Everyday Mechanics
"It Tells You How to Make and How to Do Things"

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ELECTRICAL EQUIPMENT OF THE MOTOR CAR

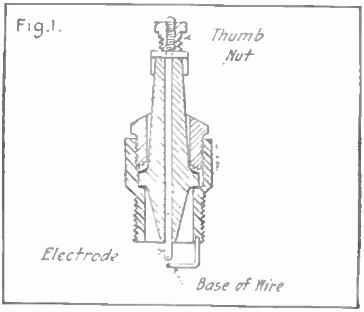
How To Understand It

By Wm. C. Houghton, M. E.

Editor's Note: This is the first of a series of practical articles on ignition, lighting and starting, written from the viewpoint of the everyday man who drives his own car. Later articles will cover the various systems in use on standard cars, dealing specifically with the actual devices in daily service in order that the reader may apply the suggestions to his own car.

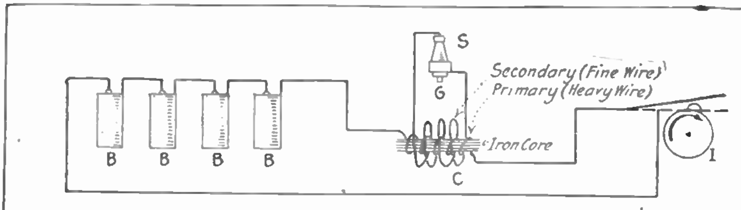
THE present series of articles is designed to meet the needs of the man who drives his own car and makes his own repairs when necessary. It goes without saying that he wishes, above all, to avoid the necessity for repairs rather than to make them. The only way to accomplish this is to know the car.

A thorough study of the book of directions will familiarize him with the operation of the machine and with more or less of the details of construction. But when something goes wrong, as it will sooner or later, nothing but a knowledge of the principles that govern the operation of the various parts will help him to locate the trouble and usually to remedy it before it becomes serious.



Cross section of a spark plug

The wealthy motorist, who buys a new car every year and leaves all repairs to his chauffeur or garage man, will not be interested in this series to such an extent as the man in moderate or comfortable circumstances who drives his own machine. But is it not possible that the chauf-



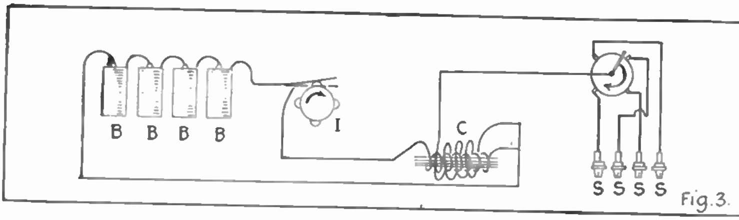
Wiring diagram of battery, spark coil and plug

feur or garage man of the wealthy owner will find some points of value in the discussion? On the other hand, the veteran motorist who has learned by long and perhaps costly experience may find something of interest to him. Such a man is quick to devour anything pertaining to his hobby.

Motor cars were called "complicated" in the days of the "one-lunger." What, then, shall we call the modern machine with its four, six, eight, or even twelve cylinders, and the seemingly infinite variety of accessories now thought indispensable? Yet, the modern motor has been simplified and standardized until it is easier to understand than some of the crude affairs of the late '90s or the early years of the new century. The fact still remains that every auxiliary device added for convenience or luxury makes one more thing to get out of order if not carefully and intelligently used.

The modern motor car without its electrical equipment would be very much like the proverbial Hamlet without the Prince of Denmark. It is not so many years since the only electrical part of an auto was its ignition apparatus, and there were inventors who believed that ignition might be better accomplished by other than electrical means. It was not until the ignition problem had been solved and the apparatus even standardized to some extent that any attempt was made to provide electric lighting. And because satisfactory lighting demanded a supply of current, both considerable in amount and dependable, it was soon followed by a further development, namely the electric starter. Since the three systems, ignition, lighting and starting, use the same apparatus to a great extent, and since failure of any of the equipment usually means trouble all along the line, it is necessary to treat the three subjects together.

Ignition is a familiar word to every motorist, yet there are many who do not really know



Wiring diagram with distributer in circuit

just what it means. The gasoline engine, so called, is technically termed an internal combustion engine. Like a steam engine, it is really a *heat motor*. But the steam engine (external combustion) requires a separate boiler with a fire which is lighted once for all, and not extinguished until the end of the run, a day or week or even a month. The usual four cylinder auto engine, on the other hand, must have fires lighted twice in every revolution. Manifestly some special devices must be used when as in the case of high speed engines some 7,000 separate fires must be started every minute. This is universally done by means of the *jump spark plug*, well known to even the greenest motorist. Its construction may, however, not be so well known. See Fig. 1. It is a very simple device consisting of a metal electrode (conducting wire) insulated from the outer steel shell by a porcelain bushing. The shell is provided with a thread which screws into a hole in the head or valve chamber of the engine. The electrode ends in a point which comes within about 1/32 of an inch of a similar point inside the shell, but does not touch it. The reader will see that there is no way for the electric current to pass except by jumping from point to point. In doing so it produces the *spark* which is really a miniature arc light, small but exceedingly hot. In order that the current may leap the gap in its circuit it must be of very *high tension, i. e.*, electrical pressure. The current supplied for the purpose, whether from dry batteries, accumlators, or magneto, is originally of very low tension, entirely incapable of "jumping" however small the gap. Even in the so-called high tension magnetos the current is generated at very low pressure and there "stepped up" by some form of induction coil, which may be built into the machine itself, but is always present. Fig. 2 is a diagram of the simplest form of ignition apparatus for a single cylinder. Note that there are two separate circuits, the first or primary from the batteries *BB* through the few turns of coarse wire wound around a bundle of iron wires forming the core of the induction coil C, thence to a contact point on the interrupter *I*, and back to the batteries via the *ground*, which, in automobile apparatus, means any part of the engine or chassis which is not insulated. So long as a steady current passes through the primary of the induction coil there will be no current whatever in the "secondary" coil, that is, the many turns of fine wire wound over the primary but insulated from it. But if the primary current is *suddenly* interrupted an instantaneous surge of "pressure," a sort of kick causes a current of very high tension to pass through the secondary coil and to the spark plug, where it leaps the gap *G* and ignites the charge of vapor in the engine cylinder. The interrupter *I* is one of the most important parts of the apparatus. It is evident that the spark must come at exactly the proper time, namely, when the engine is at or near the end of the compression stroke. For this reason it is geared to some part of the engine and *timed* so that the cam strikes the spring at the exact instant it is wanted. If the engine is running at top speed, the break, and therefore the spark, must come considerably before the end of the compression stroke, sometimes almost a quarter turn. If, on the other hand, it is running very slowly it must come nearly at the end of the stroke. When cranking the engine it must be still later, when the crank is past the center. A few years ago dislocated wrists were quite common among motorists who forgot this. Many modern cars have an automatic arrangement which times the spark according to the engine speed.

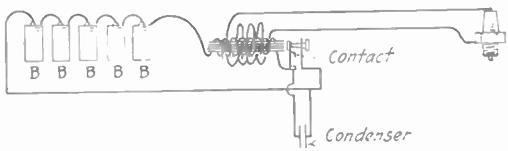


Fig. 4.

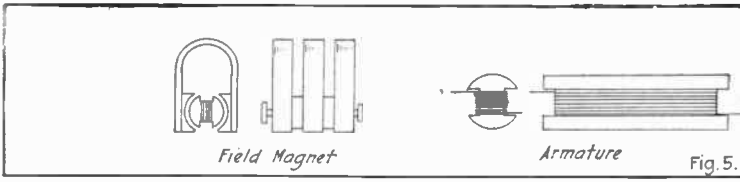
Diagram when vibrator was used in connection with coil

We have next to consider the case of a multiple cylinder engine. It is evident that there must be as many coils as there are cylinders, or that the current from a single coil must be sent first to one cylinder and then another in the order of firing.

The latter is the more common as well as the better arrangement.

It might be represented by a diagram something like Fig. 3. The arrangement of batteries, interrupter and coil is the same as in Fig. 2, but the distributor *D*, sometimes incorrectly called the timer, is added. It is really a rotary switch, and like the interrupter, is driven at half the engine speed. Its office is to send the "kick" from the coil to the proper cylinder. It must have as many distributing points as there are cylinders. The interrupter also has the same number of rises or bumps on the cam.

In the case of the earlier machines it was customary to use a vibrator on the coil, or, if there was a coil for each cylinder, one on each coil. The vibrator was placed in the primary circuit of the coil as in Fig. 4. The object was to save current, which was an important matter where dry batteries had to be relied on to furnish it. A single break coil usually required about 5 amperes of current which was passing continuously except at the break. A vibrator coil could be adjusted to give a hot spark on one ampere or less and a further saving was accomplished by using a contact device which closed the circuit only when the spark was wanted, instead of the interrupter as in Figs. 2-3. Many machines with this type of apparatus are still in use. When four or more separate vibrators were used there was almost endless trouble from one or more of them which would stick or get out of adjustment.



Field magnet and armature of magneto

This arrangement was sometimes varied by the use of a single master vibrator for all coils, or by using a single coil with distributor as noted above.

It is an axiom that no motor is better than its ignition system. The many defects of the battery system and consequent unsatisfactory service led to the development of the ignition magneto. A magneto is in effect a dynamo, the only distinction being that the dynamo has an electrically excited field, while the field of the magneto is a permanent steel magnet or a group of them, as the name indicates. It is in short a machine for generating electricity from the power of the engine itself. Without going into the description of any particular form of magneto at this time, it may be considered as composed of two essential parts, a strong steel magnet of U shape, or a number of them with soft iron pole pieces attached. Between the pole pieces a very simple armature is mounted in suitable bearings. The armature is usually of the shuttle or H type, because this shape gives a succession of sharp impulses which is just what is needed to give sharp and hot sparks. See Fig. 5. There are two impulses at each revolution, and therefore cylinder, at twice the engine speed. The interrupter is always built into a magneto of this type, and is so arranged as to keep the winding short-circuited until the electromotive force is at its highest peak, when the short circuit is suddenly broken. A small condenser is connected each side of the break. The result is a series of highly damped condenser oscillations. Gas engine ignition devices are not usually regarded as high frequency apparatus, but such they are in fact. The so-called high tension magneto differs from the simple form already described only in having a secondary coil of fine wire wound on the armature. This secondary is, however, on

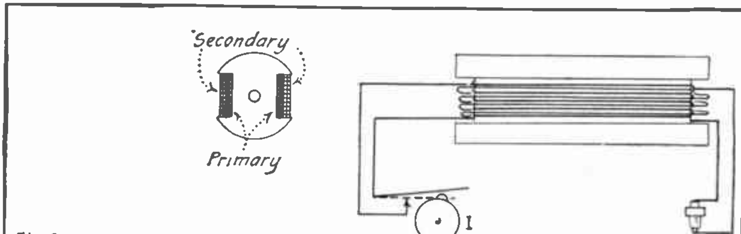


Fig. 6.

Armature of a high tension magneto and wiring diagram for same

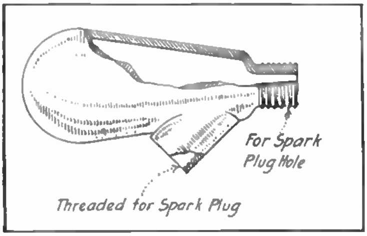
the magneto is geared to the engine at a speed ratio corresponding to the number of cylinders. Thus in a two cylinder engine it was usually connected to the half-speed shaft. In the four-cylinder models it runs at the crank shaft speed and in an eight open circuit, and has no part in the generation of the current. When the short circuit of the primary winding is broken, the secondary does its work as such, making, in fact, an induction coil of the armature. The condenser acts just as it does when used in the separate coil. It must be understood that this description applies to the ordinary type of magneto. The special apparatus used in the Ford machine will be taken up later. Some reference will also be made to other various modifications of the ignition apparatus in other machines.

The object of the present discussion is to get at principles which underlie all systems. It is suggested that the reader who wishes seriously to study this subject may benefit by consulting a text book on physics, when necessary to make clear certain points. It is impossible in articles of this kind to go back and develop all ideas from the very beginning.

