/200 in. The ends were then hardened. It was remounted on the spindle and the cones lightly ground in with emery, and finally the outside was ground with the emery wheel in slide-rest to finished size. Of course, both for the cones and for this last part the work was revolving as well. The back gear was used, and, for the sleeve, an automatic feed. The final fitting of the sleeve to its bearer was done with a piece of smooth emery paper on a stick, the parts shown by the oil marks to be higher than the rest being rubbed down until it bore all over. Fig. 13 shows the top cone. To grind this it was mounted on its spindle and secured by a locknut. This is not shown in the detail drawings, but can be seen in Fig. 1, just under the Universal joint. The four "flats" on the cone were ground by the emery wheel, the positions being found by a gear wheel. The result of machining the spindle in this way is that not the slightest suspicion of shake or tightness is present, and the "feel" of the fit is a delight to all who appreciate a piece of good workmanship.

The lever (Fig. 8) is built up. The centre part, which is shown in section in Fig. 11, is a piece of 5/16 in. mild steel, with an oval hole cut out for the sleeve. It is attached to the sleeve by two 1/8 in. screws, the ends of which are reduced to 3/32 in. and hardened. Care had to be taken that they were not made too long, or they would have pinched the spindle. The pivot end of the lever is of 1/4 in. silver steel, sweated into the stirrup (or centre piece). The end is flattened and slotted for the pivot, and afterwards hardened and tempered. The handle is of boxwood on a 3/16 in. spindle.

The driving pulley (Fig. 15) is of cast iron, and was taken from an old sewing machine. The spindle is turned from 1 in. mild steel, and on the lower end goes a brass nut 5/16 in. thick, to keep it in place. For driving the drill a squared extension (Fig. 16) is attached by a Hooke's joint to the spindle. This slides in the squared hole in the pulley spindle. A 1/4 in. diameter hole was first drilled down this, and then enlarged to 5/16 in., all except a piece 1/2 in. long, which is filed out square, a nice fit for the driving piece. This pulley is mounted on a wrought-iron bearer (Fig. 21), in which is soldered a brass bush for it and two small spindles (Fig. 23) for the guide pulleys (Fig. 19). This bearer was bored out in the rig (shown in Fig. 24) used for the others.

To balance the lever two springs of 16-gauge bicycle spoke are used (Fig. 20).



DETAILS OF A SMALL SENSITIVE DRILLING MACHINE.

The short ends are held in the holes in the pivot piece mentioned above, and the others slide freely in a small oval piece of brass soldered on to the lever. The table (Fig. 17) is a simple piece of turning, and was from same pattern as clamping washers. The spindle is shrunk in and fits without shake in the bottom bearer. The pump centre (Fig. 18) is a good sliding fit in the hole through the centre of the table and is made of silver steel.

The driving wheel (Fig. 2) is made of ½ in. deal, well seasoned. The method of construction is plainly shown in the drawing. The spokes are halved into one another at the boss, each going right across the wheel. The rim is built up in four pieces, the ends halved and nailed together, the ends of the nails being slightly riveted over. The wheel was then turned in a large lathe, into the gap of which it just fitted. This is much more satisfactory than turning it *in situ*, as a firm slide-rest tool and a steady drive can be used. This wheel itself is not weighted, as it is attached to the right-hand end of the crankshaft of a small Lorch lathe, the flywheel of which is weighted by means of an old chaff-cutter rim. Gut, ⅛ in. diameter, is used for driving, though thinner stuff might be used with advantage.

The photograph reproduced herewith shows the complete drill, lathe, and stand.—*Model Engineer*.

A BALL-GRIP SELF-CENTRING DRILL CHUCK

H. GRINSTED

This little chuck can be easily made by anyone who has access to a screw-cutting lathe. As the diagrams show, three steel balls replace the usual jaws, the balls fitting in guides consisting of radial holes drilled in the body of the chuck; the balls are closed on the tool to be held by the hollow sleeve, which is bored out with an internal taper, and screws on to the body of the chuck with a left-hand thread. The drill to be held is pushed in and its end centres itself in the taper end of the axial hole and the balls grip it centrally when tightened up by the sleeve.

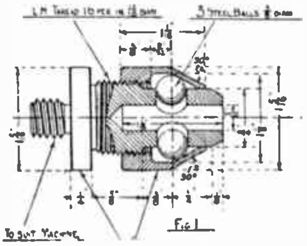


Fig. 1

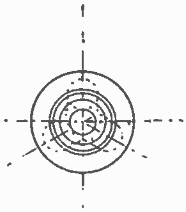


Fig. 2

It is important that the sleeve should be attached by a left-hand thread, as this makes the chuck self-tightening. Looking along the drill at the front end of the chuck, the drill, when slipping, rotates in a clockwise direction; this causes the balls to roll in a counter-clockwise direction, and the balls transmit a similar rotation, *i.e.*, counter-clockwise, to the sleeve which is therefore tightened up if the thread is left-handed.

Fig. 1 shows a conventional section through two balls, and Fig. 2 an end elevation from the front of a chuck to take drills up to 5/16 in. from 1/16 in.; ⅜ in. balls are used, so that they cannot fall through the central hole.

The holes for the balls should be carefully drilled and filed or scraped so that the back of each hole is at the same distance from the front; this ensures that the balls properly centre the drill.

The chuck is, of course, improved by case-hardening the sleeve and the ball guides, but this is not absolutely necessary.—*Model Engineer*.

75-Watt Dynamo

(*Continued from page* 186)

not take more than two or three amperes when running light.

It must be run as a dynamo in the same direction it runs as a motor. If desired to run in the opposite direction reverse field connections. No sparking whatever should be visible, even when the machine is heavily loaded. If a higher voltage is desired, wind the armature with No. 20 wire and the field with No. 22 .

For electro-plating, wind the armature with No. 16 and the field with No. 18. Do not try to wind for 110 or any higher voltage. The number of coils and commutator segments is too small for high tension currents.

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

We will now take up the design of the inductance coil that is used with this set. The well-known helix or "bird-cage" type of inductance needs no description here. The tendency at present seems to run to the use of the inductively coupled oscillation transformer instead of the auto transformer or helix type. For that reason this article will consider a type of inductively coupled oscillation transformer.

The radiation of a transmitting set, using an inductively coupled transformer is less than if an auto-transformer were used—but what is *important* is that it has greater *selectivity*. That is, if you have a high-powered wireless station, and you are sending while a nearby station is trying to receive from another station, the chances are you will prevent him from receiving if you have an auto-transformer, owing to the fact that he cannot tune you out. On the other hand, with an inductively coupled transformer, he can probably either tune you out completely or reduce your interference to such a point where it will be possible for him to receive. Likewise, the party you are sending to can, at a distance, tune you up "sharper" and pick you out of a bunch of stations with more ease, if you are using the inductive set. Thus while you probably cannot send the distance with this, as with the helix, what is more important the stations you do work with can receive you through interference, and you do not interfere with nearby stations.

As the degree of selectivity depends on the coefficient of coupling, hence by moving the two spirals of the inductively coupled transformer closer together, the selectivity becomes less and the radiation greater. In the type of inductance to be described, the spirals are at a fixed distance from one another. It is therefore possible to have a certain radiation and selectivity. As this distance has been made to conform with the other dimensions of the set, aerial, etc., it is the best combination of selectivity and radiation for commercial work in this given station, but the experimenter is advised to try varying distances until he obtains that best suited for his outfit.

Fig. 7 shows a type of inductance transformer made by the Clapp-Eastham Co. This is an excellent design, and many stations are using it. Particular attention is called to the method of adjustment on the end spiral, as a scheme similar to this will be adopted in our design.

In Fig. 8 is the front and side elevation of the set of inductance spirals designed for this outfit. The front view shows the spiral for the closed oscillating circuit. This consists of six complete convolutions of 1 in. x 1/16 in. spring brass strip. The beginning of the first turn is 5 in. from the centre of the mounting-board, and each successive turn is then spaced 1 in. from the preceding turn. This makes the end of the last turn 11 in. from the centre.

This spiral is mounted on 3/4 in. x 1 in. hard rubber insulating strips, each of which are 8 in. in length and are placed 90 degrees apart. A groove is cut 1/4 in. deep at each point where the spiral passes, thus serving to clamp the spiral in position.

These insulating strips are mounted on a mahogany board that is 1 in. thick and is cut 24 in. square. This board should be well seasoned, cut perfectly true, and free from all cracks and blemishes. In each corner, 2 in. from each side, 1 in. holes are bored to accommodate dowels by which the instrument is fastened to the instrument board.

On the opposite side of the board is placed a spiral of 3/4 in. x 1/16 in. brass, having 12 complete convolutions. This is for the open oscillating circuit and is mounted in exactly the same way as the other spiral, the only difference being that it has double the number of turns in the same space, the convolutions being placed on 1/2 in. intervals.

Contact is made to the spirals with 1/16 in. x 1/2 in. copper bars which are mounted on 1/8 in. x 1/2 in. hard rubber strips, and which run from the inner turns of each spiral to the binding posts mounted on the outside.

In order to furnish means of easily altering the amount of inductance in the open and closed oscillating circuits, independent of one another, as when tuning, etc., radial contact arms containing sliding spring clips which engage the spirals are provided. As the spiral for the open oscillating circuit is mounted facing the instrument board, it is necessary that the radial arm have a handle extending through the inductance mounting board to the side facing the operator, and that this in no way interferes with the handle controlling the spiral of the closed oscillating circuit.

Now in Fig. 9 is given an enlarged view of the section at "A-B" in the side elevation in Fig. 8. It will be seen that a hard rubber rod, 1/2 in. in diameter passes through the mounting board and is made fast to the back radial arm on the open oscillating spiral with a 1/16 in. pin. This radial arm is sweated around a brass tube 1 3/8 in. long, having an inside diameter of 1/2 in. and an outside diameter of 5/8 in., the tube fitting snugly over the shaft of rubber.

The other end of this brass tube is sweated into a brass washer which is 5/32 in. thick, and 1 in. in diameter with a 5/8 in. hole, in which the tube fits. Another washer the same size as that described, but having only a 1/2 in. hole is placed against the first washer. To this second washer, a strip of 1/16 in. x 1/2 in. bar copper is soldered, the latter running to a terminal opposite the terminal from the spiral on the same side of the mounting board, insulated from the board with a hard rubber strip.

Next a steel spring occupies a space of 5/32 in., and between this spring and the mounting board is placed a hard rubber washer 1 in. in diameter and 1/4 in. thick, with a 1/2 in. hole in the centre. The object of this is to provide a steady contact between the terminal strip and the movable element, and the spring pressing against the two washers tends to keep a good contact. At the same time, the entire set is insulated as much as possible, as with the exceedingly high potential generated in these sets too much care cannot be taken to have the insulation perfect.

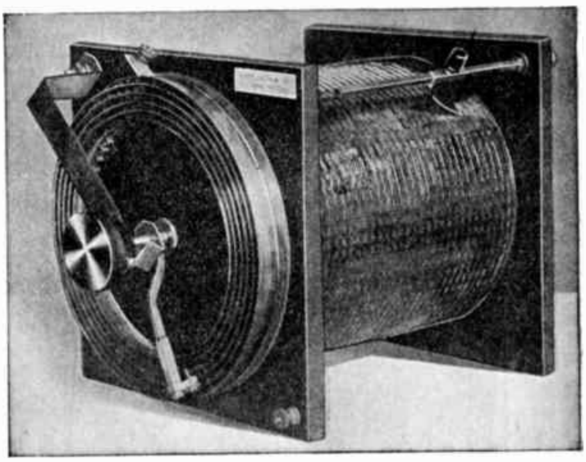


Fig. 7

The front side is made in the same way, only the radial arm and tube are *not* made fast to the hard rubber rod, but can be revolved independently of the rubber shaft. A hard rubber handle is fitted on this radial arm, for adjusting same. Referring again to Fig. 8 we see that the end of the shaft terminates in a hard rubber knob. A brass washer 3/4 in. in diameter and 1/2 in. long with a 1/2 in. hole for the rod, is placed between this handle and the front radial arm. This is to maintain the pressure of the springs against the washers.