(To be Continued.)

AUTO-KNOCKING DEVICE

When kerosene is used for fuel in an engine designed to run on gasoline vapor, trouble is experienced from the high compression of the gas prior to ignition and a pronounced knock is heard in the engine, this noise being similar to a carbon knock because it is due to the same cause, preignition of the charge. An English mechanic has devised a



This casting reduced the "knocking" when kerosene was used

simple attachment to eliminate this knock, which he calls an "anti-pinking" device. As shown herewith, it is a very simple hollow casting having an enlargement or bulb at the top, threaded at the neck to fit the spark plug hole and carrying a boss on one side to take the spark plug. Its function is to reduce the compression by increasing the combustion chamber space and is said to reduce "knocking" appreciably when the engine is run on kerosene fuel.

Contributed by VICTOR W. PAGE.

HOW TO MAKE A LEAD TREE

Procure two drams of lead and place it in about a quart of water. Let the liquid settle for a day or two, being careful to keep out the dust. Pour the clear liquid into a small, clear bottle and hang in it a piece of zinc. Place it again on one side, and do not disturb it; in a few days crystals of lead will arrange themselves upon the zinc in the form of a tree or shrub.

Contributed by HENRY GEORGE FRANK.

CONSTRUCTION OF A MODEL SUB-SEA TRANSPORT WITH SELECTIVE RADIO CONTROL

BY THE EDITOR

BEFORE we take up the actual construction of *EM2*, the second submersible model to be developed and constructed in the EVERYDAY MECHANICS' LABORATORY, let us consider a few points of interest and importance to the prospective builder.

In the first place, this model is scarcely a toy or plaything. It is too large, costly, and practical properly to be placed in that category. The hull is nearly eight feet in length and, with machinery and ballast installed, the weight is a good 175 lbs. without water ballast. The cost of the actual materials and parts exclusive of the builder's labor is well over one hundred dollars.

The model is designed primarily for practical work as a graphic illustration of selective radiodynamic or wireless control. It is sufficiently large and rugged to be used day in and day out in an exhibition for preparedness or for theatrical or entertainment purposes. Accordingly, it is assumed that the ambitious model makers who undertake the construction of *EM2* will have in view the ultimate exhibition of the model for financial remuneration or from a spirit of patriotism or, possibly, merely as an evidence of their craftsmanship in the event that they are possessed sufficient of worldly goods to justify an expenditure of time and money to this extent in the pursuit of their hobby.

The Design of *EM2* was suggested by the successful submarine merchantman *Deutschland*. The hull is patterned somewhat after the Lake ship-section submersible but the characteristic design is carried a step farther, giving *EM2* good surface riding qualities rather than submerged speed. The bow and deck lines of our model resemble somewhat those of a torpedo boat destroyer submerged to such an extent that her deck is almost awash. This design gives us ample room for machinery and controls, and it also affords space in the lower hull for ballast tanks by means of which the craft may be partially submerged while at rest.

The Hull. Figs. 1 and 2 are photographs of the finished hull of white pine, with all compartments in place, and with the twin propellers installed. Fig. 3 is a scale drawing of the hull in plan and section. The readers who have followed the former submarine series in EVERYDAY will note that we have again used the laminated plank method of con-

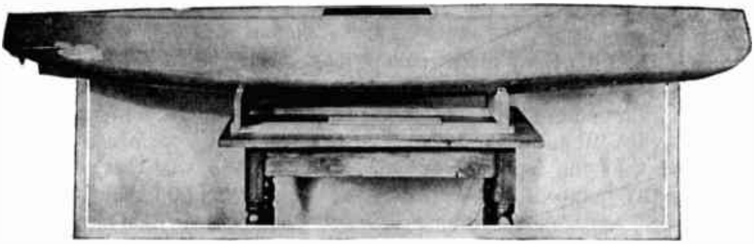


Fig. 1. Profile of hull

struction. It is strong, quick and easy, and aside from the apparent waste of lumber cut from the interior of the hull, it is as economical as any other method. With us, no lumber is wasted, for we find an ultimate use for every scrap.

For convenience, the boards, of which the hull is made, are numbered from 1 to 12, starting with the top board or gunwale piece and finishing with the keel piece. Right here let us state that the latter piece of board is not permanently secured in building the hull as it is to be discarded after the hull lines are developed. This board is displaced by the actual keel of lead shown in one of the photographs.

From Fig. 3 the builder can lay out full-sized patterns of the twelve planks on heavy paper from which the designs may be transferred to the boards preparatory to sawing out. Let it be understood that the dimensions given are the finished sizes. The hull planks are to be cut somewhat oversize, say ¼ in., to permit of working down with drawknife and spokeshave.

The method of procedure is first to saw out the entire twelve planks roughly to shape, nailing them with just a few brads to each other to form a more or less substantial mass of wood which bears some resemblance to the finished hull. Then before the inside is hollowed out, the drawknife work is started. The tools must be keen and, for the benefit of the worker who has used the drawknife in but a desultory way, let us suggest that the proper and most effective method is a diagonal stroke which pears off the wood just as a jack-knife would cut it. This stroke lessens the labor tremendously and produces great execution. Be careful to work with the grain or you may have some nasty holes to fill after your work is done.

The hull may be worked down to its finished lines with the drawknife before the work on the inside is attempted. The only part to leave for the last is the actual "smoothing down" process which calls for the spoke-shave.

Before taking the planks apart ready for sawing out the interior of the hull, be sure to mark each plank with its number in such manner that the number cannot be readily effaced. Also mark for "bow" and "stern" to obviate possible confusion in reassembling. When this is done, take all planks apart and draw the brads. Then mark the No. 1 plank with the opening at the top which you will note has for its most important dimension 7¼ in. width. This is made for the benefit of the storage battery which is of the standard automobile lighting type and of 6 volts, 80 ampere-hours capacity. A storage battery of the same type but of 4 volts and 40 ampere-hours capacity supplies the current for the controls while the larger one drives the vessel. As the width of each battery is 7¼ in. the dimension specified is ample to accommodate the set. The other dimensions of the opening are not so important and the opening may well be scribed directly upon the No. 1 plank, after which it is to be cut out by means of a compass saw or preferably a power jig saw. This opening serves as the guide or template for the openings in planks 2, 3, 4, 5 and 6. These openings are exactly alike.

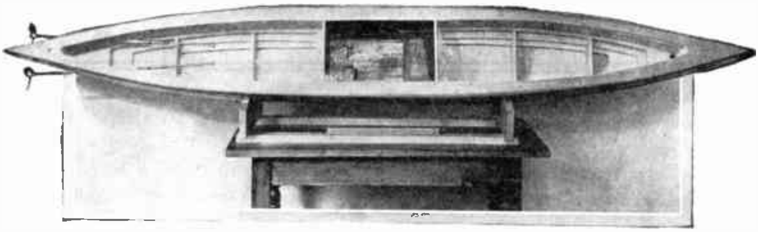


Fig. 2. Looking down into hull

Reference to the sectional view shows us that Nos. 7 and 8 begin to form the compartments. Nos. 9 and 10 are still smaller, to care for the curvature of the lower part of the hull. These openings should be scribed individually on the several planks to make sure that the opening, when cut, will not pierce the wall or make it too thin in places. Fig. 2 shows very clearly how the openings become smaller as the bottom of the hull is reached.

The assembly of the hull planks after the openings have been cut is started with No. 1, which is placed face down on the bench. No. 2 is to be nailed to this, care being taken to "register" the planks accurately. The other planks follow in natural order. Before nailing the planks, however, attention must be called to the sealing compound which cements the boards together and renders the hull impervious to water. The cement we have used with great success is made as follows: To one pint of the best bath tub enamel add one pound of good white lead, stirring thoroughly until the lead is taken up by the enamel. Then add ½ lb. of ordinary whiting (powder), mixing until the mass has assumed the consistency of thin, smooth putty. Add to this ¼ pint of good dryer to make the cement set quickly.

Apply the compound to *both* planks where they are to come in contact. A brush will serve notwithstanding the thickness of the mixture. After making sure of the register, nail bow and stern with a single brad to hold in place. Then start at one end and nail with 1½ in. brads for this, the starting plank. Place brads not more than two inches apart throughout the entire length of the hull.

When the second plank is secured to the first, wipe the cement from the seam where it has been squeezed out and paint the surface of No. 2 and of No. 3 ready for register and nailing as before. Repeat with No. 4, but when you come to that portion of the hull where the propeller shafts are to pass through, refrain from placing nails in No. 4 and also in No. 5 at the critical places where the bit would have to pass in boring the propeller shaft holes. This location is clearly indicated in the drawing and the photographs. It was with the object of aiding the builder to avoid nails at these points that we included the propeller shafts in this opening in-

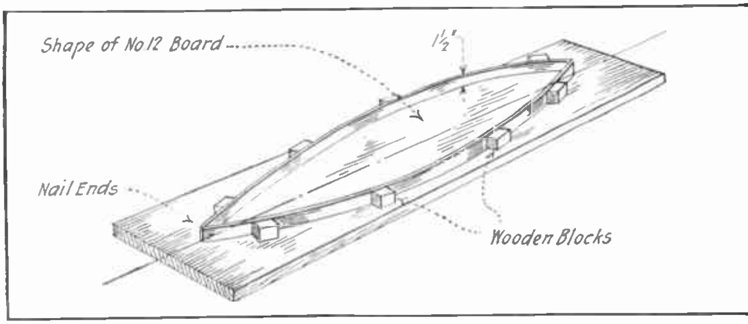


Fig. 4. Construction of mold for the keel

stalment, even though their construction does not come until later.

When the hull has been assembled up to the point where the No. 12 or keel plank is to be laid, nail this one on with a dozen brads but do not put any cement in the union. As stated before, this plank will ultimately be discarded.

The hull may now be wiped clean with a cloth slightly moistened with turpentine and the cement permitted to dry for at least two days. After that the spokeshave may be used freely to true up the lines, removing the inevitable "bumps" left by the drawknife. The final finish is with sandpaper. The priming coat of paint may then be applied. Our paint store sold us a very good ships paint in battleship gray. To this we added a quantity of pure white lead to lighten the shade somewhat. The first coat was applied after a cradle had been made for the hull, and then we saw the imperfections. Here and there we could see a depression or a "bump." After the first coat was dry, we did not hesitate to use the spokeshave freely, taking down the high spots. The nicks and depressions were filled with the same compound we used in the assembly of the hull. The mixture was made thicker, however, by the addition of a double quantity of whiting. This "putty" is different from the ordinary variety in that it "sticks" wherever it touches (the hands are no exception) and it dries as hard as stone. After a day of drying, the putty is still soft enough to permit of smoothing up with sandpaper, and when it is finally covered with paint, the imperfection is absolutely invisible. The white spots on the hull in the photographs indicate where the depressions have been filled.

When the hull paint is bone dry, the work on the interior may be started. All "whiskers" are removed with coarse sandpaper which will smooth out the saw marks to a great extent. The compartments shown in the lower hold in Fig. 2 are merely to keep the water from surging back and forth when the craft is in motion. These bulkheads are well perforated with holes and are secured with brads. The storage battery compartment is made absolutely watertight. The drawing gives the details, the dotted lines indicating the compartment wall of ¼ in. whitewood. The cement is freely used in assembling this compartment, the walls being literally plastered with it. When the cement is bone dry, the battery compartment is given three consecutive coats of some good acid-resisting compound obtainable from a large electrical supply store.

The entire interior of the hull is next to be plastered with the

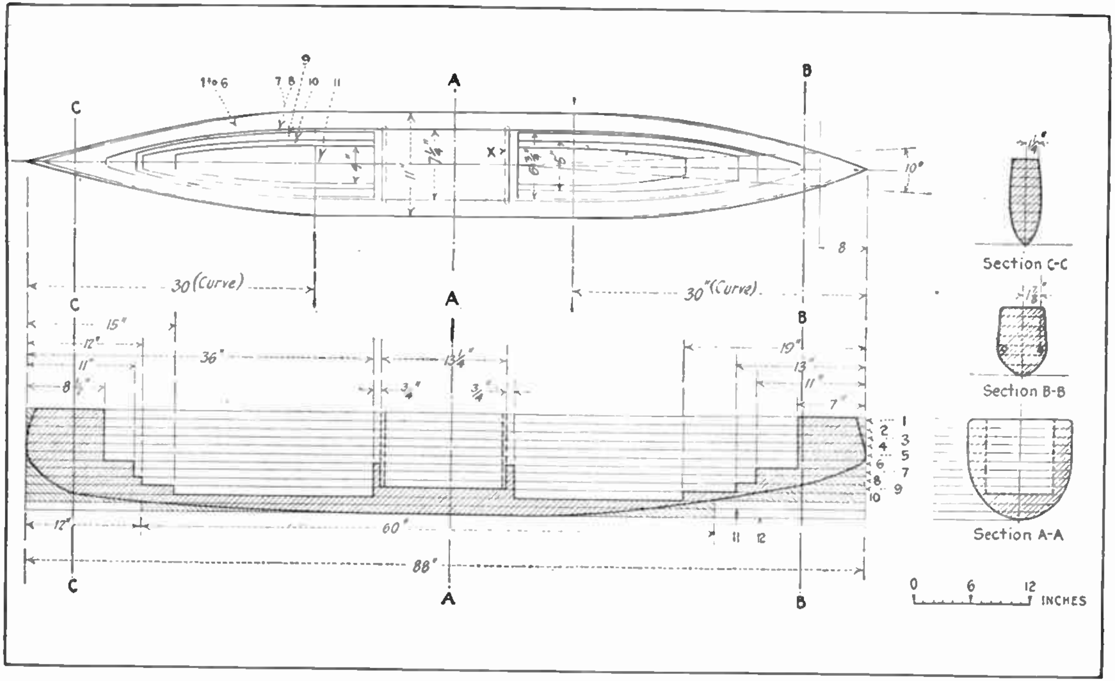


Fig. 3. Hull of the submarine in detail

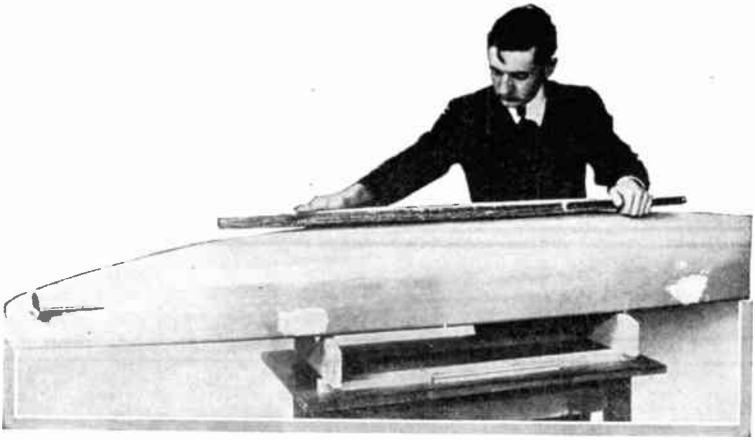


Fig. 5. Notice the proportion of the keel to the hull

cement made somewhat thinner through the addition of more enamel. The mixture should be worked well into all corners and cracks until every corner is rounded out with the paint. The water compartments below should receive an especially liberal dose of the mixture.

The Keel. While the interior of the hull is drying out, the builder may turn his attention to the construction of the keel which is of lead.

The nicest way to make it is to take the No. 12 plank and, using it as a pattern, make a sand mould for the lead casting. If this is deemed impracticable, make a mould as shown in Fig. 4, using the No. 12 plank to give you the profile. Take this mould directly to a manufacturer of lead pipe or plumber's supply house and have them pour the lead for you. It is as cheap and very much easier than to attempt to cast such a load yourself. The keel should weigh 75 lbs. and the simplest way to gauge this is to place the mould on the scales and pour until the desired weight is attained. Our keel is about an inch thick. Its shape and the proportion it bears to the hull is shown in Fig. 5. The keel is secured to the hull by means of a quantity of flat head brass machine screws passing through the No. 11 hull plank and into tapped holes in the keel. All cracks, holes and other blemishes are filled with the cement and after painting, the keel looks as though it had grown on the hull.

(*To be Continued.*)

Intensifying Negatives

All amateur photographers have at one time or another felt the need of a simple intensifier that could be used after the hypo bath.

To do this, make up a solution of the following proportions:

10 grains sulphite of soda.
1 grain iodide of mercury.
100 C. C. of water.

This should be thoroughly mixed and kept in a stock bottle.

After the negative is fixed and it is desired to intensify same, wash it and immerse it in the solution. The high lights will turn brown and the intensification can be stopped at the proper moment by placing the film or plate in the regular developing solution.

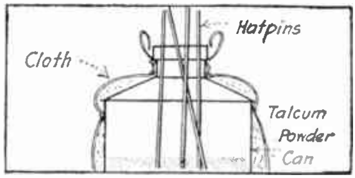
Should it be over intensified, it can be reduced by immersing in the hypo bath before it is placed in the developer since the later acts as a fixer for the intensified negative.

The film when taken from the intensifying bath is impervious to the action of light but is acted upon chemically by the air and should therefore be placed in the developer solution at once. The negative is washed and dried in the usual manner after being intensified.

Contributed by T. W. Benson.

A Hatpin Holder

Take a discarded talcum powder box with a perforated top. The box may be covered with a piece of fancy figured ribbon or



A hatpin holder made of a talcum powder box

brocade: the edges may be finished with galloon if necessary.

Into the opening at the top several hatpins may be thrust. The holder may be weighted by partly filling it with cornmeal or powder.

Contributed by Mary F. Scott.

Emptying Powder or Salts Into Spoon From Bottle

When trying to get a teaspoonful of powder or salts out of a bottle which is not quite wide enough to put the teaspoon into, instead of shaking the contents of the bottle into the teaspoon, hold the bottle over the spoon on a slant and roll the bottle between the fingers.

This will let out the right amount into the spoon without wasting any.

Contributed by L. H. Anderson.

CONSTRUCTION OF A ONE-HALF HORSE-POWER GASOLINE ENGINE

By Wm. C. Houghton, M. E.

Part III.

MAIN BEARINGS—Hold the castings in lathe chuck by the longer end of the shaft boss. A self centering chuck is best for this, but it can be managed in an independent four-jaw chuck. In any case, considerable care will be necessary to see that the boss runs true and that it is firmly held. Face off the end of boss and center either with a tool held in tailstock chuck or in tool post. Take care that center is large enough to hold drill and that there is no projection in the middle of it. Drill through casting with a ⅝ in. drill held against back center and bore out true to about 47/64 in. diameter, *i. e.*, large enough to permit the end of a ¾ in. reamer to enter. After drilling and reaming both castings, they may be put on an arbor and the other end of the bosses faced off. For the next operation, which is drilling and tapping for the side rods, the angle plate must be used. Bolt to the face plate of lathe not forgetting to put newspaper between the two. Put the ½ in. steel pin in the hole in shelf of angle plate, and on this the ¾ in. bushing. At this point it is well to see that the pin is in line with the lathe centers, although the centering can be done approximately after the casting is bolted in place. In any case, the angle plate must be shifted up or down to center the side rod boss vertically.

Center with lathe tool, drill to 1½ in. depth with ⅜ in. drill and bore out enough to true the hole, but not larger than 13/32 in. Tap ½ in. -13 threads. If a ½ in. -20 tap is available it is rather better than the standard 13 thread. In this case bore to 7/16 in. diameter. The tap may be started in the lathe and finished by hand, if considered safer. Face off end of boss, and before removing from the angle plate measure the distance from face to point of angle plate, making a note of it so that the second bearing may be made the same length.

After the second bearing has been bored and tapped, swing it around 90 degrees and face off the foot. It is well to make a shallow recess in the middle, say 1/32 in. deep, to insure a firm bearing on the feet at the ends.

Measure and note distance from angle as before, in order to get bearings of same height. A thirty-second greater or less height makes little difference *if the two are alike.*

The right hand bearing must next be mounted with the half speed gear boss centered. Put the ½ in. tap in the side rod hole and line up with the bed of the lathe by the use of a square. Next shift the angle plate until the casting is centered exactly 1½ in. from the center of the shaft hole. This is the half sum of the pitch diameters of the gears, and if not accurate the gears will not mesh properly. Face off boss ½ in. back of end of bearing, center, drill 5/16 in. to a depth of ⅝ in., and tap ⅜ in. 24 threads. Next turn down to 9/16 in. diameter, going back ¼ in. to a square shoulder.

The bearings are now completed except for drilling the quarter inch screw holes in the foot. This is best done from the bottom. Holes may be laid out and center punched. The castings are held in the angle plate in the same position as for facing off the foot, but the angle plate is taken off the face plate and held against drill pad in the tailstock. The castings are then to be turned half round on the pin and the oil holes drilled and tapped for oil cups.

Fly Wheel Shafts—For the right hand half shaft a piece of 1¼ in. machine steel will be required. This should be carefully centered and turned to dimension shown in drawing. The part for the gear wheel is to be turned to 1 3/16 in. diameter and ⅜ in. width. The rest of the shaft may well be left somewhat oversize until the gear is cut. The integral gear is so much better than the separate parts that it is worth the additional expense of cutting to order. If desired, a stock gear may be used, but if so it must be brass, as the ring of stock around the shaft is too thin for cast iron. About the only way of securing the separate gear is by drilling and pinning. The

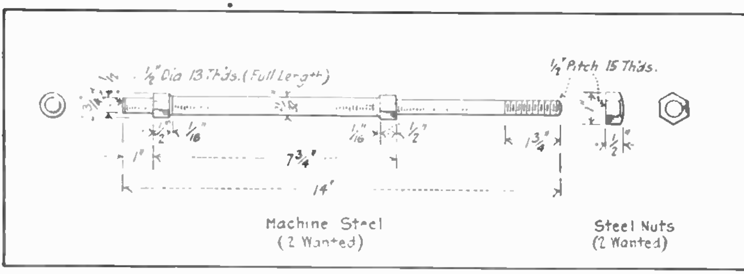


Fig. 12. Dimensions of side rods

fly-wheel end of shaft is turned to standard Morse taper, 7/16 in. per foot, and the end threaded for a special nut which secures the wheel. The taper gives a firm and true fit. The bearing part of shaft must be finished very smoothly using a dead smooth file and polished with emery cloth and oil. The left hand half shaft may be turned down from a piece of ⅞ in. machine steel, or ¾ in. cold rolled steel may be used, but in that case, great care must be used in centering to turn the taper. The former plan is safer.

Crank Pin—A three-inch piece of 1 in. cold rolled steel is to be used for the crank pin. Center and turn to dimensions as per drawing. The threaded portion at the ends may well be chased nearly to size in the lathe and finished with a standard die to insure a true thread. The nuts may be made of ⅞ in. hexagon cold rolled steel. Standard check nuts may be used, but they are not so good. In any case, the main reliance for stiffness of shaft should be in the *fit* of the *crank pin ends* rather than the pull of the nuts.