Thus, by turning the knob, we can revolve the back radial arm, thereby varying the inductance in the open oscillating circuit, and by adjusting

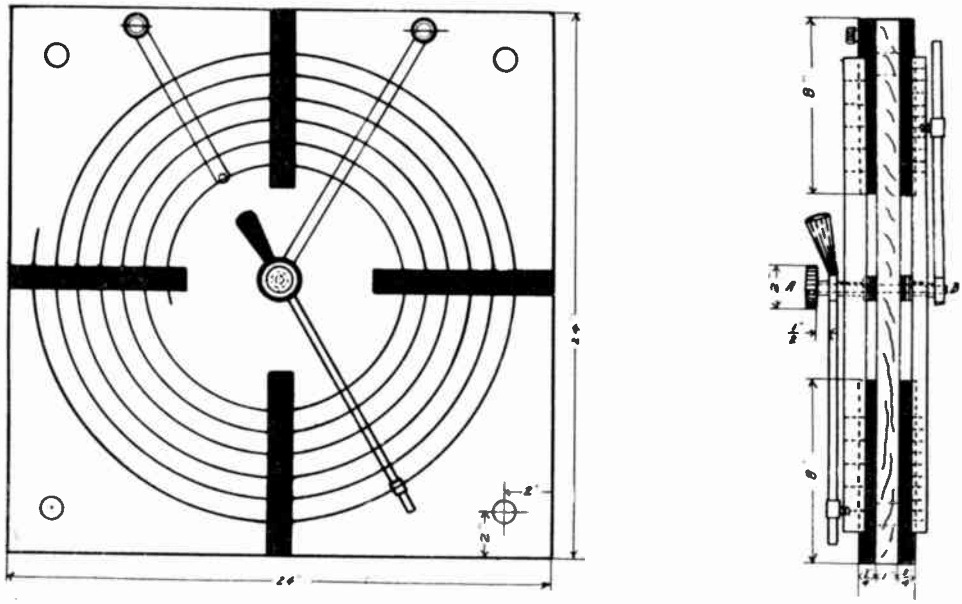
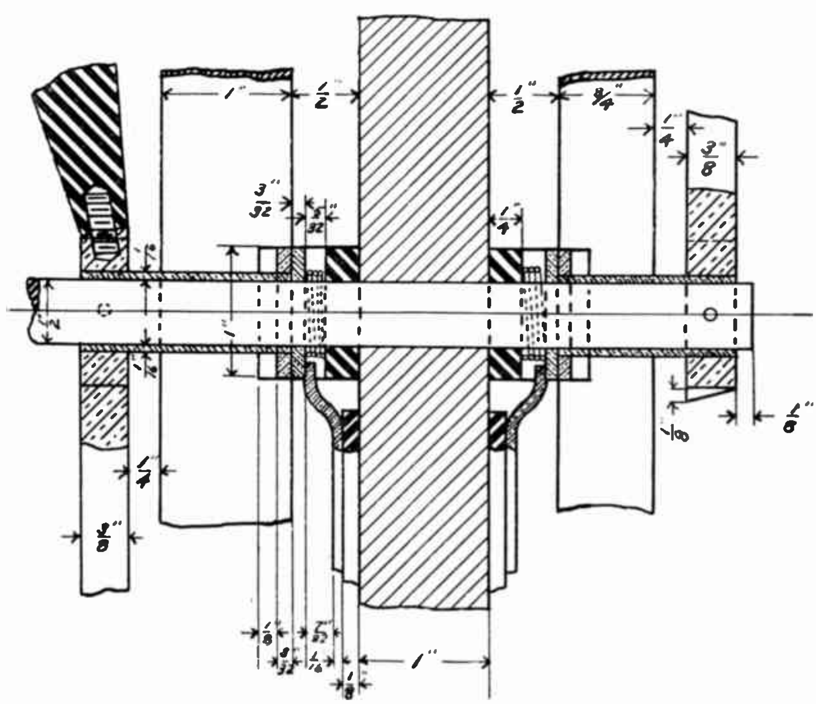


Fig No. 8 — **INDUCTANCE SPIRALS.**



Section at A B, showing details

Fig No 9

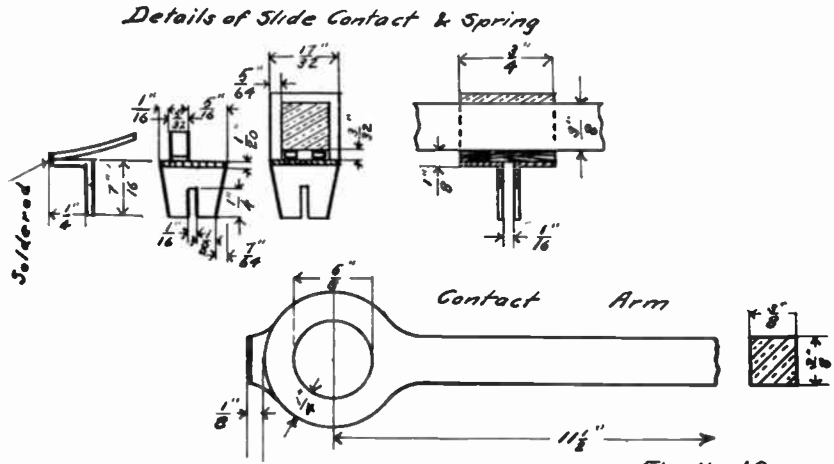


Fig No. 10

with the handle, vary the inductance of the closed oscillating circuit.

In Fig. 10 is given the construction details of the radial contact arm and the slide contact. The slide contact consists of a piece of metal bent to fit snugly about the three sides of the radial arm. The fourth side is made by soldering the two pieces of spring brass, which, when fastened to the cap form the clips that engage the inductance spirals and at the same time maintain pressure against the radial arm. The ends of the clips are split to allow easier conformation with the curves of the spirals.

The contact arm is of brass and may be either made from a casting or by fitting a brass rod to a round section. This permits extremely rapid changes when tuning and is particularly desirable when the experimenter has the use of a wave meter and desires to make a record of the various wave lengths for the different convolutions.

We have now treated all of the parts of the transmitting side with the exception of the key. Many of the failures of operators can be traced to a poor key. A key that makes imperfect contact, causing a "stringy" irregular spark, sticks, and frequently is the cause of a meaningless string of dots and dashes, easily confuses and disgusts the receiving operator, and frequently after spending several hours trying to decipher what the transmitting station is trying to send, the receiving operator gets mad and refuses to listen in. A good key should have ample contacts that come together *flat* when the key is depressed, and a sufficient amount of tension in the spring to prevent sticking. It should be so designed to conform naturally to the hand of the operator, and not tire him out with continous use.

The type illustrated in Fig. 11 represents a good design recently placed on the market. This key is easy on the operator and presents an exceedingly neat appearance.

Having completed a description of the transmitting apparatus we will now arrange the instruments on the instrument board. The reader is advised to review the preceding articles of this series covering the construction of the

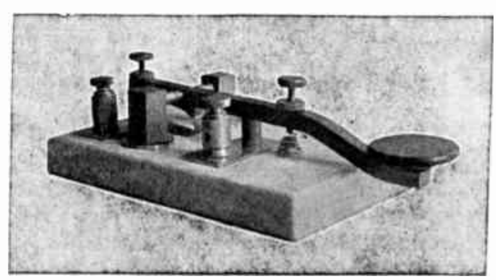


Fig. 11

"Concrete Wireless Station" and the erection of the aerial masts and antenna, in order that the position of the building, situation of the apparatus, etc., may be familiar.

In Fig. 12 is a photograph of the instrument board and equipment installed by the writer in the wireless station at

Fort Levett, Maine. This will give the experimenter an idea of the neat appearance it is possible to attain by an intelligent grouping of the apparatus. In this photograph the transformer is back of the desk on the floor, the condenser being above it. The condenser is of the oil-immersed type. The leads from the transformer to the condenser are copper bars which continue up to the spark gaps on the instrument board. Two spark gaps are placed on this board, one being short-circuited by a copper bar when the other is in use. Above the spark gaps is the inductance helix; then the hot wire meter; and finally, the aerial switch. The aerial switch is controlled by two chains which pass through pulleys in the ceiling and hang right over the desk within easy reach of the operator.

In Fig. 13 is shown the method of placing our apparatus. This is different from the set just described as the aerial switch is at the bottom, with the spark gap and hot wire meter on opposite sides in the centre, and the oscillation transformer at the top. As our board is mounted 9 in. from the wall, sufficient clearance is allowed for getting at the motor in the rear. The snap switch controlling this motor is placed below the spark gap. The transformer and condenser can be placed under the table out of reach of the operator. Where the connecting bars pass through the operating table, micanite or hard rubber insulators at least 2 in. in diameter should encircle them.

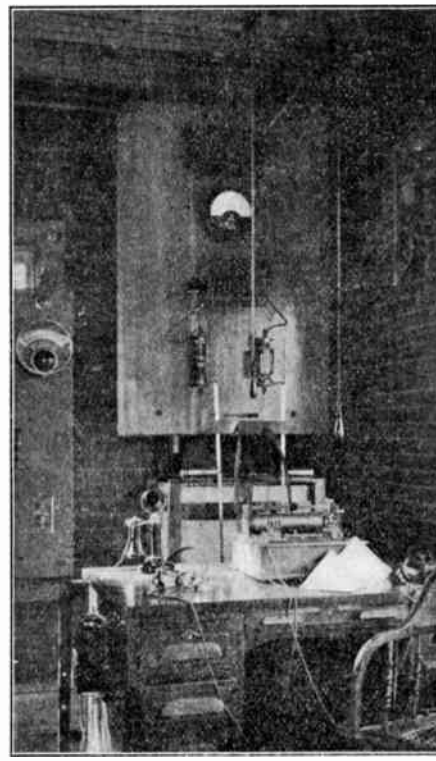
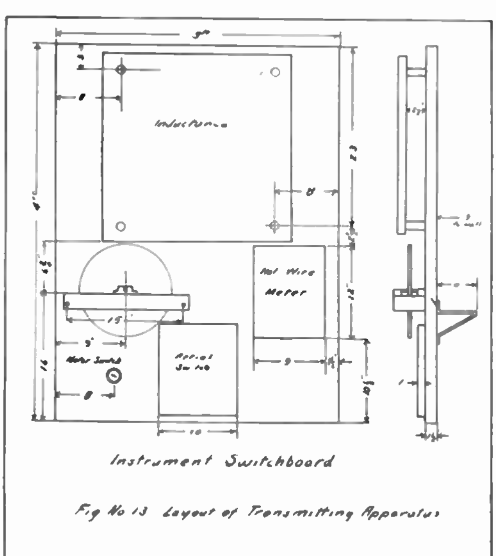
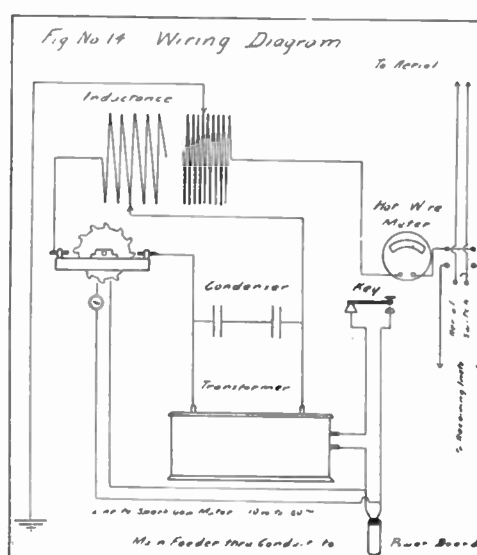


Fig. 12





In Fig. 14 is given the wiring scheme to be followed with this outfit. All connections between the transformer, condenser, spark gap, inductance, hot wire meter and aerial switch should be of 1/8 in. x 3/4 in. copper bar. Sharp bends of this bar should be avoided. The aerial lead wires should be of approved high tension cable run directly from the insulators to the aerial switch. The ground connection should be of 1/8 in. x 1 in. bar copper.