Fly Wheels—There are a number of different methods by which the fly wheels may be successfully machined. The particular one to be adopted will of course depend upon the facilities at hand. The author had a 10 in. lathe with a large four-jaw chuck in which the wheels were centered, drilled and bored to nearly the correct taper, but somewhat smaller than the full size of the shaft. The shaft boss and the rim were then faced off. The wheel was then removed from the chuck and the hole hand-reamed until the shaft could be pushed in to about 1/32 in. less than the full depth. When the nut was tightened up it drew the shaft into position. The wheel with the shaft was then mounted between centers and driven by a face plate stud while the face was turned crowning

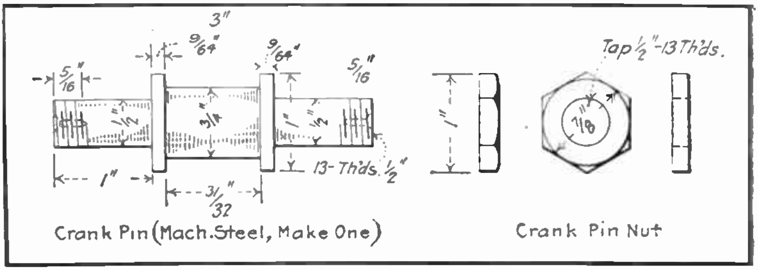


Fig. 13. Dimensions of crank pin and nut

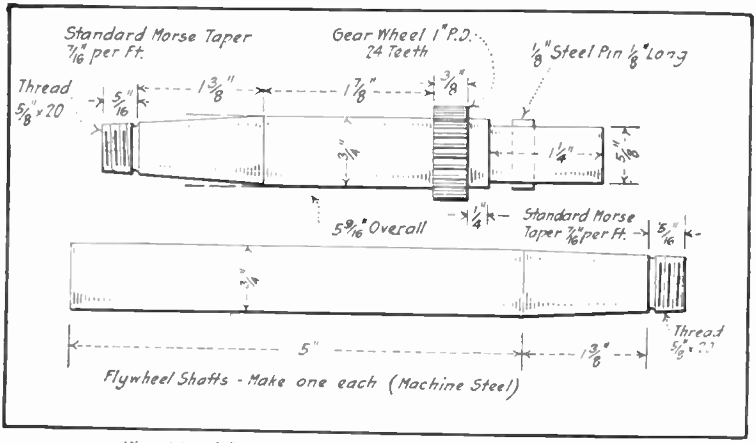


Fig. 14. Dimensions and details of the flywheel shafts

and the second side of the rim and shaft boss faced off. A short piece of machine steel was then turned to a taper at each end to fit in the two wheels and just long enough to bring the rims together when pressed on tightly. The crank pin bosses were of course placed one over the other. The whole thing was then put in the drill press after center punching the crank pin boss and a 7/16 in. hole drilled through both bosses. This was followed by a ½ in. rose reamer. The two wheels were then taken apart and the bosses faced off with a counterbore 1 in. diameter and ½ in. guide pin. If the large chuck had not been available, the first operation could have been performed by bolting the wheels to a face plate with spacing blocks of ⅞ in. hard wood to set out from the plate. Another method would be to lay out, drill and ream the crank pin hole first. A half inch steel pin is then set in the lathe face plate exactly 2 in. from the center. The pin is used to center and drive the wheel and to get the crank pin and shaft centers exactly alike in the two wheels. The wheels are bolted to face plate as noted above. They may be reversed to finish back of rim and hub.

It should be noted that the hub bosses project more on one side of the wheel. This is the *outside* when the shaft is assembled, and the larger end of the taper comes on this side. Consequently the wheels should be mounted with the *higher boss out* for the first operation.

The half speed gear stud, shown in same drawing with

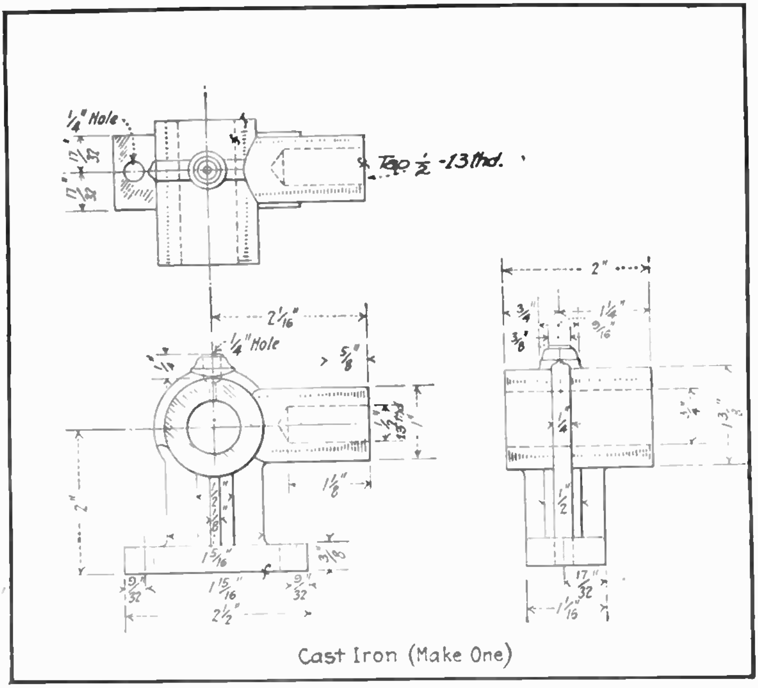


Fig. 15. Dimensions of bearing

main bearings is turned from a piece of ⅝ in. hexagon cold rolled steel. The hexagonal collar in the middle serves as a nut for screwing it in place. The threaded portion should be sufficiently oversize to screw into the boss rather hard. If there is any doubt as to whether it will "stay put," it should be drilled and pinned.

The side rods are intended to take the strain off the cylinder explosions, reinforcing the rather slender cast iron bearing pedestals which would be entirely inadequate without them. In the modified design of the engine they also support the overhanging cylinder. They are to be turned from ¾ in. hex cold rolled steel. The shorter threaded stud at one end is screwed into the main bearing. The longer end, turned to ½ in. diameter and threaded only at the end, passes through the cylinder collars which are drawn up to the

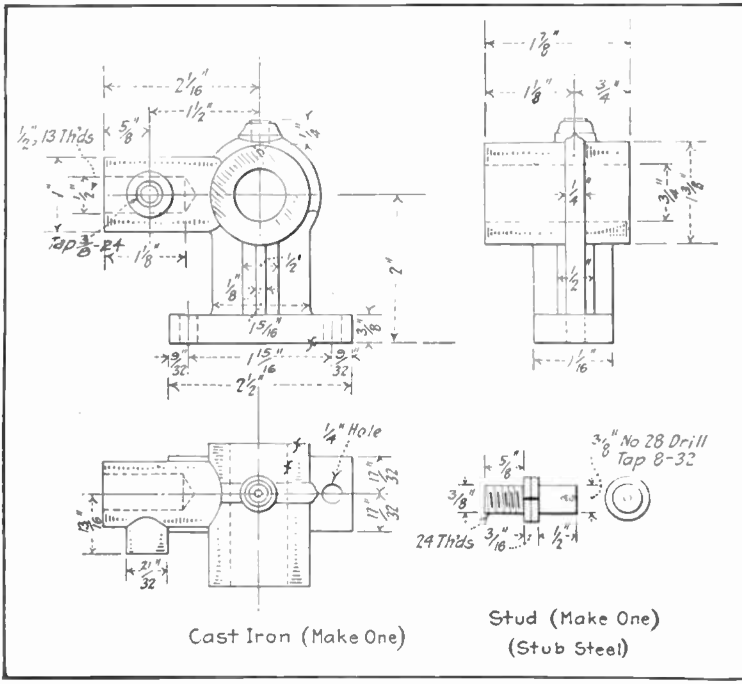


Fig. 16. Dimensions of bearing and stud

shoulders of the rods by standard hexagon nuts. Standard threads may be used at both ends, though the author prefers a finer thread at the bearing end. If saving time and expense is more important than appearance, 14 in. pieces of half inch round steel may be used instead of the turned rods, and distance pieces of half inch iron pipe slipped on between front cylinder collars and bearings. This construction is equally good mechanically, but does not look so workmanlike.

At this point of the construction the main parts of the engine may well be assembled. If the bed plate has not been planed the tops of the pedestals for bearings and cylinder may be filed up true, which need not be a long task if the straight edge and winding strips are judiciously used. If the alignment is not perfect, it may be corrected when cylinder and bearings are temporarily bolted in place. Assemble main bearings, side rods, cylinder and collars, but do *not* put crank shaft

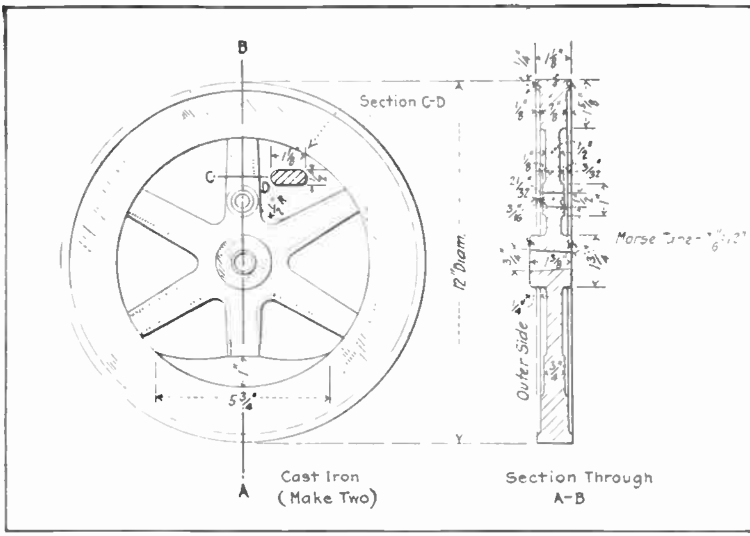


Fig. 17. Fly wheels

and fly wheels in place. Slip a ¾ in. cold rolled steel rod through the bearings. It should be easily turned with the fingers. If not the cylinder collars are out of line or the rods twisted around or slightly bent. When all is free, put the cylinder and bearing assemblage in place on bed. Scribe the holes and bearings, punch and drill holes in pedestals with a No. 9 drill. Tap out (20 threads) and secure bearings temporarily with one screw in each. Note if cylinder collar comes approximately correct with its pedestal. Remove cylinder, punch and drill a ⅜ in. hole near each end of pedestal, spot through these holes and drill 9/32 in. holes in collar extension and tap out ⅜ in. -16 threads.

Now put in all screws and see if shaft still turns freely. If not, slack off one or two screws at a time until shaft is free and it will appear where the bed plate is out of true. A little filing in the right place will soon put matters right. If the rod is free when all is tight there will be no trouble when the crank shaft is put in place, providing of course, that is also true. Further assembling may well be left until all parts are machined.

The next instalment will take up the smaller parts of the engine, valves, valve gearing, ignition and timing devices, etc.

(To be Continued.)

HOW WE BUILT A LEAN-TO

By Waller Parker

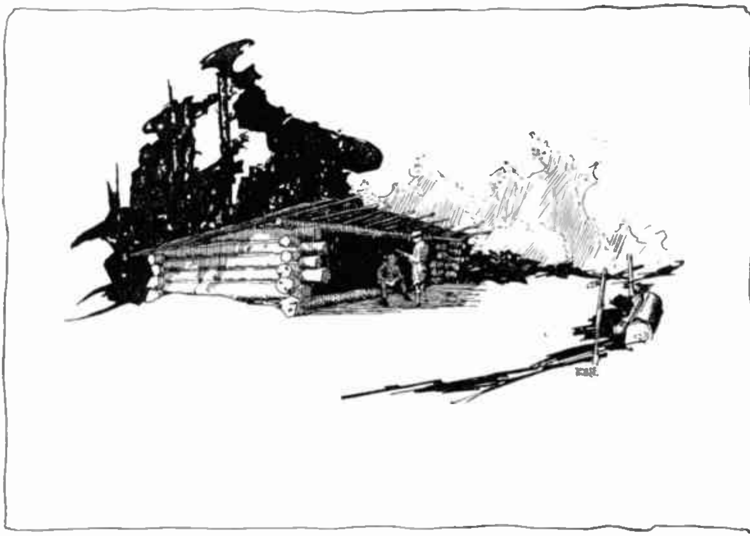
With Illustrations by the Author

SWEENEY was not there! We fired three shots into the stump of a large birch and waited.

It was night and raining.

We were standing on a point of forest land jutting into the narrows of Big Square Pond. "flivver" gleamed dismally over the scene showing us more dismally that the trail ended here, and that we had no place to sleep.

Ages passed. Suddenly several yelps like the bays of a hound came to us with a fresh gale of



Beauty and strength were characteristic of this lean-to

There were five of us, and we were cold and wet and hungry. A chill west wind lashed the huge bushes about us, making them groan and creak as if they, too, were cold and wet and hungry. The lights of our wind. And then came Sweeney from out the darkness with two tiny guide boats.

Sweeney was to be our guide. I shall never forget him. He was a tall man of so powerful a build that he impressed you with awe as a panther might. His face was clean cut, shrewd, and ruddy with health. He was distinguished looking and yet rough of manner.

He assisted in piling our duffle aboard the boats, and somehow through the storm and choppy seas, we made camp. I have never understood how. When it was over I remember a feeling of relieved suspense and the welcome supper waiting.

That night I experienced the ever new thrills of sleeping out of doors upon freshly-cut balsam, of hearing the storm lash about me, and then peace. I was in the great log lean-to.

The next day marked open-season for deer hunting. We had come to camp in search of this sport, and four fine bucks fell to our lead during the three weeks of our stay.

My friend, Mr. Curtis, has asked me to describe the construction of this lean-to for you. I find it hard not to tell you of the thrills and experiences that befell us instead, but he will not let me.

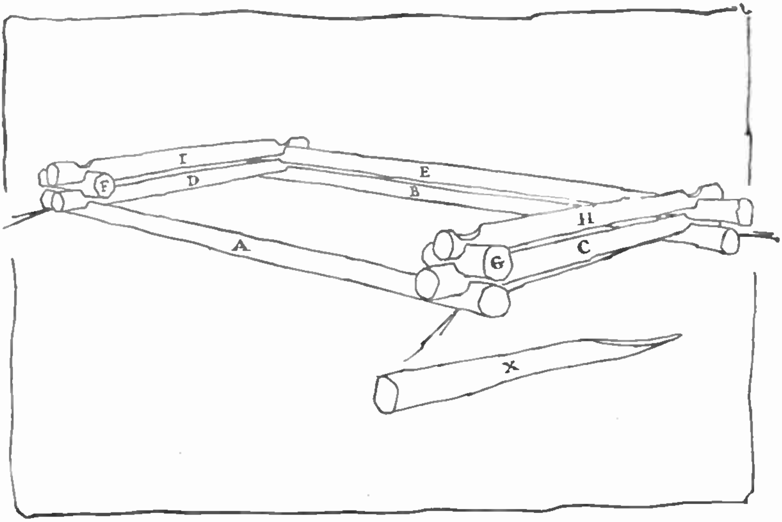
Evidences of the terrific storm were all about us next morning. Then it occurred to me that I had slept comfortably and warm. I find it appropriate to mention this, because I wish to impress you with the importance of a desirable lean-to site. All the rules governing the selection of a tent site are applicable. I will, however, bring before you only two which are important.

In order to insure dryness, we must build upon raised ground. Either select a knoll upon which to construct or build up with sand a portion of the site five or six feet outside the dimensions of the lean-to, allowing the ground to slope directly away from the structure on all sides. This will allow water to drain off instead of into the edifice.

The direction of storm-winds must influence the facing of a lean-to. No directions can consistently be given, as all localities are affected differently. The structure I am describing is located in the Adirondacks, where the worst storms come out of the west. Naturally enough then, the back of the structure was to the west, the open side to the east.

The lean-to on Square Pond is twenty-two feet in length by ten feet in depth, height in front butting the ends of the structure five and one-half feet, in the rear three feet. The roof is allowed to project in front beyond the ends of the sides, so as to form additional shelter. These measurements are, I believe, larger than allowed to be placed upon State property, the size allowed, however, being only a few feet smaller.

Beauty and strength were characteristic of this lean-to, and I think it was due to the immense size of logs used. They ranged from 8 to 14 in. in diameter, depending upon their position, the



How the logs were placed

larger logs being at the base. These were cut and hauled from timber country close to camp; a two-wheeled cart being used to facilitate the handling. A good way of hauling logs, however, when horses or carts are not accessible, and when four or more strong men are about, is to fasten ropes about the log at either end. Allow ten feet or more play to fall from each fastening on either side of the log. When done, this will show four ropes, two from either end of the log extending in opposite directions. Now make the four ends into shoulder harness similar to that used on a pack basket, and it will be found that a very heavy log can be dragged by the men in harness.

I understand that in olden times the construction of a log cabin was an event, and that upon such an occasion, friends from miles around would gather to the building to participate, and at the same time make merry.

Screw-holes for the Cupboard

If your cupboard is too small for convenience, buy a dozen screw-hooks and screw them to the bottom of the shelf about 6 in. apart. Hang your cups and small pitchers on them.

To remove rust stains from white materials boil them in water which has in it one tablespoonful of cream of tartar to every quart of water.—Emma F. Murray.

SIMPLE AUDION CIRCUITS AND APPARATUS

By M. B. Sleeper

With Drawings by the Author

THE use of the Audion detector, and the construction of the apparatus to use with it, is not such a complex matter as the operators are led to believe by the intricate diagrams and explanations that are often given. With the advent of the tubular audion it becomes possible for amateurs to purchase the bulbs alone. Although many operators prefer to buy the complete Audion sets, others have only the detector itself, and it is for the benefit of these people that the description of an audion panel is given.

Fig. 4 is a front view of the controls mounted on a wooden or hard rubber panel. As far as possible, Bakalite should be used in such cases. It is a little more difficult to obtain, but it is as cheap as hard rubber, more permanent in finish, and a better insulator. This panel is 7⅝ in. long, by 5½ in. high. The use of coaxial handles for the potentiometer and rheostat makes a considerable saving in space, although, if the tools necessary for the work are not at hand, it will be as satisfactory to mount the rheostat at the front.

Since some bulbs are rather critical in adjustment, a potentiometer is better than a switch for controlling the B, or high voltage battery. The carbon sector can now be purchased separately, but the contacts generally supplied are of spring brass. This is a decided disadvantage, for, after a short time, a coating of brass forms over the surface of the carbon sector. The effect is to short circuit the batteries, and give very little variation in current across the filiament and plate. Fig. 5 shows the connections for the secondary circuit of a loose coupler when potentiometer control is used, while Fig. 6 gives the connections for a 9-point switch to vary the current.

The batteries used with the Audion detector are usually of the 3-cell, flashlight type, giving 4½ volts for each battery. Ten batteries are needed. As soon as a cell tests below 4 volts, it must be thrown out, as it will injure the others. Moreover, they must be kept where they will not reeze or be excessively hot. Damp weather is injurious to wireless instruments, and to batteries particularly.

The sectional drawing in Fig. 4 shows how the potentiometer

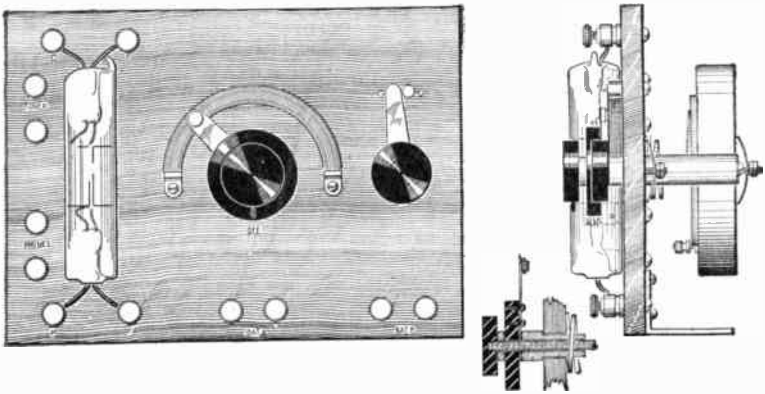


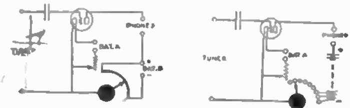
Fig. 4. Details of an Audion panel with coaxial controls for the potentiometer and rheostat

contact is fastened to the handle. The circuit is completed through the brass bushing and thin brass strip soldered to it. It is unnecessary to insulate the rheostat control rod from the outer bushing, as this connection forms a part of the circuit in Figs. 5 and 6. A nine-point switch can be used in place of the potentiometer. In this case, the batteries must be behind the audion panel, but if a potentiometer is used, a B battery box, such as is described later, can be employed.

A brass strip, fastened by machine screws through the holes in the base of the rheostat, is, in turn, held by screws to the hard rubber or brass supports which hold the rheostat from the panel. Tension on the two handles is kept by the bow-spring under the nuts on the end of the long shaft. The rheostat contact is also fastened to this shaft by nuts. The spring furnishes an excellent connection with the contact. Dimensions may vary for the rheostat, but it must have ten ohms resistance in the winding. Make sure that the coil is not simply iron wire.

Since current is always flowing through the potentiometer, a switch is needed to open the circuit when the detector is not in use. With a switch control for the high voltage cells, this is unnecessary as the circuit is only completed by the ionic discharge from the filiament to the plate through the grid. The A battery, or low-voltage battery, is cut out at the "off" position of the rheostat.

This panel can be supported by angle irons, or can be used as the front of a battery box. A 6-volt storage battery is the best source of energy for the filiament, although two sets of four dry cells, joined in series multiple, are good enough if the Audion is not used steadily for very long periods. Every connection must be soldered. Amateur operators



Figs. 5 and 6. Secondary circuit with potentiometer and circuit with battery switch

are apt to overlook this precaution, and think it too much trouble, but it is so important that the Navy Department specifies that all connections in their

charge from collecting on the grid. The standard type consists of two sheets of tin foil 1½ in. by 1½ in., separated by a thin piece of mica. This can be fastened to the back of the panel, under a square of fiber, or mounted separately.

For a close adjustment, an instrument like that in Fig. 7 is preferable. This is composed of two square uprights, on a hard rubber base. On the inside face of one upright is soldered a perfectly flat, brass disc, 1½ in. diameter. The other post has a ¼ in. hole, through which slides a brass rod. When the other disc is soldered to the end of the rod, it should be pushed up against

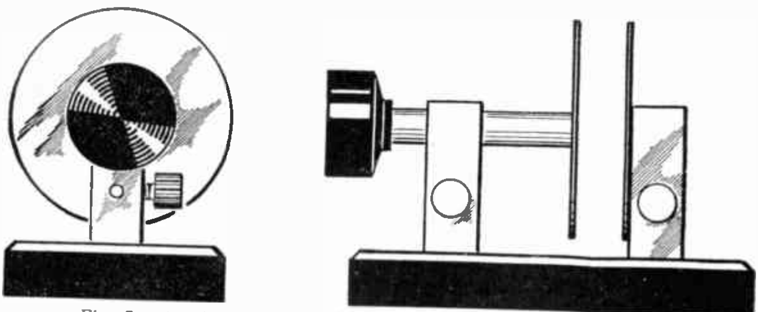


Fig. 7. A grid condenser of brass plates coated with thin shellac

apparatus shall be soldered. Moreover, to make the appearance as fine as possible, the connection wires should be bent at right angles.

A tiny condenser is joined to the grid to prevent a positive

the stationery plate, and soldered in this position. In this way it is easy to make the two plates perfectly parallel. A very thin, smooth coat of shellac on the faces of the discs prevents them from short circuiting. Holes and screws in the uprights serve as binding posts.

Fig. 8 illustrates a separate battery B box. This type has the advantage of registering the voltage of the separate cells. While some of the boxes now sold have clip-connections for a ready removal of the batteries, this is not advisable; the extra work of soldering connections is worth the security it gives against a drop in voltage through high-resistance joints.

The front view of the box shows the contacts, double-lever switch, and voltmeter. The view at the left is of the box with the end piece removed. It shows how room is made, by a spacing-block, for the connections to the switch points. Few experimenters realize that the rounded, or short contact of the batteries is the negative, or zinc pole, as shown in the upper drawing of Fig. 8.

The constructional details of the box are simple, and can be easily followed by the builder. It will be noted that tension is kept on this switch, as in most of the others shown in this book, by a bow-spring under two nuts, at the back of the front panel. Only the battery connections have been drawn in, but a diagram is given in the upper corner of the illustration. It will be seen that the two switch levers are connected by flexible cords, to the voltmeter, while the external connections are made to the right hand battery and to the left hand switch lever.