All low potential wiring to the motor and transformer to conform with the Underwriters Code.

Referring again to Fig. 14 it is seen that the closed oscillating circuit consists of the condenser (bridged across the transformer) in series with the inductance spiral and spark gap. The open oscillating circuit consists of the aerial through the aerial switch to the hot wire meter thence to the spiral inductance to ground.

With careful tuning this set (5 k.w.) should easily be able to work 500 miles over land and 1,200 over water under ordinary conditions, with the aerial previously described.

The next article of this series will describe the construction of the Hot Wire Meter and a Wave Meter to be used with this set.

(To be continued)

A SIMPLE METHOD OF CALCULATING CAPACITY OF CONDENSERS

ERNEST C. CROCKER

An electrical condenser has the power of storing electricity for a short time, much as a storage battery does, and this property is called capacity.

The charge is held on the surfaces of the plates, and the quantity that a condenser may hold depends on the size of the plates, their nearness to opposing plates and the material between them. This intervening material is called the dielectric. The four commonest dielectrics are air, paraffined paper, mica and glass. The metal of which the plates are composed has no influence on the capacity.

If we have two plates, one on each side, there is one active surface on each side of the condenser, and if we have three plates, there will be two active surfaces. Active surfaces are those directly facing the plates of the opposite side. It being regular custom to have an odd number of plates, there will be twice as many active surfaces as there are plates on the side having the smaller number. It will be the side with the smaller number of plates that we will consider in the following formula:

$$\frac{.00045 \times S \times N \times K}{D} = \text{capacity in micro farads}$$

where

S = sq. in. area of plate (one side)

N = number of plates on smaller side

D = thickness of dielectric in thousandths of an inch

K = capacity value of dielectric.

Values of K

Air = 1.000
Paraffined paper = 2.0 to 2.2
Petroleum oils = 2.1 to 3.0
Ebonite = 2.7 to 3.4
Castor oil = 4.7 to 4.8
Glass (ordinary) = 5 to 6
Mica = 6.5 to 8.0
Glass (crown) = 9 to 10
Water (pure) = 80

Example 1:—Illustrating use of formula. Find capacity of paraffined paper condenser: 61 plates (total), 60 sq. in. per plate, thickness of dielectric .003 in.

$S = 60$; $N = 30$; $D = 3$; $K = 2$.

$$\frac{.00045 \times 60 \times 30 \times 2}{3} = .54 \text{ mfd.}$$

Example 2:—Find capacity of glass plate sending condenser, 11 plates 6 in. x 10 in., glass .06 in. thick.

$S = 60$; $N = 5$; $D = 60$; $K = 5$.

$$\frac{.00045 \times 60 \times 5 \times 5}{60} = .01125 \text{ mfd.}$$

This formula is very accurate when the distance between the plates is small, but in the case of rotary condensers this is sometimes made so large that an allowance must be made for it. The following corrections may be used after the capacity has been calculated by the previous method.

	4 in. diam. plates	6 in. diam. plates
1/16 in. between plates	add 2%	add 1%
3/32 in. " "	" 4%	" 2%
1/8 in. " "	" 8%	" 4%

A formula for finding the area of a rotary condenser plate, is the following: Area = 2/5 (diam.)^2.

Example 3:—Find area of plate 5 in. diameter.
Area = 2/5 (25) = 10 sq. in.

Example 4:—Find capacity of rotary condenser of 31 plates, 5 in. diameter. 1/16 in. between plates.
$S=10$; $N=15$; $D=.06$; $K=1$;

$$\frac{.00045 \times 10 \times 15}{60} = .001125 \text{ mfd.}$$

Correction = 6%
.001125 = value by formula
.0000675 = correction.

.0011925
Capacity = .0011925 mfd.

A NON-INDUCTIVE WIRE POTENTIOMETER

C. C. WHITTAKER

The following instructions are for making a very efficient non-inductive potentiometer for wireless work.

The non-inductive effect in this piece of apparatus is found desirable when close tuning is sought. Suppose the tuner is adjusted for maximum loudness or clearness, if the local current is now changed with an inductive potentiometer to suit some irregularity of the detector, the tune is at once altered. Thus we see, by using the non-inductive type, the tuning circuit may be adjusted once and the battery circuit changed with impunity, thereafter.

The non-inductive quality of the latter type is obtained by having half of its winding opposed to the other half.

A convenient form and size is given below:

Have a disc of hard wood, 4 1/8 in. in diameter, turned out, having a circular groove 3/8 in. wide and 3/8 in. deep with inner diameter of 2 3/8 in. This groove forms a receptacle for the wire.

The outer edge of the disc is fitted, as in illustration, with 24 battery binding posts, having their heads filed down till the slots can no longer be seen. This leaves a plane surface for the sliding contact.

The wire necessary is two ounces of No. 30 German silver. This quantity has a resistance of about 760 ohms and will make about 576 turns in the groove. Since there are 24 binding posts, there will be 24 turns connected to each post.

The wire is wound by first fastening an end to binding post No. 1 in the illustration. Then 24 turns are wound on in a direction counter clockwise and the end is brought out to binding post No. 2. Then the same number of turns are wound on in the opposite direction and

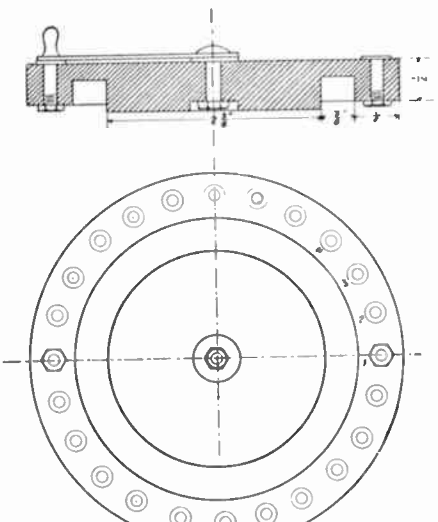


Fig. 1

the end brought out to binding post No. 3, etc., till the whole number of turns is deposited, the last end being connected to the 23d binding post.

The switch arm must be made wide enough to reach from one binding post to the adjacent one without breaking contact.

THE BULLETIN'S FREE WIRELESS COURSE

By the COLLINS' LABORATORY STAFF

Introduction—The object of this series of instruction papers is to fit young men and women to become practical wireless operators. It is a rational course designed to teach not only the beginner the elementary principles of electro-magnetic phenomena as utilized in the wireless arts, but to enable the practical telegraph operator to acquire a thorough working knowledge of this newest and most promising branch of applied electricity.

To become thoroughly familiar with the subject in the shortest possible time it is advisable for two or more students to discuss the theory involved and to perform the experiments described. Where time will permit, the making of various pieces of wireless apparatus will be advantageous but since it is not an operator's business to build instruments, this is not an essential part of a wireless telegraph course; but the installation and operation of an equipment is of exceeding importance and it is here that theory and practice should go hand in hand. The present paper should be thoroughly studied, since it treats of not only the theory of transmitters but the practical aspects of installation as well and thus begins the actual work which determines the capabilities of an operator.

Next to a familiar knowledge of the elementary principles the manipulation of the wireless telegraph instrument and the sending of the codes are most desirable.

With a thorough grasp of the former and a fair skill with the latter, the other and more complex things a wireless operator must know will come quickly and easily, and with them—success.

THE AERIAL SWITCH

Types of Aerial Switches.—Having described the various types of transmitters and receptors, the means for *changing over* or connecting these alternately to the aerial wire system must next be considered. There are two general types of aerial switches, namely: (1) the *manual*, or hand-operated, *switch*, and (2) the *automatic* switch.

Manual Switches.—In the earliest wireless apparatus the change-over from the transmitter to the receptor and *vice-versa* was effected in the most primative manner imaginable and consisted of a plug and socket so that the aerial could be plugged in with either the sending or the receiving apparatus as desired.

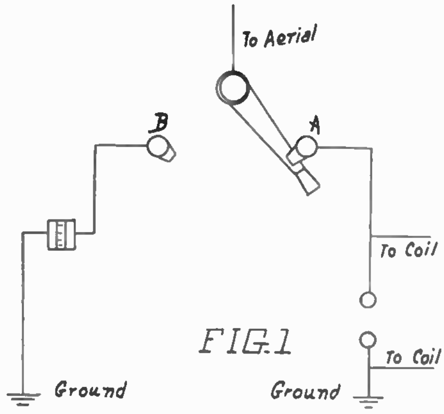


FIG. 1

A decided improvement consisted of a change-over switch having a single blade which was pivoted at the end, the aerial being connected therewith. The blade was made long and this permitted the split contacts *A* and *B*, Fig. 1, and which are connected to the transmitter and the receptor to be separated beyond the striking distance of the coil.

A Simple Switch.—An ordinary 15-ampere, double-pole, double-throw knife switch mounted on a porcelain or a hard-wood block makes a very good and serviceable switch for small stations. Where the secondary potentials develop a striking distance of 1 in. or more, the blades of the switch must be increased in length and more widely separated. Fig. 2 shows the connections for this type of switch.

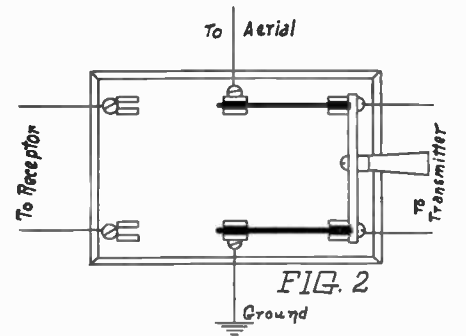
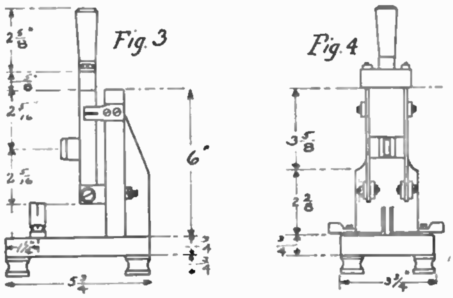


FIG. 2

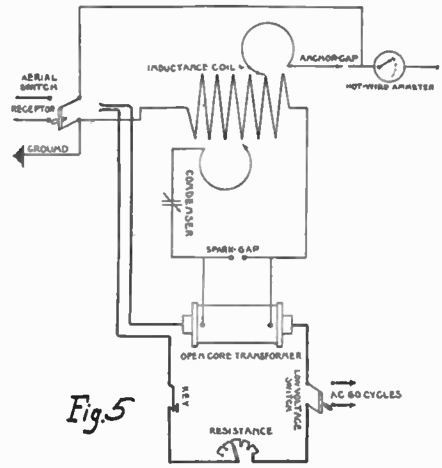
The aerial is connected to the hinge of the blade *A* while the ground is attached to the hinge *B*. The split contact *C* leads to one side of the spark-gap or sending tuning coil, as the case may be, of the transmitter and the split contact *D* to the opposite side of the gap or coil. The oppositely disposed split contacts *E* and *F* are connected to the detector if the receptor is a simple untuned one or with the tuning coil where the system is a tuned one.

A Standard Switch. A most excellent type of switch for standard stations is shown in Figs. 3 and 4, and the connections are illustrated in the diagram Fig. 5. In this switch the construction is such that the blades move through an arc of 90 degrees instead of 180 degrees as in the switch previously described.

Like the preceding switch, however, the aerial is secured to one of the blade hinges *A* and the ground to the opposite hinge *B*. An anchor-gap is interposed between the sending helix and the aerial, and this serves as an automatic electric valve, since when the transmitter is in operation the sparks fill the gap and close the circuit, but when the receptor is utilized the gap remains open and thus insulates the transmitter from the aerial.



Therefore only one pair of split contacts, *C* and *D*, are employed to make connections with the switch blades and these lead to the receptor. A brass plug which is insulated from the blades makes connection with a pair of spring contacts, *E*, the latter being insulated from each other. A lead from either contact connects with the primary of the transformer and the source of current, so that when the plug is forced between the contacts the primary of the transformer circuit is completed when the key is closed.



The diagram, Fig. 5, shows the connections, and it is obvious that when the switch is thrown over for receiving the primary circuit is broken, and hence the transmitter and the receptor are always insulated from each other.

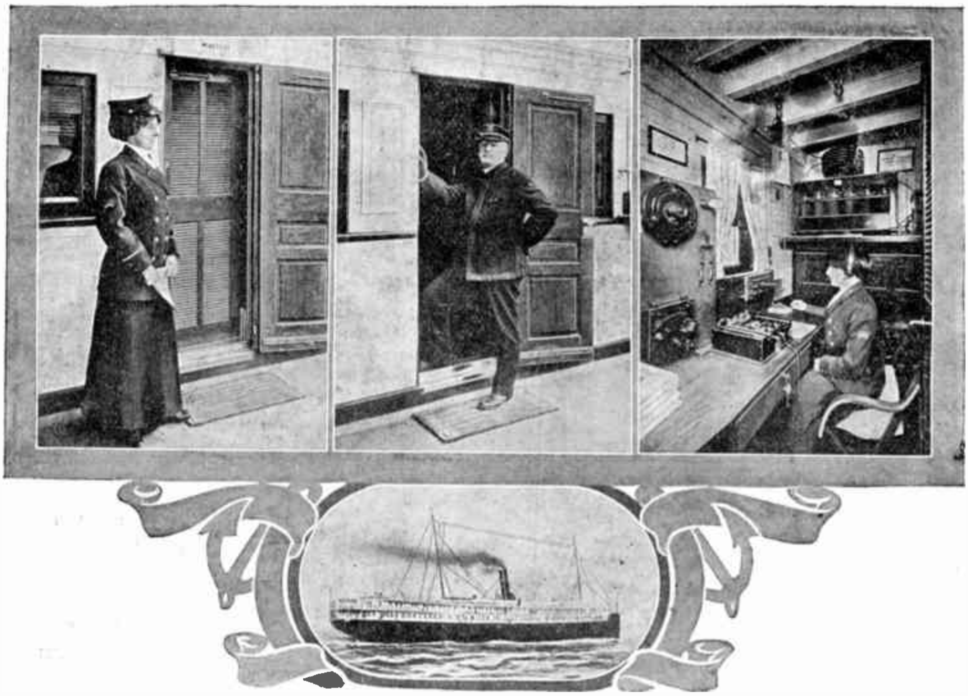
FIRST GIRL WIRELESS OPERATOR

Clyde Steamship Company sets precedent by putting woman wireless operator on its flagship

When the Clyde Steamship *Mohawk* left New York on Tuesday, November 29th, on its regular trip to Charleston and Jacksonville, it had aboard as wireless operator the first woman who ever bore the responsibility of this position on an ocean steamer. The officials of both the Clyde Line and the United Wireless Company have considered for some time the advisability of employing a woman in this capacity, and have only awaited the discovery of one who combined the necessary experience and skill with the other qualities that are required in this very important position.

Miss Graynella Packer, of Jacksonville, is the young lady to whom has fallen the honor of being the first of her sex in this new field. When seen aboard the *Mohawk*, Miss Packer was busily engaged in the ship's wireless room and going about her work as unconcernedly as if she were ensconced in the snuggest and safest telegraph office on land and quite unmindful of the fact that she was a centre of interest to the 300 passengers bound south on the liner.

"Afraid of the responsibilities of my position?" she said in reply to a question. "Well, hardly. I'm impressed with them, if that is what you mean, but you know that women are assuming all sorts of responsibilities in the business world these days, and I am only one of many girls who have taken up work that requires qualities which of old were attributed only to men. I'm not afraid of my work; I'm delighted with it. And while I hope that my experience



Miss Packer Capt. Nemble Wireless Room on the *Mohawk*

will not include many critical incidents, I know, nevertheless, that I shall be ready to do all that is required of me under all circumstances.

"There is a strict code of honor among wireless operators—sort of a wireless code, you might say. It knows just one precept and that is, 'stick to your post.' Operators on shipboard are trained to the same standards of fidelity to duty as are the captains themselves, and we have yet to know of an instance where the wireless operator was found lacking in a crisis. That's why I don't fear the responsibility. I know that my duty is simply to sit at this instrument and take and send messages, and I shall not let conditions influence my work in the least.

"Besides, you know, while this is my first voyage as an operator, it is really my seventeenth trip on a Clyde Line steamship between New York and Jacksonville. I know the boats and I know the officers on them, and I cannot imagine a safer mode of travel or more pleasant and comfortable surroundings in which to work. It was while en route to New York on the Clyde steamship *Comanche* that I first became interested in wireless and much of my operating experience at sea has been gained on the various steamers of this line. So I'm very much at home here, you see."

Miss Packer is twenty-two years old and has had two years' experience as manager of the telegraph office at Sanford, Florida. She has aspirations as a concert vocal soloist and will take vocal training each week during the steamship's stay in New York. She has never known wireless operators personally, but has been much impressed with the heroism of Jack Binns, operator on the steamer *Republic*, and with the daring and resourcefulness of the wireless man on the recent Wellman dirigible attempt. She believes that she has been most attracted to wireless work by the sense of mystery with which she was thrilled when she first received messages while coming up from Jacksonville on a Clyde Liner. She asserts that this feeling of annihilating distance by a flash of electricity is almost overwhelming to the beginner.

Miss Packer has been a telegraph operator for a number of years. She predicts that women will play a great part in the wireless of the future.

ELECTRICITY IN HOME AND OFFICE

DESIGN AND CONSTRUCTION OF A PRIVATE LIGHTING PLANT—Part III

STANLEY CURTIS

It was the intention of the writer to take up the selection of the storage battery and gasoline engine in this article, but in view of the fact that the April issue of *Electrician and Mechanic* will be a special Storage Battery Number it was deemed advisable to change the original order of the description so that this most important point might receive additional attention. The present article will therefore take up the switchboard and the construction and use of its instruments.

In the February issue an error was made in combining the diagrams of connection board and field magnet winding. The diagram of the winding is not incorrect in itself, but if the ends of the winding are connected as shown in drawing of the connection board, the current would flow in opposite directions around the field cores, one thereby neutralizing the magnetism in the other, and no magnetism would be in evidence at the pole pieces. If wound in this manner, it would only be necessary to join a starting end and a finishing end to the terminals of the rheostat, while the remaining starting and finishing ends would be connected to the brush leads. This will be fully taken up in the article on the setting-up and operating of the plant. By connecting the two fields in multiple the machine can be run at a lower speed and be made to generate a lower voltage without giving any trouble about "picking-up." This connection, however, is chiefly useful for experimental purposes and will receive due attention later. The principle of the field magnet winding is extremely simple to understand. With a "Manchester" type of field, such as is used in the machine in question, the current should flow around both cores in the same direction to produce a north pole at top and a south pole at the bottom or vice versa.

The winding may be in the same direction on both cores, or it may be in opposite directions, providing the ends are properly connected.

Fig. 33 shows the layout of the switchboard. The writer's board was of mahogany, ¾ in. thick and 24 in. square. This is scarcely large enough to accommodate all of the instruments shown in the drawing which is to scale. At first the board only contained voltmeter, ammeter, field rheostat and main switch, for which its size was ample. However, with the addition of the wattmeter, cut-out and circuit breaker, it became crowded, to say the least. Therefore, the advice is given to use a board at least 30 x 30 in., providing it is desired to use the full equipment shown.

A brief sketch of the operation and use of each instrument will be given to enlighten those who do not understand.

In the first place, a wooden switchboard would not be permitted by the Underwriters if the voltage was higher than that used. Indeed, the use of wood will not be permitted under any circumstances in certain localities, and this fact should be taken into consideration. Slate is, without a doubt, much better and marble is ideal. The little generator used in this plant will produce a startling flash on short circuit, and the danger of fire, from lack of proper care in installation, must not be lost sight of.

To sum up the operation of the board, let us trace the circuits. The feeders from the dynamo are connected to the

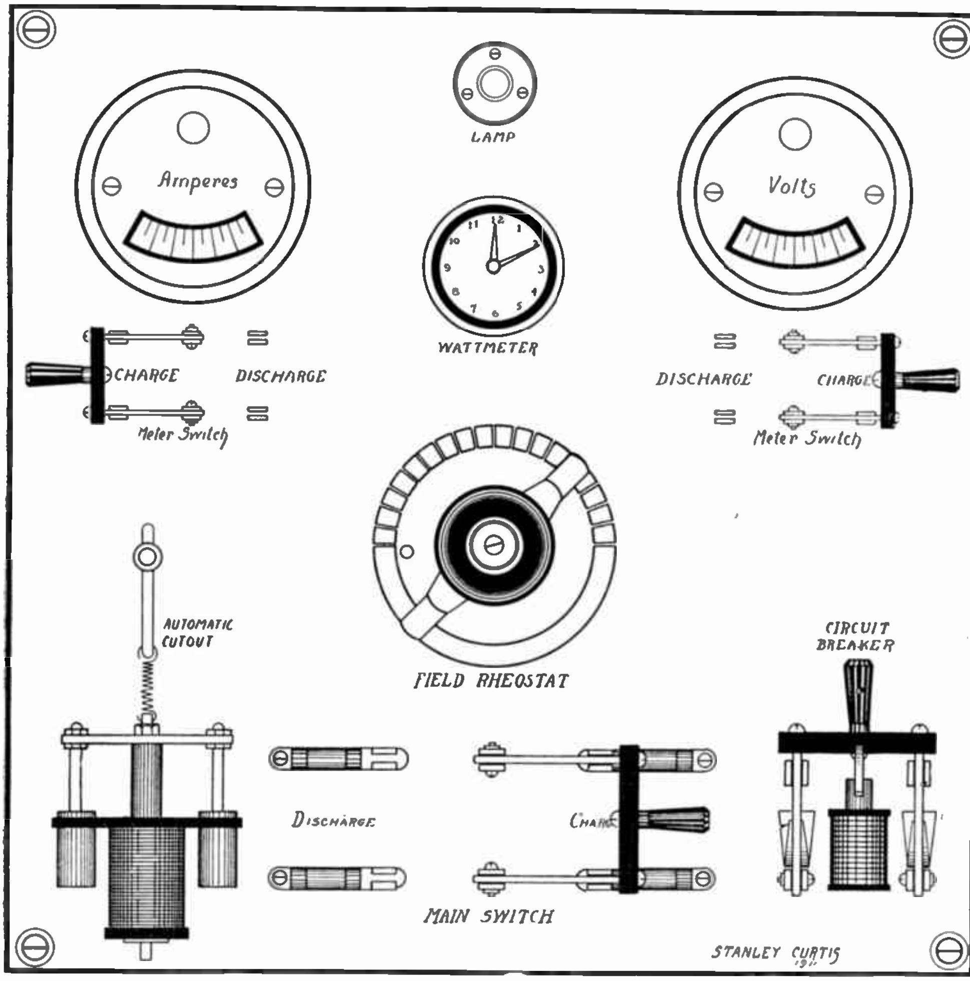


Fig. 33

clips at the right hand end of the main switch. The blades of the main switch are connected to the storage battery terminals, while the left-hand clips are connected to the lighting circuit. By merely throwing the switch from right to left, the dynamo is cut out and the storage battery is ready to supply current to the lamps. The field rheostat regulates the voltage of the dynamo while battery is charging. The voltmeter and ammeter at top of board may be cut into the charging or discharging circuits by means of double throw switches. A lamp at top of board should be connected to a battery of dry cells or other source of current, independent of the plant. This lamp may be a small battery tungsten, as it is merely used to illuminate the switchboard to take readings of the meters. The wattmeter is a home-made affair, hardly deserving of the name still it does its work accurately enough to serve as a reliable guide to the number of ampere hours drawn from the battery. Its construction will be fully explained later. The automatic cut-out, or charging switch, serves to open the charging circuit if the voltage falls below a pre-determined point. This is essential, as otherwise the battery would discharge itself by running the dynamo as a motor. The circuit-breaker is a refinement, but a very convenient one. It is connected in series with storage battery and lighting circuit. Should a short circuit or other heavy overload occur on the line, the breaker will open the circuit automatically and protect the battery from injury. Fuses serve the same purpose but are not as reliable.