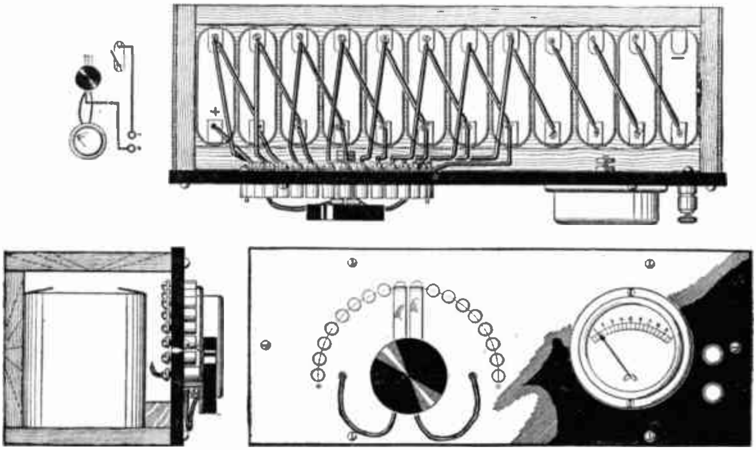


Fig. 8. By means of a double pole switch, the voltage of each cell may be read. The left hand lead from the switch is a plug, to disconnect the meter

Experimenters who do not wish to use the rotary rheostat, or want to mount a rheostat on the battery B box, will find the type in Fig. 9 well adapted to the purpose.

It consists of a hard rubber rod, 3⅛ in. long by ¾ in. in diameter, wound for 3 in. with No. 24 single silk covered, 18 per cent. German silver wire. The slide is of unique design. It is made from disc of hard rubber, ⅜ in. thick, by 1¼ in. in diameter. In the center is a hole just large enough to slip over the winding on the tube. Just the upper part of the disc is cut away, so that there will be an opening at the top for the slider contact. A flexible wire, fastened beneath one binding post serves as one connection, while the other is made by one end of the winding, fastened under the second binding post. The rod below the coil passes through a hole in the sliders and keeps it from turning about the coil. The binding posts are held to the hard rubber rod by short pieces of threaded brass rod, screwed into holes in the hard rubber.

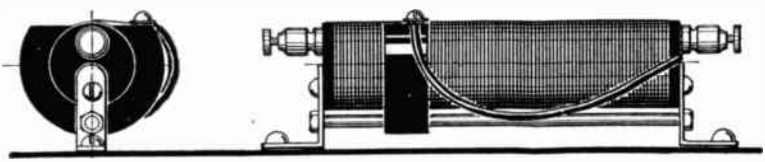


Fig. 9. The slider of this rheostat moves over the coil itself

This type of rheostat is much neater in appearance than the porcelain-base ones, although for all practical purposes the latter are entirely satisfactory.

A High Efficiency 200-Meter Receiving Set

Long distance receiving from 200-meter transmitters has become so popular that a receptor for this purpose will be described. Regenerative circuits have been described in other publications, but the results obtained with simple apparatus, carefully tuned, does not justify the use of elaborate circuits. The author has copied Nauen, Germany, at noon time in the laboratory of the National Electric Signaling Company, using a single Audion bulb with the ordinary loose coupler circuit. A separate bulb was used to produce a heterodyne or beat effect, as the received oscillations were undamped.

The set described here is not difficult to build, yet will give remarkably good results. The loose coupler, Figs. 10 and 11, is designed for wire lengths of 200 to 400 meters on an antenna having a natural period of 150 meters.

The most important part of the coupler is the peculiar winding. Many experimenters have seen the coils of the couplers used by the Telefunken Company, and wondered how they were wound, but no explanation has been published previously. The small drawing in Fig. 10 shows how it is done. To make it clear, the under wires are shown larger, although they are actually the same size. The method is as follows: When the wire is brought through a hole in the tube at the beginning of the winding, one turn is put around the tube. Then a second turn is wound directly over the first. Just opposite the starting point, the wire is bent sharply to the right, and a turn is made over the tube, beside the first one. After that, another turn is wound over the one just put on. In other words, the second turn is put over the first, the fourth over the third, sixth over the fifth, and so on. This method has been found one of the best to reduce distributed capacity. If trouble is experienced in the keeping the wire in place, melted bees-wax or thick shellac will help. Both primary and secondary are wound in this manner.

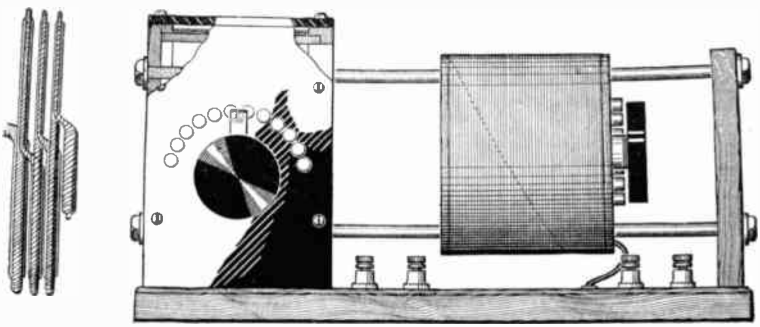


Fig. 10. For 200 meter reception, a small coupler gives the best results. This instrument has a special winding

Litzendraht was used in the original coupler, although stranded lamp cord, if not over 0.1 in. in diameter, can be used. Litzendraht is now sold by wireless supply houses in two sizes—10 strands of number 38 enameled wire, 0.051 in. in diameter over the outer insulation, with 2,000 feet per pound, and 20 strands of number 38 enameled wire, 0.094 in. in diameter, with 1,000 feet per pound. The wires are slightly

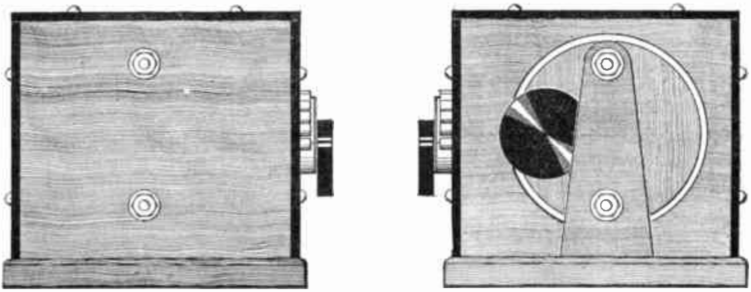


Fig. 11. End views of the small coupler. The secondary switch handle protrudes far enough to be grasped easily

twisted, and are covered with a single, braided silk wrapper.

In this coupler, the primary tube is 3¾ in. in diameter, and 2⅜ in. long. This gives a winding space of 2 in., which will hold 20 turns of the large size Litzendraht, or, since the winding is two layers deep, a total of 40 turns. Taps are taken from the outer wires on the following turns: 2, 4, 6, 8, 12, 16, 20, 24, 28, 32, 36, 40, giving it a total of 12 taps. Great care must be used in making the taps. Since the wire is too heavy to bring out in loops, single wires are soldered to the turns and brought to the switch points. It is not an easy matter to scrape the enamel from number 38 wires. The best method is to dissolve the enamel by dipping the part where the silk covering has been scraped away, in alcohol. No acid flux should be used in making electrical joints; rosin in powder or dissolved in alcohol is the only flux to use. The Litzendraht wires are carefully tinned, and the tap wire wound over the exposed part. A short application of the soldering iron will remelt the solder, and complete the joint. For the benefit of those who think that, because of its name, Litzendraht was first used in Germany, it may be said that the first patents on the uses of stranded, insulated wires were issued in the United States.

The secondary tube is 3 in. in diameter, while the winding space is 2¼ in. long. This allows for 23 turns of the large size Litzendraht, two layers deep. Taps are taken on the 6, 12, 18, 24, 30, 38, 46 turns. The seven point switch is fitted with a flat, hard rubber handle, 1½ in. in diameter, with the center of the shaft ½ in. in from the outside of the coil. This makes it easy to grip the handle in adjusting the switch. The wooden end pieces fit inside the coil, but have a flange 3.4 in. in

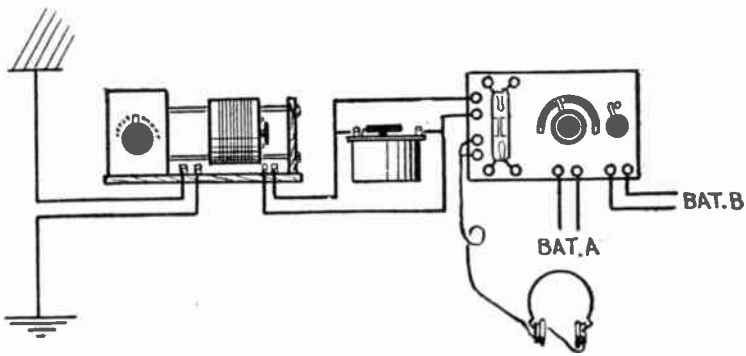


Fig. 12. Connections for the coupler, Audion panel, variable condenser and phones

diameter, to support the end turns when the coil is being wound.

Connections to the binding posts are made beneath the base. A flexible cord runs from the secondary to make connection to two of the posts. It is not advisable to use the supporting rods as conductors as any sliding contacts vary in resistance, and interfere with the operation of the set.

The two end views in Fig. 11 show the wooden ends and hard rubber housing for the primary, as well as the secondary support. In Fig. 10, the sectional drawings of the primary give the details of construction. There is nothing unusual about this instrument except the simplicity of design and the method of winding the coils. As a matter of fact, simplicity makes for efficiency, although experimenters do not as a rule realize this. The unnecessary, illconstructed, extra parts so often seen on home-made apparatus do not add in any way to the credit due an experimenter for making his own instrument, and invariably make evident his inexperience.

This loose coupler, connected as in Fig. 12, either with the audion panel already described or with the standard de Forest set, will give the results of other sets in receiving 200 meter transmitters mentioned from time to time in the current magazines. It is so simple that it cannot go wrong, or get out of order just when an important message is being relayed, or some distant station is coming in. The secondary condenser, of 23 plates or approximately 0.0005 microfarads, allows this circuit to be sharply tuned.

In Fig. 13 is a view of this coupler, assembled in a case with the variable condenser. This makes a compact tuning unit. The hard rubber panel is 12½ in.

long. 4¾ in. wide, and ¼ in thick. The construction of the tuner is the same, except for the secondary switch. Instead of a supporting post for the secondary rods, however, the right hand end of the case is used, as the rods are so far back that they will not interfere with the condenser. In mounting the condenser, the case ordinarily provided is removed, as well as the scale and hard rubber support for the secondary contacts. This is fastened to the coil end by machine screws put through the wooden end from the inside, and threaded into the hard rubber. Holes are provided for the switch points and indicator rod. As will be seen from the other view, a rod, threaded at one end by a 6/32 die, is held stationary to the contact-support by two nuts. The other end is

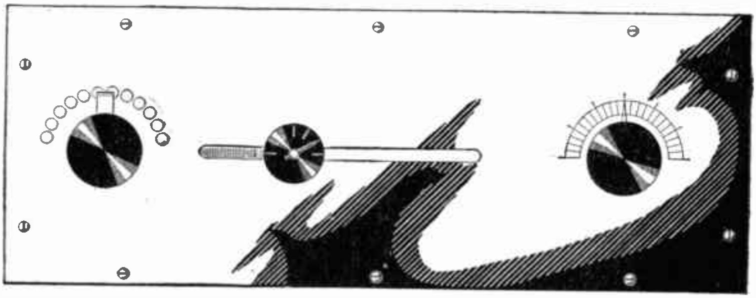


Fig. 13. A 200-meter tuning unit
The 12-point primary switch, secondary and coupling switch, and the condenser handle are placed conveniently

binding posts on the top. Then, with screws threaded into the front panel, the top of the condenser is fastened to the back of the panel. An extension on the shaft makes up for the added length necessary to hold the handle, because of the thickness of the panel.

Fig. 14 shows two views of the secondary switch. The handle serves to adjust the inductance and the coupling. A slot in the panel permits the lateral movement. At the left, Fig. 16, is the drilled for a small pointer, which indicates the position of the secondary switch. Over this rod is a tube, threaded at each end by a 10/26 die. Two nuts hold the switch contact at one end, while the other is screwed into the handle. In the drawing, the rod and tube are broken, but this is simply to show the length reduced.

Binding posts can be mounted at the front or back, whichever is most convenient for the particular station where it is to be used.