The construction of volt and ammeter is shown in Fig. 34. The chief disadvantage of this type of instrument is its inaccuracy when left in circuit, as the soft iron piece, *J*, will retain a certain amount of residual magnetism which will cause it to lag back when the current is diminished. This defect should not be dwelt upon too strongly, as the instrument will give excellent service, considering its extreme simplicity of construction. It requires considerable care in its construction, however, in order to produce good results.

The base, cover and side casing may be gotten out first. Turn up a disc of ½ in. mahogany 6 in. in diameter for the base of each instrument and also the covers, 5 in. in diameter from ¼ or ⅜ in. stock. The casing may be cut from a piece of 4½ in. brass tubing or it may be bent up from 1/16 in. sheet brass. The width is 2¾ in. from base to cover. The two upper drawings, Fig. 34, give front and side elevations of the case complete. An opening is cut through the cover directly over the dial and a piece of glass, *N* in sectional view at the right, is mortised in the under side. The cover is secured to base by means of long screws, *I*, which pass down on either side of the instrument. These screws should be of brass or other non-magnetic metal.

The bobbin consists of a piece of brass tubing, *F*, 1 in. in diameter and 2 in. long, fitted with ends of ¼ in. fiber, *G*, 2 in. diameter. The movement is composed of a piece of 5/16 in. aluminum rod, *K*, 1¾ in. long, having a needle point *L*, *L*, fitted in either end. The rod may be chucked and a needle drill run in either end for a distance of about ¼ in. and the broken end of a steel sewing needle forced in. The soft iron piece, *J*, is ¾ in. wide and 1½ in. long. It may be cut from heavy sheet iron and must be most carefully annealed. Bend one end around rod, *K*; remove rod and close up the end still more. On forcing rod through again the iron will be held with sufficient firmness. The iron is curved in the centre, as shown in the left-hand view at *J*. A pointer, *A*, of light wood is fitted into a hole in the outer end of aluminum rod. The pointer should be inserted prior to the needle in that end, so that needle may be forced down through, or into, the wood.

The screws, *B*, *B*, were taken from an old clockworks in which they had served to support the balance wheel. The screw at the left is mounted in a piece of 3/16 in. fiber, fitted into bottom of bobbin, while the outer screw is mounted in a cross piece of ⅛ in. brass, *D*. This is secured to bobbin end by screws, *C*.

The dial or scale is mounted on a stand, as shown at *H*, *M*.

The voltmeter and ammeter are identical in construction, the only difference is in the winding. Wind 4 oz. of No. 36 s.c.c. copper magnet wire on the bobbin for the voltmeter, and bring ends to the 8-32 screws *E*, *E*, which pass through the base. For the ammeter, wind about 25 turns of No. 10 d.c.c. wire on the bobbin and connect to screws *E*, *E*. Solder these connections securely, especially in the ammeter, as this instrument must carry the entire current of the lighting circuit without offering practically any resistance.

To calibrate the voltmeter, a standard instrument, together with about 25 dry cells in series, will be required. The scale should read to 30 volts. Several methods may be used for the calibration of the instruments, but the following will be found quite satisfactory. Connect the standard voltmeter and the one to be calibrated in multiple. Arrange the battery so that one cell may be added to the series at a time. Insert a water rheostat in series with one cell of battery and the meters. Adjust water rheostat until the standard meter reads 1 volt. Mark one division on other instrument. Add another cell and adjust to 2 volts. Mark second division and proceed in this manner until the entire scale is marked off. It may be found that the resistance of the home-made instrument is so low that the pointer will show a full deflection on less than 30 volts. In this case it is only necessary to place a resistance unit of No. 36 German silver wire in series with voltmeter coil. The amount of the deflection will vary considerably with different weights of pointers, quality of soft iron piece and delicacy of pivoted bearings. The idea is to have the least

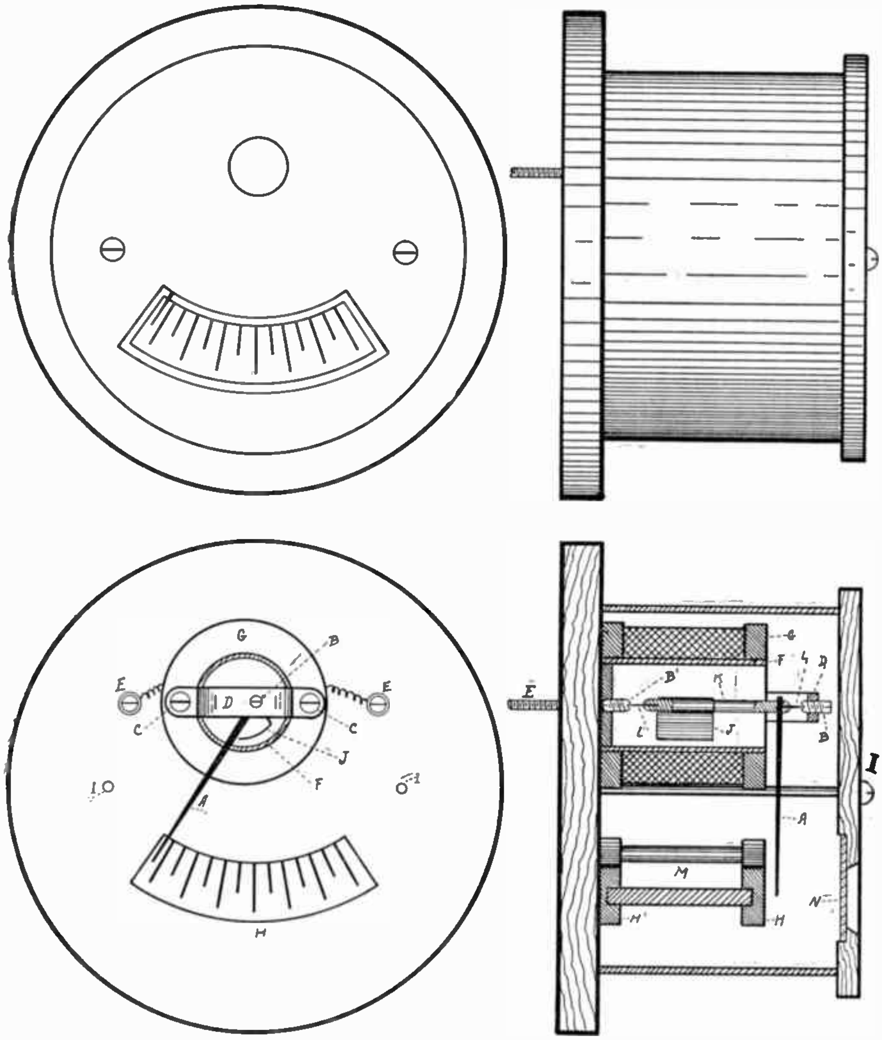


Fig. 34

possible amount of friction and as little weight as possible. By adding resistance to the coil, the deflection is made less. If there is not enough deflection, there is too much wire on the bobbin and some may be unwound. There is very little likelihood of this, however.

In the case of the ammeter, the home-made instrument is connected *in series* with a standard one and all of the available dry cells connected in *multiple*. The scale is to read to 20 amperes. Place the water rheostat in series with battery and the two meters. By gradually lowering the plate of the rheostat, more current will flow and the divisions marked. If the ammeter deflection is full at less than 20 amperes, take off a few turns. If not great enough, add one or two. The data given is taken from the writer's instruments and will be found to give just about the correct deflection.

A voltmeter is always connected in parallel or multiple with a circuit and must therefore be of high resistance. The ammeter is connected in series with the circuit and its resistance must therefore be practically zero, as it has to carry the entire amount of current flowing through the circuit. In ammeters to measure very heavy currents, it would be impracticable to use a conductor of sufficient cross-section on the bobbin of the instrument. In these meters a "shunt" of low resistance carries the main current, while the coil of the meter is of high resistance and actually measures the drop in volts across the shunt. In installing a shunt ammeter, the flexible leads from meter to shunt block must not be shortened or lengthened as they form a part of the resistance in the instrument. Shunt meters are employed exclusively in large power plants and also in even comparatively small electroplating plants.

As previously stated, the automatic switch, Figs. 35, 36, 37, was added to the writer's plant after the original installation was completed. The original engine, a small air-cooled bicycle motor, had a trick of slowing down and frequently stopping, in which event the battery would run the dynamo as a motor, and this would keep the engine turning against compression until it took a notion to resume its explosions. This "automatic" feature of the plant was not very desirable, as frequently after an 8 or 10 hour's run the battery would be only partially charged. The switch, to be described, was built to cope with the difficulty, and it worked admirably. The mercury contacts were substituted after considerable trouble had been experienced with flat copper contacts, which would soon become roughened and burnt by the arcing when the switch opened. This opening operation was frequent, too, with the first engine. After the installation of a 2 h.p. water-cooled engine, to be described, the writer doubts if the switch has ever had to do its work.

The principle of operation is very simple. The solenoid, *B*, Fig. 36, is connected in shunt with the dynamo terminals. The soft iron plunger, *C*, is arranged to slide easily into the solenoid and is held out by the spiral spring, Q. On its upper extremity, the plunger carries a brass cross-piece, *E*, in which the contact pieces, *D,D*, are secured. These pieces pass through fiber covers, *K,K*, into the cups, *I,I*, which are one-third filled with mercury. Water is poured on the mercury to extinguish the small arc, but is hardly necessary. The mercury cups are in series with the charging circuit. When the voltage of the dynamo becomes sufficiently high, the solenoid draws the plunger down into it and the contact rods will complete the circuit with the mercury. Should the voltage fall from any cause, the spring would overcome the solenoid's magnetism and the circuit would be opened. Just as soon as the voltage came up again, the contact would be automatically made and battery would go on charging. The amount of voltage required to make contact may be nicely regulated by means of rod, *O*, to which spring is attached.

The solenoid is composed of 1¼ lbs. of No. 27 d.c.c. wire wound on a bobbin. A piece of seamless brass tubing, *M*, ¾ in. inside diameter, is fitted with fiber ends. The top end also carries the mercury cups, *I,I*, which are the small brass receptacles in which Williams' shaving soap is sold. A point is made of this, as it is difficult to fit a bottom into a receptacle to hold mercury. Solder will not do at all, as the mercury will form an amalgam with the tin and the bottom will drop out or leak mercury, as the writer knows to his cost. If suitable cups are not at hand, turn a well fitting plug of hard wood for the ends of a piece of brass tubing and drive the plug in, afterwards treating the bottom to shellac. Do not shellac inside of tube, or mercury will fail to make contact. The clamps, *J*, are ½ in. x 1/16 in. brass or copper strip and are equipped with long 8-32 screws, which pass through base and switchboard. The bobbin is wound and ends of wire joined to screws, *A,A*, which also pass through base.

The plunger, *C*, is a piece of cold rolled steel, carefully annealed. Drill a ¼ in. hole through the centre. Mount on ¼ in. arbor and turn outside to a scant ¾ in. in diameter. Polish surface with very fine emery cloth. The length of plunger is 2½ in. and it should be an easy sliding fit in the brass tube, *M*. Procure a piece of ¼ in. square brass rod, *F*, 6 in. long. Turn it down to a circular form for 3 in. of its length and run a ¼–20 die over the circular end. The rod will pass through the centre of plunger up to the square portion. The cross piece, *E*, is of ¾ in. x 3/16 in. brass bar, about 4⅛ in. long. Holes for contact rods, *D*, are drilled 3½ in. apart on centres. The rods are of brass and are faced off squarely on one end, while the other end is threaded for hexagon bolts,

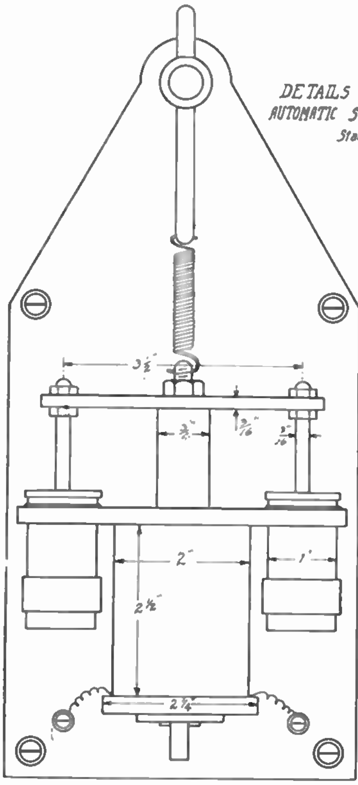


Fig. 35

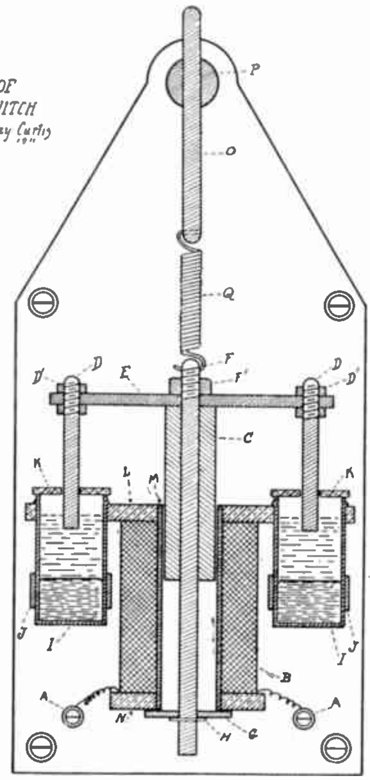


Fig. 36

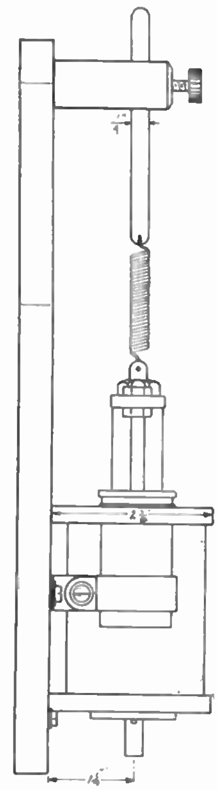


Fig. 37

D'. The rods are 2¼ in. in length and 3/16 in. in diameter. Cross-piece, plunger and centre rod may now be assembled and the 1/16 in. hole for spring, *Q*, drilled just above the nut, *F'*. The square portion of the rod slides through a washer or plate, *G*, which is secured to the bobbin end by short screws. This plate holds the rod, and consequently the cross-arm, in the proper position, so that the contact pieces are held centrally in mercury cups. A pin, *H*, is inserted to prevent the rod jumping out of the hole if current is suddenly removed from solenoid. The proper position for plunger is shown in the drawing, *i.e.*, inserted for about one-third its total length. The adjusting rod, *O*, is supported in a pillar, *P*, in which it may be clamped by milled head screw, as shown in Fig. 37. The spring is No. 18 spring brass wire, wound on an arbor until its closed length is about 1½ in. The rod, *O*, should have an adjustment of about 3 in.

The covers *K*, *K*, are of ⅛ in. fiber, and are laid loosely on top of cups. The hole in centre must be of ample size to allow contact rods to pass through without friction; ¼ in. is none too large. The plunger must be free in its action, and a little flake graphite rubbed over the iron cylinder and on the inside of tube will help matters. Plate, *G*, should have several holes in it to permit the air, driven down by plunger, to escape, as otherwise it would act as a cushion to restrain the downward action of plunger.

Dimensions have been purposely left off the drawing, as other builders may use such scrap material as they have on hand to construct a larger or smaller switch. This switch will consume from ¼ to 1/3 of an ampere while it is in shunt with charging circuit, and it will operate on voltages of from 20 to 40, the voltage required of course being dependent upon tension of spring. A lower or higher voltage might be used by winding solenoid with coarser or finer wire.

(To be continued)

HERE AND THERE

Final Instructions

Little Harold was getting final instructions before starting for a party.

"Now," cautioned his mother, "at supper if they ask you a second time to have something you must decline."

Harold agreed and trotted off.

At one stage of the feast the hostess noticed how eagerly the little fellow was applying himself to the task of disposing of a generous dish of marmalade. When he had finished she inquired, "Won't you have some more, dear?"

The child looked up at her quickly. "I can't accept the second time," he said earnestly after a slight pause, "but if you'll ask me a third time I think it will be all right."

He was asked.—*Woman's Home Companion.*

A fashionably dressed young woman entered the post-office in a large Western city, hesitated a moment, and stepped up to the stamp window. The stamp clerk looked up expectantly, and she asked: "Do you sell stamps here?"

The clerk politely answered, "Yes."

"I would like to see some, please," was the unusual request.

The clerk dazedly handed out a large sheet of the two-cent variety, which the young woman carefully examined. Pointing to one near the centre, she said, "I will take this one, please."

—*Everybody's.*

The five-year-old son of the Rev. Stephen S. Wise was driving up Fifth avenue recently with his mother. As they approached the entrance to Central Park she called his attention to Saint Gaudens's famous work, the equestrian statue of General Sherman led by Victory.

"But, mamma," he queried, "why does not the gentleman get off the horse and let the lady ride?"

The teacher was giving a geography lesson, and the class, having traveled from London to Labrador, and from Tressaly to Timbuctoo, was thoroughly worn out. "And now," said the teacher, "we come to Germany, that important country governed by the Kaiser. Tommy Jones, what is a Kaiser?" "Pleas' em," yawned Tommy Jones, "a stream o' hot water springin' up an' disturbin' the earth!"

A Bright Boy

"Now, Tommie," said the teacher, "you may give me an example of a coincidence."

"Why—er," said Tommie, with some hesitation, "why—er—why—me fadder and me mudder was both married on de same day."—*Harper's Weekly.*

Look Who's Here

Lord Roberts once promised to inspect the boys' brigade battalion in Glasgow, but at the last moment was prevented by illness. A local officer was secured to fill his place, and in selling tickets for the inspection it was thought only fair to let purchasers know that the distinguished field marshal would not be present. One small brigade boy came up and asked for two tickets for his father and mother. The clerk said, "Do your father and mother know that Lord Roberts is not to be present?" The boy replied, with a look of self-confidence, "it's no Lord Roberts they're comin' to see, it's me."

Unexpected Generosity

Mamma—"And you say your Uncle Titewad gave you a penny, Tommie!"

Tommie—"Yes, ma'am."

Mamma—"And what did you say?"

Tommie—"I was so surprised I couldn't say anything, mamma!"

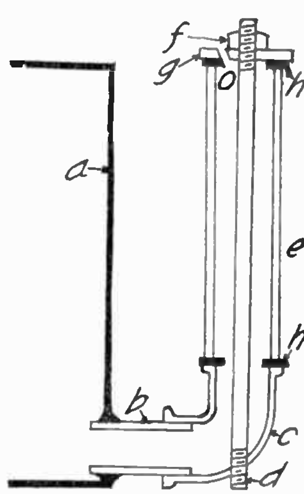
— *Yonkers Statesman.*

PRACTICAL HINTS

A Sight Gauge for a Gasoline Tank

JAS. P. LEWIS

The accompanying sketch shows a cross-section view of an easily made sight-gauge for a gasoline tank. A short piece of brass or iron pipe *b*, about ⅜ in. in diameter is soldered neatly to the tank *a*, near the bottom. The other end of *b* is threaded to take an elbow *c*. At *d* on this elbow is bored a small hole which is tapped to take a ⅛ in. rod somewhat longer than the height of the gasoline tank, and having both ends threaded for a short distance. It might be well to solder this rod to the elbow also. *G* is a brass disc having a hole in centre large enough to allow the rod to pass through and another small one near the edge.



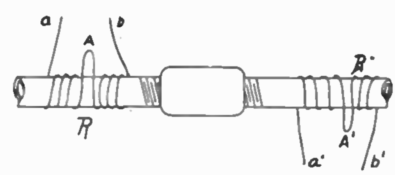
A piece of heavy glass tubing is now secured, about ½ in. outside diameter. This is cut to proper length and the ends smoothed with emery paper. It is then placed in position upon the rod, between the brass disc and face of elbow. Two cork washers are also placed as shown at *hoh'*, and the nut *f* tightened up on the rod. The purpose of the hole at *o* is to allow the air to enter and escape as the tank is filled or emptied.

Some kind of guard to protect the glass from blows may be constructed if thought necessary.

How to Unscrew a Pipe

A. D. STETHERS

Sometimes a person has no pipe wrench at hand when he needs one, or the wrench you have is not large enough to fit the pipe or strong enough to turn the pipe. In this case take a strong

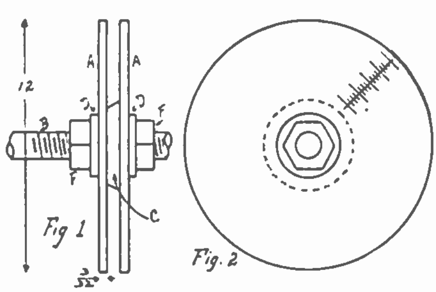


rope that is not too stiff to wind around the pipe in good shape, and wind it around the ends of the pipe as at *R* and *R'*. Hang hold of the free ends *a* and *b* and pull slightly, to keep the rope from unwinding, and place a crow-bar or hand-spike in loop *A* and turn towards the free ends *a* and *b*. Place another rope in a reversed way at *R'*, and put a bar or hand-spike through loop *A'* and hang to the free ends *a'* and *b'*, and turn towards *a'* and *b'*. This way takes two men, one at each rope. If you are alone tie the free ends *a* and *b*, and run the two tied ends through loop *A*, and place a bar through the loop formed by the two tied ends *a* and *b* and turn towards the left. Do the same with free ends *a'* and *b'* at *R* and turn towards the left. This is a handy and strong method to turn pipes out of pump cylinders. If the rope slips on a slimy pipe, clean pipe and put cement, lime or resin under rope, let dry and turn.