The connecions are the same as in Fig. 12. This set may seem too simple to appeal to many operators, but it is a pleasure and a surprise to operate it. A little experience will show where the adjustments should be for 200 meter stations. In listening-in the coupling is made very close, then loosened for sharper tuning. Less trouble is experienced from longer wave stations with this set than with larger tuners, as the coils are so small they cannot oscillate freely to high wavelengths.

Safety spark gaps, connected across the antenna and ground,

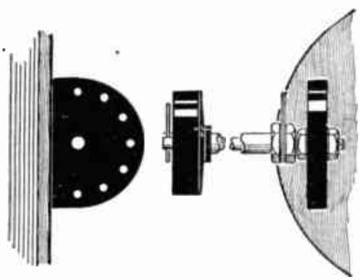


Fig. 14. This shows how the secondary switch is mounted and the indicator is arranged

are found in few experimental stations, although all commercial apparatus is furnished with such a protection. Fig. 15 shows such an instrument. It is composed of two uprights, in one of which is threaded a pointed thumb screw. The thread should be fine, to allow a close adjustment, as the gap must not be more than 0.01 in., to be effective.

This gap may not seem necessary, but at some time when the antenna is left ungrounded, or a very heavy static discharge occurs, it may be the means of saving the detector or phones, or even prevent an injury to the operator himself. Do not make the mistake, however, of connecting the gap outside the antenna

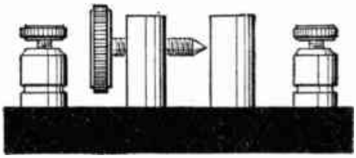


Fig. 15. A protective condenser may save the apparatus or operator

switch, where it provides a short circuit for the transmitter, but directly across the terminals of the receiving tuner.

A simple way of determining the diameter of a wire is to wind one inch of wire on a nail or pencil and divide the length of the part wound by the number of turns. Ths will give the diameter in fractions of an inch. Reliable results can be obtained for diameters as small as .005 of an inch. This method is also useful in making the designs for loading coils and loose couplers.

JOHN BULLWINKEL.

DESIGN AND CONSTRUCTION OF AN ALTERNATING CURRENT GENERATOR

¾ Kilowatt Output, Single Phase, 110 Volts, 7 Amperes, 1,800 R. P. M.

Part III

By A. E. Watson, E. E.
Professor of Electrical Engineering in Brown University

FIGURE 11 shows a 32-slot armature punching suitable for single-phase and two-phase alternating currents and for direct current windings of both the multiple and series type. For three-phase alternating currents, however, a number of slots divisible by six will be necessary, leading therefore to a choice between 24, 30 and 36. Of these perhaps the 24 will be the most acceptable, and it will also be appropriate for all the other windings. In general, especially when the pole pieces are of solid rather than of laminated iron, the larger the number of slots the better, and if the slots are nearly closed at the tops the production of eddy currents in the polar projections will not be serious. Large, wide open slots usually demand laminated pole pieces. With numerous slots there can be assured a good alternating current wave-form, or, with direct currents, freedom from sparking at the brushes, but since all the slots require adequate insulation, there may then be a sacrifice of space for wires. Twenty-four slots for a minimum, and 32 for a maximum, will be good limits. A 1⅛ in. or 1¼ in. center hole will allow for a liberal size of shaft, but a pinhole or keyway should also be provided.

While the straight-sided sort of slots can be milled out of suitable blanks, it is likely that the larger number of builders will prefer to purchase the sheets ready to use, thereby saving a great amount of time without much increase in the actual cost. Sometimes a visit to an electrical repair shop will result in finding some abandoned armature core, the stock in which is still as good as ever, and can be obtained for the price of junk. whatever the source, about 10 lbs. will be required, and the sheets should be of iron not over .025 in. thick, and preferably only .014 in., well annealed, the burrs removed by hammering or filing, then one side coated with very thin asphaltum varnish.

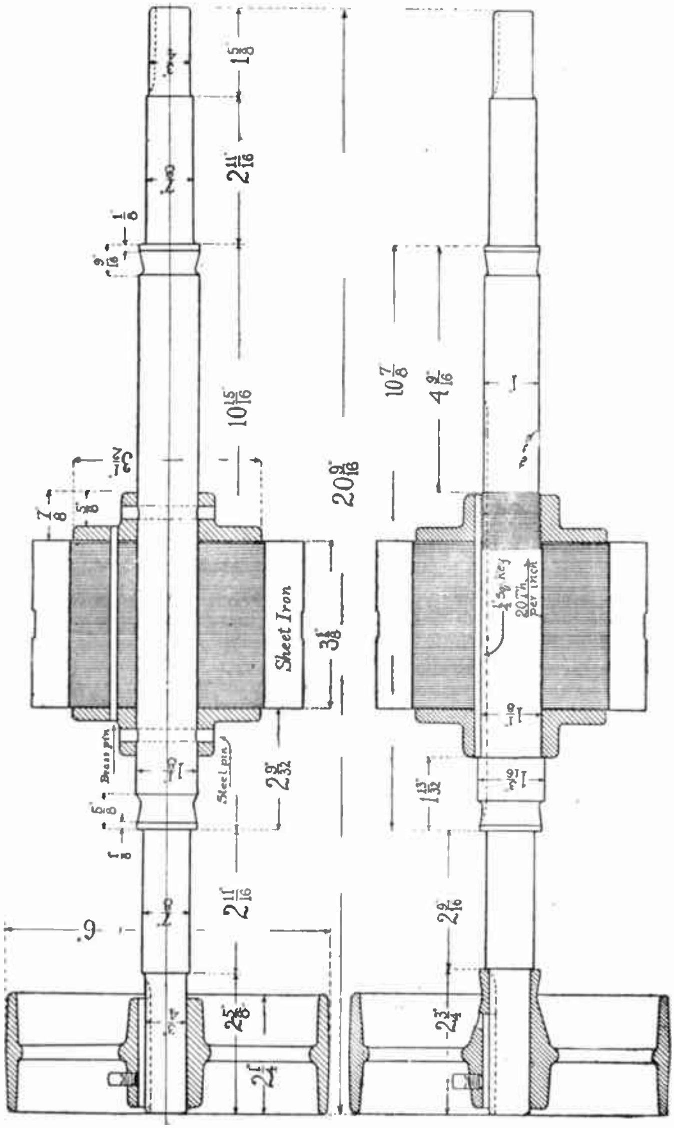


Fig. 12. Shaft (two constructions), armature and pulley

After drying, the sheets should again be examined, and if any globules of the varnish are found on the edges, they should be scraped off.

Much heavier shafts are now used in dynamo machinery than were thought necessary ten to twenty years ago. Perhaps the demands of induction motors, with their small clearances, were responsible for the introduction of larger wearing surfaces, but the change has been advantageous even in direct current machines. To follow the present good practice the dimensions recommended for the generator in this article may appear larger than the reader expects.

Figure 12 shows two somewhat different constructions, both being intended for laminations with a 1⅛ in. central hole. The upper one represents a piece of cold-rolled steel that has been carefully centered, say in a lathe by the aid of a back-rest, with no turning done upon this central portion, the cast iron heads being merely pinned in position. The lower view shows a method of using a piece of 1¼ in. diameter black machinery steel, completely turned, the portion forming a shoulder being left as large as the stock will permit. Other differences in details will be observed, principally in the manner of caring for the end-thrust and for securing the core from slipping. With the full 1⅛ in. size carried as far as the bearings, as shown in the upper view, there will be provided shoulders of sufficient surface, but if the construction in the lower view is followed, the shoulder at the collector-ring end will be too small, so that the device of extending the pully-hub is a very satisfactory expedient. In this case the small shoulder at the other end is carried a little further back so as to surely relieve it from possible rubbing. If the sheet iron punchings comprising the core have a keyway, this should be utilized, but sometimes a pin hole only is provided, in which case the construction will be that shown in the upper view. A rather large pulley is shown, but the actual size employed will, of course, depend upon the particular driving power available. In general it is best to use large diameters of pulleys and rather slack belts.

It is not good machine practice to turn any part at once to its final dimensions. The steel stock is quite likely to be under internal stresses, and when the restraining external layers are removed, the shaft may be left with a slight crook. To avoid this possibility a preliminary turning should be done on all the parts, then, when close approximation has been reached, to take the final chip, and then to draw-file and polish the running surfaces. For the latter process a block of pumice may well be used.

but by no means either emery powder or emery cloth. Such material once embedded in the soft metal will unrelentingly grind the bearings.

A good order for the work will be to bore and ream the armature heads and pulley, and perhaps fully finish them before turning the shaft, for they can then be used as gauges to determine the exact diameters. If the second of the two constructions is followed, the hub can be safely bored out to 1 1/32 in., and threaded 20 to the inch in the lathe until the edges are fairly sharp. Then, when threading the shaft, a good fit will be obtained just before sharp tops are reached, but certainly sufficient for all needs.

If the pinned-head construction is to be used, the head nearest the pulley is first to be secured. Then, after the core is assembled by slipping on the sheets one at a time, the whole is tightly pressed and the other head pinned. If the sheets are in any way afflicted with raw edges, they should be hammered or filed flat before attempting to assemble them. Toothed punchings with nearly closed slots are the sort recommended, but if those with wide open slots are used, the central punchings must be made of a slightly smaller diameter to permit the use of binding wires. The location of this belt is indicated in the drawing. It can, however, be cut in the assembled core after temporarily filling the slots with hard wood strips that will support the teeth.

After securing one of the heads in place the shaft can be stood on end and the sheets, one or two at a time, be slipped on, driving them firmly together by use of a piece of iron pipe. They

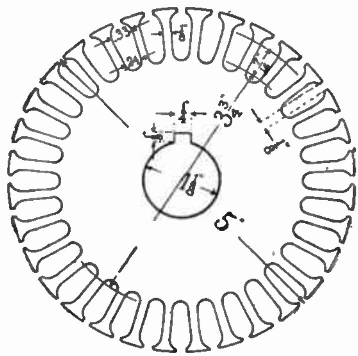


Fig. 11. Armature punchings

should be such a fit on the shaft as not to spring back after this driving, but to remain where intended of their own accord. If the construction shown in the first view is the one selected, the pin-hole may suffice as an index for assembling the sheets in the right order, for, along with the suggestion conveyed by the burr on the edge, there will ordinarily be failure for the slots to match in any other than one position. Usually manufacturers find it advantageous to provide a distinctive mark in addition to pin hole or keyway, whereby a glance will show the right side of the sheet. In case the second construction is selected, the key is to be made with a sufficiently loose fit in the shaft and in both heads to permit ready driving along after the sheet iron is in place. Stand the shaft on end, having the key extending toward the pulley-end bearing as far as possible and the other end being not over 3⅛ in. from the inner face of the flange. As the sheets are slid into place, the key should guide them to an accurate matching of the slots. To get the required number on the shaft some trials will be necessary and several wood clamps convenient for tightly squeezing the mass while measuring. When assured of the full space of 3⅛ in. being occupied, the second head can either be slipped on, held with clamps while the pin hole is being drilled and the pin (of brass, not iron) slipped in, or the head can be screwed on. Then the key is driven back so as to lock both heads securely.

As machine operations are subject to slight variations, the slots will not exactly match and some filing will probably be necessary to remove the sharp and overhanging edges of the sheets. During such filing it will be a protection against bending the ends of the teeth if clamps are again used, for once bent away from the rest of the mass there will be difficulty in getting them tightly back into place.

When the shaft and core have been thus finished, it will be advisable as a protection from rust or other injury to wind paper around the polished portions, secure it with twine or wire, and soak it with oil. Vaseline is frequently used for prevention of rust, but the paper is more effective.

Armature Winding

While 24 or 32-slot punchings have been proposed for the armature as being most easily obtained, all the slots cannot well be used for the single-phase winding. Those not needed for wires are simply ignored. The coils can be wound in place entirely by hand. By preparing them on suitable forms and then transferring them to the core, a better looking and perhaps better balanced structure may result. The formed coils will first be described, but with the essential scheme once in mind the builder will have no difficulty in deciding upon the procedure.

Blocks can be made of some such hard wood as maple, in the shapes shown in Fig. 13, the end view representing three strips with conical sides between other pieces that merely serve as washers. The other view shows their length and the rounded ends. All the pieces are to be drilled alike for slipping onto two bolts that will secure the whole assemblage to the face plate of a lathe.