A Convenient Section-former

J. H. STEWART

When building spark coils or transformers, the secondaries are usually divided into sections for purposes of better insulation, and to lessen the chances of break-down. The sections are wound in forms constructed along the lines of the one shown in the drawing (Fig. 1). Numerous description of section-formers have been published from time to time, so that the general method of construction need not be given of this one. The point of interest in this former lies in the material used for the sides *A*. Usually the sides are made of thin sheet brass, which is often quite difficult to get perfectly flat after it has been cut to shape, especially in the larger formers of about 12 in. diameter. The material used for the sides of the present former is glass, ordinary window glass or any other kind. It is advisable to get the glass cut to shape by an expert glass-cutter or at a picture frame manufacturer's, although the amateur could do it himself if he has the means. The main thing is to have the edges perfectly smooth so as not to cut or injure the insulation of the fine wire to be wound. The rough edges may be melted down nice and smooth by means of a Bunsen flame. After cutting two discs of equal diameters, a hole is drilled through each to just clear the ½ in. threaded shaft *B*. One of the discs is then laid flat on a table and a divided mark scratched from centre to rim beginning ⅛ in. from the centre hole and ending ⅛ in. from the rim. This is to prevent breaking along



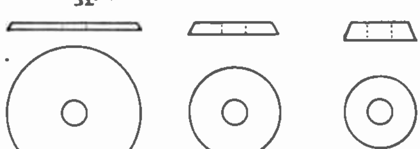


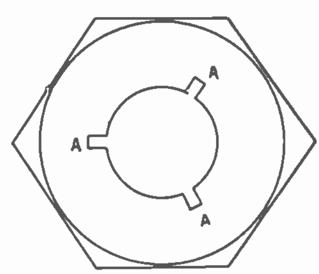
Figure 3

the line of scratch. The line is divided and marked as shown in Fig. 2. A number of cores with beveled edges may be turned up on a lathe and may be made in different sizes to suit the individual coil under construction (Fig. 3). The smaller the coil the thicker may be the sections; therefore, the cores are thicker on the smaller ones. Soft wood washers *D* are placed between the nuts *F* and the glass *A*, and the nuts screwed up tight. The shaft is placed in a turning machine, and, as the wire is wound on, the operator may watch the "pie" as it fills up the space, so that nothing may go wrong and so that he also may tell how much wire he has wound by looking to see where the wire is on the scale. The dimensions given are approximate and may be changed to suit the individual.

An Emergency Die

HOWARD TUCKER

Being called upon a short time ago to cut a thread on a brass rod, and not having any die to do it with, I picked up a steel nut which was lying near, and placed it in a vise. I then cut three nicks in it as shown in the drawing.



These nicks were used so that the nut would not bind on the rod. The nut being placed in an upright position in the vise, the rod was put into the jaws of a hand drill and the end tapered a little. Then the tapered end of the rod was introduced into the hole in the nut, and the handle of the drill turned, whereupon a good thread was cut upon the rod.

To Soften Cast Iron For Drilling

H. W. H. STILLWELL

Heat to a cherry red, having it lie level in the fire. Then with tongs, put on a piece of brimstone, a little less in size than the hole is to be. This softens the iron entirely through. Let it lie in the fire until slightly cooled, when it is ready to drill.

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.

1548. **Closed Core Transformer.** J. J. D., Hart, Mich., asks: Can you inform me how much empire cloth and how much linotape is required for closed core transformer described in June and July, 1909, numbers of *Electrician and Mechanic*, by W. C. Getz? I think he ought to have specified the amount in the article. Ans.—For the closed core transformer described in the issues mentioned, it will require about two rolls of Linotape, and 1 sq. yd. of empire cloth.

1549. **Induction Coil.** W. J. H., Galena, Kans., asks: if a small closed core transformer can be successfully used on direct currents, when employing an ordinary interrupter? Ans.—No, the straight form of core alone is applicable when direct currents are the source of power. The reason lies in the fact that due to the residual or retentive qualities of the iron, the magnetism does not disappear with the rupture of the current. With alternating currents this defect is not evident, for at each reversal the remanent magnetism is thoroughly cleared out, and a new induction established in the opposite direction.

1550. **Small Motor.** F. S. B., Rock Hill, S.C., asks: what must be the resistance in the field and armature coils of a 110 volt .5 ampere direct current motor, and what sizes of wire to use? Motor is supposed to give $\frac{1}{20}$ h.p. Ans.—You do not state whether you propose a shunt or series field winding, but in the absence of more definite data, we can advise you to use a wire three sizes larger than that on armature, if you employ a series field, or three sizes smaller if a shunt. You should have the parts so proportioned as to require about three times the weight of wire on field that there is on armature. You have sent no sketch of the machine so we cannot judge what space is provided for the wire, but to carry the proposed current, the armature should have not finer than No. 29. It is of great importance to get the proper number of turns of wire on the armature and to have a definite strength of field magnetism. The resistance of the armature winding is not the thing to desire but to be reduced to the lowest possible amount. Control should be effected by the counter electromotive force set up, as the armature revolves, not by its dead ohmic resistance.

1551. **House Wiring.** E. C. B., Edwardsville, Ill., asks: (1) Does a certain sketch show an economical plan for wiring a house of eight rooms? They are arranged in two groups of four in parallel. (2) How can a person calculate the number of ampere turns required to produce a magnet of given strength? (3) What is the solution used for making rust joints on sheet iron? Ans.—(1) Yes, but if you can bring the two mains to the centre of the house, to a cabinet, in which the switches and fuses are placed, it will be still better. Separate the different circuits as much as possible, so the blowing of a fuse will cause the extinction of only a few lamps. (2) The computation of a magnetic circuit is not a short process. You must be familiar with the proper degrees of magnetism allowable for various qualities of iron, then having decided how many lines of force are desired, make a drawing, to scale, of the actual shape of the magnet. Make due allowance for magnetic leakage, apportion cross sections of metal sufficient to carry the desired flux, and find the reluctance of every separate portion. Morrow and Reid's Arithmetic of Electricity and Magnetism is about the only book that we can recommend as helpful in such problems to one who does not care to explore the theory. (3) Iron filings saturated with sal-ammoniac dissolved in water are often used for stopping cracks in castings, or filling the space between two that do not well fit. Unless you have sheet iron of considerable thickness, we should imagine that the rusting process would not be particularly satisfactory. Why not solder the parts together?

1552. **Storage Battery.** F. W., Agna, Cal., asks: what is meant by "floating" one on the line, and how can the battery be prevented from discharging through dynamo when an accidental stop takes place? Ans.—You need to interpose an underload circuit breaker between battery and dynamo. Such a device somewhat resembles an ordinary overload circuit breaker, except that it lets go when the current diminishes to a certain minimum. You can cobble one together by making a solenoid of wire large enough to carry the maximum charging current; this can act on an iron plunger fitted to a contact arm, so that when down, an inverted U of copper wire will connect the mercury in two otherwise separate cups. A slender retractile spring will withdraw the U when no current flows. Put this device in one side of main line. The "floating" battery receives current when the voltage is sufficiently high, and delivers current when the voltage of generator is low.

1553. **Dynamo.** A. E. K., Harrisburg, Pa., has made a dynamo of an intended capacity of 1 k.w., but has encountered some difficulties. At first, field coils were wound with 6,000 turns of No. 22 wire, and armature with 288 turns of No. 20. When driven at speeds between 2,300 and 3,000, armature would give only about 95 volts. He then wound armature with 432 turns of No. 22, and now can get nothing. Can we suggest the reason? Field magnet is of Edison pattern, of cast iron; armature is 5½ in. long, 3¾ in. in diameter, with 24 slots, ¼ in. x ¼ in.; air gap, 1/16 in.; weight of machine 180 lbs. Ans.—Weight of machine is sufficient to develop the output you desire, but the proportions of the armature are not the best; slots should be somewhat deeper,—at least ⅜ in., and deeper, if possible. To develop 110 volts you ought not to have to use smaller than No. 18 wire, and even then you will be limited to about 8 amperes. With the finer sizes you have used you would not get the 1 k.w. unless the voltage rose to over 200. We cannot judge if the field magnet is rightly proportioned, unless you send a carefully drawn sketch, with essential dimensions specified. In the armature you have probably made an error of procedure that might not occur in the next trial. The best you can do is to procure a copy of Watson's "How to Build a 1 k.w. Dynamo." This gives most explicit drawings and data for a machine of nearly the same size of armature,—shorter, but of larger diameter. The scheme of winding is unchanged.

1554. **Telephone Generator.** L. W., St. Louis, Mo., asks: (1) What is the difference between a series and a bridging magneto? (2) What are the connections for a jump spark generator for ignitor of gasoline engine? (3) Can a five-bar magneto be rewound to give sparks? Ans.—(1) A series generator, or magneto, is ordinarily of smaller size than the other, and wound with finer wire. In consequence of the bridging sort having to operate a number of bells in parallel, more current is required, though at no reduction of voltage, therefore about the same number of turns are needed, though of larger wire. (2) You must interpose an induction coil, the secondary of which supplies a voltage high enough to jump the gap at the spark plug. (3) No, it cannot safely be wound for the high voltage.

1555. **Electrolysis.** J. R. A., West Allis, Wis., asks: (1) What is the best current and voltage to use for decomposing water? (2) What is the amount of hydrogen and oxygen produced or liberated by a given current in a given time? Ans—(1) The minimum voltage will be 1.47. Of course you must use more than that to overcome the ohmic resistance of the particular apparatus you may employ. Ordinary water is such a poor conductor that you will need to add sulphuric acid to bring down the resistance. The number of amperes is purely dependent upon the quantity of the gases you wish to liberate in a given time. (2) 1 gram (.0022 lb.) of water occupies a space of 1 cubic centimeter; the same weight of air, at ordinary conditions, occupies 773 cubic centimeters; of hydrogen gas, the bulk would be about 11,200 cubic centimeters, or 682 cubic inches. A current of 1 ampere maintained for one hour will separate .037 gram of hydrogen, or in 27 hours entire gram weight of the gas will appear. At the same time one half the bulk of oxygen will be obtained, but its weight will be eight times as much. Nine grams of water will therefore have been decomposed.

1556. **Magneto.** R. A., Cadillac, Mich., asks if a telephone magneto-generator can be rewound for direct currents and used with an induction coil for jump spark ignition. He has wound one with No. 22 wire, but while it seems to give a strong current it will not energize an electromagnet. Ans.—We do not know how large a generator you have, but some of our correspondents have successfully accomplished what you have aimed for. You must recognize that while the commutator will allow uni-directional currents in the exterior circuits, the flow is not steady, like that from a battery, but highly pulsating. Its behavior will still imitate alternating current, and fine wire coils will exhibit a great choking effect. This disability is reduced, as is illustrated in the large single phase railway motors in use on some roads, by using the fewest possible turns of wire, employing large currents but low electromotive forces. Try your present armature winding on a coil wound with much coarser wire, and then, if the results are encouraging, rewind the machine with No. 18 wire. The primary of the induction coil may properly be constructed with only one or two layers of No. 14 or 16 wire.

1557. **Efficiency of Lamps.** D. B., Lansing, Mich., expresses an appreciation of the help he gets by reading the *Electrician and Mechanic*, and asks how many 16 c.p. incandescent lamps can be run from a 6 h.p. engine? Ans.—You do not state whether you have a steam or gas engine. The former can be run at its full-rated capacity, but under such a load the gas engine might not maintain a steady voltage. Again, lamps can be bought of various economies, or "efficiencies," as the trade expression goes. With carbon filament lamps and poor regulation, lamp breakage will be excessive unless an allowance of 4 watts per c.p. is made. With ordinary good regulation, 3.5 watt lamps will be better, and with the best regulation—probably obtainable only in case storage batteries are operated in parallel with the lamps,—3 watts per c.p. are permissible. A still more economical grade of carbon filament lamps, known as the GEM, are practicable for closely regulated circuits, and require but 2.5 watts per c.p. Tantalum lamps require 2 watts, and tungsten 1.25 to 1.3 watts per c.p. Allowing 746 watts as the equivalent of an h.p., you can easily figure how many of any size of lamps you can operate.

1558. **Wattmeter.** E. M., Magog, Quebec, asks: (1) Can a recording wattmeter be put on the primary side of an 11,000 volt circuit?

(2) Do such instruments measure the total output of a generator? (3) What kind of electric generator should be used for developing 1,400 to 1,500 h.p. in a water-fall? Ans.—(1) No, you should use current and potential transformers, so that only low voltages will be brought within reach. (2) Yes, they indicate for electric power what a water or gas meter does for its sort. (3) If the distance to which the power is to be transmitted is more than a few hundred feet, you should use alternating currents, and preferably the 3-phase apparatus. With short distances, about 500 volts can be used, without transformers; but for a distance of several miles 2,200 volts give higher economy of copper, and for 10 miles or more, 10,000 volts, or still higher, sometimes an allowance being roughly estimated at 1,000 volts per mile.

1559. **Edison Battery.** S. C. S., St. Joseph, Mo., asks: how much return can be gotten from one of the new Edison storage cells? Ans.—The manufacturers state that about 60 per cent. return is obtainable. While this does not favorably compare with the 80 per cent. efficiency of the lead cell, there are other considerations to which the makers call attention, and these are in the line of small deterioration and need of repairs. The lead cells are chronic offenders in these particulars.

1560. **Conduction.** G. W. G., New York City, asks: if heat is a conductor of electricity? He finds that a spark 2 in. long can be obtained between points when alcohol is ignited in their vicinity, but ordinarily, only ¼ in. sparks. Ans.—You will recognize that "heat" alone is rather an abstract term, and we cannot find any such isolated thing. Heat exists only in something physical. Your experience that heated vapors are conductors is correct, and such a statement is properly made in all text books on physics. The case is often disastrously illustrated, when by some short-circuit at a switchboard or dynamo, vaporized copper is formed, and this is readily a conductor.

1561. **Telephone.** E. S., Providence, R.I., asks: (1) Why does not a 1,000 ohm receiver give a louder sound than one of the ordinary long distance sort, having only about 100 ohms resistance? (2) What is the use of a detector? (3) In the case of house wiring, when one of the wires has black insulation and the other white, which is the grounded one? (4) If the current is alternating, can a rectifier be employed so as to operate a direct current motor? Ans.—(1) The efficacy of a telephone receiver depends not upon the resistance of the coils, but upon the number of ampere turns. In the case of wireless messages, the current is so exceedingly minute that unless it passes around the iron core a large number of times no effect upon the magnetism is made. In order to get enough turns of the wire in the small space, it must be of very fine size. Incidentally, such a coil will have a high resistance, but this is to be regarded as a defect, and the instrument would work much better if the same number of turns could be put on without involving so many ohms. Some unscrupulous makers have actually foistered upon the public, receivers wound with German silver wire. Thereby when measured, the expected resistance is found, but the instrument is quite useless for wireless work, for it lacks in ampere-turns. With your other receiver, the larger current passing through a smaller number of turns gives a higher product. (2) This recognizes the presence of the electric waves. (3) In Providence, the white wire is the grounded one. The other gets dirty from the particles of dust attracted by the charge of electricity the wire possesses. This is particularly noticed on the 250 volt direct current circuits. (4) No, the rectifier is an expensive nuisance, good for short runs only, and for small currents. From the fact that the solution quickly gets hot, there is evidence of a great waste of power.

1562. **Small Dynamo.** L. E. P., Chicago, Ill., sends a sketch of a small 4-pole machine, field being built up of sheet iron punchings; armature core is 2$\frac{1}{16}$ in. in diameter, and 1½ in. long axially. There are 16 slots, each ¼ in. x ¼ in. He proposes to put 92 wires per slot, No. 24 in size, and 1,270 turns per spool of the same size, for the field. The four coils will be connected in series with each other, but in shunt to the armature. He proposes to put two rings on the shaft, on the other end from the commutator, so as to be able also to get alternating currents. About 25 volts are desired, and he asks if the design of machine is good, and how many amperes it will supply? Ans.—You have shown considerable care in the drawing and in the computations, but we regret to state that the machine is defective in two vital points. In the first place, it is rather doubtful if a machine that has its field magnet composed entirely of good sheet iron will generate,—that is, "pick up" or build up its magnetism. You must be sure of having some residual magnetism. This could be provided in your case by clamping the mass of sheet iron between two iron castings, made as thin as the foundry could cast. The other consideration is that you are counting on having too many volts between adjacent segments of the commutator. With four poles, you will need brushes in four places, and you will have your full voltage across but one insulation. You can readily run the armature at a speed of 2,400 revolutions, and at that the frequency of the alternations would be 40 per second even if you had but two field poles. Large machines are now made to run from steam turbines at 3,600 revolutions, and if you provide suitable bearings, yours can be driven at that speed, and give you the full 60 cycles. You did not explain whether you had in mind just how you would wind armature to fit the four-pole requirement. Aside from the objections pointed out, the machine would give the voltage desired, and a current, with parallel wound armature, of 3 amperes. Two wires would connect to each collector ring, opposite segments of the commutator leading to one ring, segments one-quarter way around connecting to the other. We advise you to make machine with two poles only.

TRADE NOTES

An informal banquet was given early in January by Henry Disston & Sons to representatives of the big saw and tool-making concern, who went to Philadelphia from all parts of the Union and from Canada to attend a series of trade conferences.

Besides the corps of salesmen, there was present at the banquet a large number of saw experts who spend their time in lumber camps and sawing centres to aid millmen in any and every way that their experience and knowledge enables them to render assistance.

All the executive departments of the great home organizations were also represented at the banquet.

It is the general sentiment of all Disston salesmen and representatives that the next twelve months will be the best selling year of their experience despite the fact that 1910 was a record breaker.

Business reports brought in from every section of the United States are optimistic, and men who are in the closest possible touch with actual conditions are confident of boom trade for the lines they represent.

One of the western salesmen said: "Mr. Toastmaster, I want to say that I am proud to be in the Disston employ. It is an honor to be associated with this management and to have the privilege of selling Disston goods. I have had no difficulty whatever in obtaining and maintaining our full share of the business in my section, and this by reason of well-known high quality and efficiency of the Disston goods. The future looks even brighter than the past. The treatment accorded us by the management makes us loyal to the core, and we shall ever stand by the house of Disston and its goods. In saying this I know I am echoing the sentiment of everybody here."

During the week all representatives have made careful study of the manufacturing processes and executive policies of the great plant on Tacony. Officers of the company have spared no effort to thoroughly acquaint their men with the principles, purposes and ideals of the great organization of which they are a part.

Mr. Robert J. Johnson, second vice-president, acted as toastmaster at the banquet.

With Mr. Johnson at the head of the table were Mr. William Miller, Secretary; Frank Gould, Manager of Shelf Goods, and E. F. Cooper, Manager of the Mill Goods Department.

We are in receipt of the "Year Book for 1911–12," from the School of Applied Arts, Battle Creek, Michigan. The publication is beautifully gotten up in color and contains numerous samples of the work done by students of this school. The system of teaching is a unique one, and the scope covered by its twelve complete courses is exceedingly wide. Readers who are interested in the study of drawing will find it to their advantage to write for prospectus and terms.

BOOK REVIEWS

The Boy Aviators on Secret Service, or *Working With Wireless*, by Captain Wilbur Lawton. New York, Hurst & Co., 1910. Price, 50 cents.

This book, the second of the "Boy Aviator Series," introduces Frank and Harry Chester, the "Boy Aviators" at the office of the Secretary of the Navy in Washington, after their return from Nicaragua, where they had passed through a series of strange adventures and perils in an airship. In this volume the boys are offered and accept an important commission on Secret Service in Nicaragua. Their adventures are startling in the extreme, and will no doubt be followed with intense interest by all of the readers of the first volume of the series.

Electrician's Operating and Testing Manual, A handbook for men in charge of electrical apparatus, repair men, trouble men, lamp trimmers and electricians generally. By Henry C. Horstmann and Victor H. Tousley. Chicago, Fred'k J. Drake & Co., 1910. Price, $1.50.

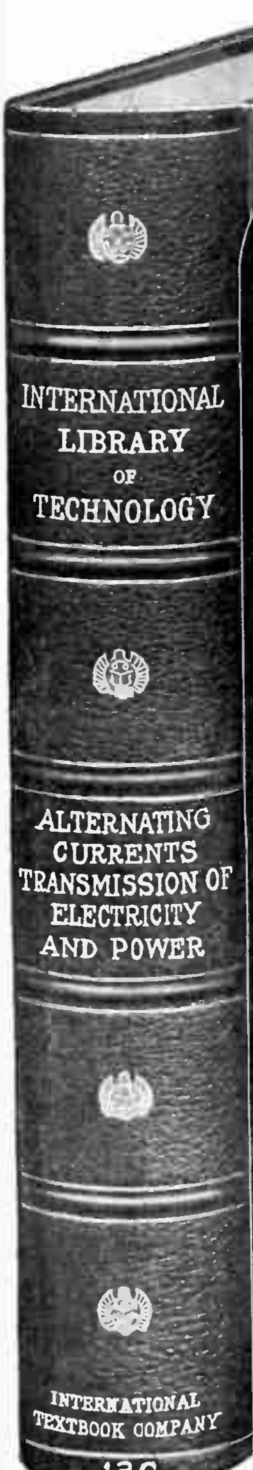
The authors of this book have produced a number of practical educational text books on electrical subjects, and this is a worthy successor. It is complete in itself, taking up the underlying principles of all ordinary electrical apparatus, giving details of its operation, and instructions for its care and use. For any of the classes of men named in the title, the book will prove an invaluable assistant.

How It Flies, or the Conquest of the Air. The Story of Man's Endeavors to Fly and of the Inventions by Which He Has Succeeded. By Richard Ferris, B.S., C.E. Illustrated by over one hundred and fifty half-tone and line drawings, showing the stages of development from the earliest balloon to the latest monoplane and biplane. New York, Thomas Nelson & Sons, 1910. Price, $1.20 net; postage 15 cents.

Among the flood of books on aeronautics and aviation now appearing on the market, this fills a useful place, as it is not so much historical as a resumé of present-day conditions. It details the various types of flying machines and gives instructions for building and operating them, accompanied by many detail drawings and photographs. Chapters on balloons, both free and dirigible, are equally full, and the book closes with a chronicle of aviation achievements and a dictionary of aeronautical terms.

Arts-Crafts Lamps. By John D. Adams. Chicago, Popular Mechanics Co., 1911. Price, 25 cents.

A recent writer has said that America knows only two styles of furniture construction: the colonial and the mission. Much has recently been written on the mission style, and this book certainly displays considerable ingenuity in the author, who has evolved sixteen different designs for lamps in this rectangular construction. Full constructional details are given, and the book will prove of great value to the amateur carpenter and metal worker.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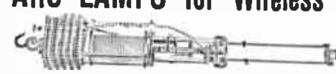

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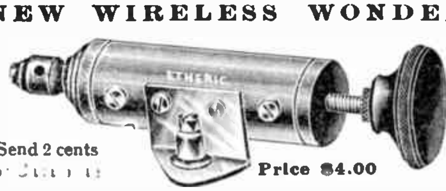

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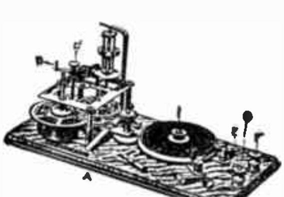

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