An explanation of the winding itself will make clear the construction and use of the forms. Fig. 14 shows the groups of coils, presumably bound with tape, in place on the core. When completed, there will be three concentric coils for each pole of the field magnet. An inmost coil is represented as occupying slots 1 and 4, 2 and 3 being completely empty, while in the next place a similar coil is shown in slots 9 and 12, but surrounded with a larger coil in slots 8 and 13. In the third and fourth positions all three coils are seen, inmost ones being in slots 17-20 and 25-28, middle coils in slots 16-21 and 24-29, outside ones in slots 15-22 and 25-30.

The wooden forms are therefore to wind four sets of three coils, each group being a continuous path without the necessity of cutting and soldering. It will be seen that the proper size for the three conical strips can be assured by matching them with the appropriate slots in a sample punching. The length of the strip that forms the inmost coil is such as to permit the sides of the coil to come for about a quarter of an inch straight through the slots at both ends, then curved into a semi-circle. By this apparently superfluous length, sufficient leeway will be afforded to stretch the successive turns over the teeth and into the slots. The second coil is to have the same length of straight sides but have somewhat over ¼ in. clearance from the semi-circular end of the other. Similarly, the outside coil is to have clearance from its neighbor. These openings between the sections permit each to be easily taped when in position on the core and also provide ventilation ducts, so necessary in dynamo machinery.

The builder will understand that the conical shapes of the

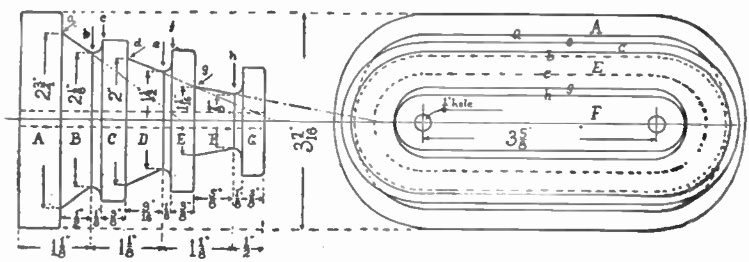


Fig. 13. Wooden form for winding the triple armature coils as a unit

winding strips belong to the end view only, while at the ends the coils will appear somewhat as shown in the assembled view of the machine in Fig. 1. After cutting the strips to the right length, the correct end shape will be obtained by rounding them with a jig-saw or band-saw, that is, perpendicular to their main surfaces. One strip will be ⅝ in. thick, one 9/16, and one ½ in., separated by suitably larger pieces ½ in. thick that are rounded out on one side to fit the adjoining face of a conical strip.

With the several pieces bolted together, the winding is to be started in the smallest space, the requisite number of turns being wound in a manner as nearly as possible to imitate the coil in its final position. Then, without cutting the wire, proceed to put an equal number of turns in the next space, and similarly in the third. Then the wire can be cut.

As the forms are removed, the coils may temporarily be tied at their semi-circular ends with soft string, preparatory to their being transferred to the core. Insulation for the slots can well consist of two or three layers of varnished cambric, or one layer of "fish-paper" and one of cambric, each piece being about 3 in. x 3½ in. As a matter of caution and economy, the builder should first try a few pieces to determine for himself the most convenient dimensions. Two pieces of very thin sheet brass or copper, about 2 in. x 3¼ in. will be necessary for guiding the wires into place.

After inserting the insulation so as to have it protrude equally at the top and ends of any one of the slots, the two sheet metal pieces are to be slipped in, and one side of an inner coil slid, a few wires at a time, in place. Then the sheets transferred to the third slot distant, and the other side of the coil worked in The two other parts of the same group are to be treated in similar manner as will be recognized. Each coil should be wound with cotton tape—not rubber—and this can be done, as preferred, after each section is placed or when all three are ready. An exactly similar arrangement is to be made in the three remaining positions on the core, the terminals of all four sets being left at the collector-ring end.

If it is desired that the machine shall have an output of 110 volts and 60 cycles at full load, each of the coils should consist of 30 turns, and with due allowance for insulation in the specified size of slots it should be possible to use No. 15 double cotton covered wire, but of course No. 16 will more readily be entered. At any rate, it will be desirable for the builder to make a trial of the matter, and this he can easily do by filling a slot with bits of wire a few inches long. Shellac a suitable length of the proposed size a day before making the trial, then the insulation will be firmly prevented from ravelling. Even if more than the expected number of wires can be entered, some allowance in the final coils must be made for the effect of crooks and crosses. If less than 30 wires are used, the 110 volts can still be secured, either by increasing the ampere-turns of the field winding, which may mean an undesirable degree of heat, or by proportionally increasing the speed, which involves a corresponding increase in the frequency of the alternations. About 4½ pounds of No. 15 wire will be required, but if that size is found to be impracticable, about 3¾ lbs. of No. 16 may be substituted. If the smaller size is used, the limit of 30 turns per coil need not be followed, for with a few more, a higher voltage, a lower speed, or less field excitation may be realized.

It is a simple matter to connect the four groups of armature coils in a correct manner, the care being quite like that of connecting field coils for alternate north and south polarity. The arrangement is shown in Fig. 15, representing outside ends of two adjacent coils connected together, then two inside ends of one of these coils and that of the next, then two outside ends, and finally the remaining inside ends connected to the collector rings. Proof of the correct connections can be made by sending a direct current from some suitably low voltage source through the windings from one ring to the other, and observing with a compass needle if the desired sequence of poles is ‹ tained.

When the coils have l placed, correctly connected, taped, fiber or slender w strips should be forced in o windings to hold the wire being thrown out by centı force or from chafing a each other, and then the s fluous insulation trimmed off. ditional provisions against cen fugal forces may be necessaı especially if there is any likel hood of wishing to drive the dy namo for frequencies approaching 100 or 120 per second. Bands of thick paper insulation can be wrapped around the protruding ends of the coils, and over them can be wound, in the regular manner, a dozen or twenty turns of No. 20 brass wire. Thin copper binding clips should be soldered around these binding wires in a few places. Several coats of shellac or other moisture-proof varnish should be applied, and the completed structure placed in a warm place to dry.

With 24-slot punchings, the arrangement of the winding will be a little different from that just described for the 32-slot sort. Only one slot will be left empty in the center of each group, and each of the groups will consist of two full coils and one half-coil, but in consequence of the increased size of the slots ·here will be about the same total mber of turns in the whole ıding. The builder should ‹e a numbered diagram and ·ate coils as follows: A full slots 1 and 3, a concentric slots 24 and 4, and a coil ‹ing one-half of slots 23 and nilar inside coils in slots 7 ɔ, 13 and 15, 19 and 21; in-ediate coils in slots 6 and 12 and 16, 18 and 22; half-ls in slots 5 and 11, 11 and 17, and 23. Of course the order f connections among the coils nd to the collector rings will be ·he same as described for the former winding.

In case higher voltages are preferred the builder can easily secure them by proportionally increasing the number of turns, using correspondingly finer wire but increasing the thickness of the insulation in the slots. For lower voltages involving fewer turns, the size of wire cannot readily be increased, for then it may be too large to enter the narrow openings in the slots, or be too stiff for comfortable handling. The proper recourse will be to adopt parallel rather than series connections between the groups of coils, or to wind several small wires in parallel. The four groups can be arranged in two sets, each set consisting of two coils in series, and the sets connected in parallel with each other. Such an arrangement will permit half potential and double current. Or, all four groups can be connected in parallel, giving one-quarter voltage and four times the current. In addition, the builder will ordinarily have on hand some equipment of transformers, so that almost any desired voltage outside of these simple ratios can be made available.

Field Winding

To adapt the field magnet for excitation from a standard 110-volt direct current source, the spools can be wound with No. 25 single cotton covered magnet wire, about ten pounds in all being necessary. Connection with the inside end of the windings should not be made by drilling holes through the fiber flanges, but by soldering the wire to a strip of thin copper ribbon not over .01 in. thick. To make room for this strip and its insulation, a radial cut may be made in the fiber flange, about one half the thickness being removed. A broken hack-saw blade and a carpenter's chisel will be useful tools, but the spool should be securely clamped to a bench during the cutting, otherwise there will be too much danger of cutting one's hand. Four rings of "Fuller board," the sort of hard glossy material used for making note-book covers, will be required; also some long strips of thin but tough paper about 1 9/16 in. wide for winding on the tin necks of the spools.

After placing one of the spools on its arbor in the lathe, or other winding device, stick one end of a paper strip to the metal with thick shellac, waiting perhaps five minutes for the adhesion to be firm, then winding on sufficient turns to give a thickness of at least 1/16 in., sticking the end with shellac, and temporarily tying it with string. With a wad of paper wet with shellac, fill the bottom of the slot that is to receive the sheet copper, so as to prevent accidental contact. Lay in the strip, stick on a piece of paper to fill the remaining space, and then one of the paper washers, sticking it with shellac and pressing it in place with blocks until thoroughly dry. The winding can then proceed in regular manner. About 66 turns per layer, and 38 layers (with occasional strips of thin paper) should be possible before the spool is filled. When the last layer is about half wound, a strip of cotton tape about 2 in. or 3 in. long can be laid on, protruding at one end, and temporarily held there with a tack; then, when within two or three turns of the final, this end is to be laid back but leaving a loop as large as a lead pencil, and the last layer but one wound over it. The wire is then to be cut with proper allowance, the end thrust through the loop, the tape drawn tight, stuck with shellac, and allowed to dry. Only after the second or third coat of shellac has dried will it be proper to trim the protruding end

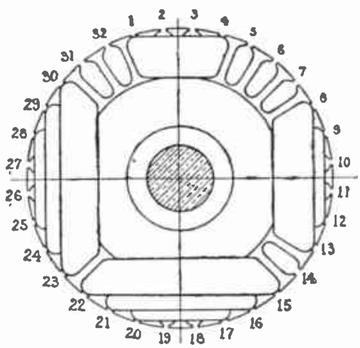


Fig. 14. End view of armature winding, incomplete

of the tape, but finally the spool will present a very fine appearance, the connection with the inner end being secure, and if that to the outer end is broken, it can easily be recovered. Another way of providing for the outer connection is to solder on a strip of sheet copper similar to that used for the inner end, attaching it to the last two turns, and extending out on the opposite side of the flange from the other strip. Still another method is to solder on a piece of lamp cord and securing this under one or two tapes as if it was the fine wire itself.

On each spool there will be about 2,600 turns, and at room temperature, the resistance will be close to 77 ohms, so that the four in series will have a combined resistance of slightly over 300 ohms. With 110 volts impressed, the current will therefore be .37 of an ampere, giving a maximum of nearly 1,000 ampere-turns, quite sufficient to bring the magnetic circuit to a considerable degree of saturation. With the increase of resistance due to the warming of the coils during use, together with the effect of the field rheostat, the working current will be within the proper range for both the iron and the copper.

After placing the spools on the pole-pieces they are to be connected in series so as to produce alternate north and south poles. This result can be secured by connecting together the inside ends of any two adjacent spools, then in the next place two outside ends, then again two inside ends, and finally two outside ends for leading to the connection terminals at the top of the machine. If the sheet copper strips have been used they can be left long enough to overlap and be fastened together with small screws and nuts. Uniformity in placing the spools should be observed, all terminals being at the ends of spools furthest from armature or all nearest the armature.

If some potential other than 110 volts is desired for the field excitation, a different size of wire may be used, but two different adaptations can be made with the size just described, similar to the manner of grouping the armature coils; for having two series-parallel groups, a voltage of 50 to 55 will be proper, while with all four in parallel, the voltage can again be halved. Still, there is an advantage in using as large a wire as possible and having the four coils in series. The finer the wire, not only the more does it cost, but the larger the proportionate space occupied by the covering, so a greater weight of wire, and more ampere-turns can be gotten into a given space by use of the largest permissible size. Advantage would therefore be found in the use of No. 22 wire for 50-volt excitation, No. 19 for 25 volts, and No. 13 for 6 volts, the number of amperes required increasing inversely as the voltage, being about .75 ampere, 1.5 amperes, and 6 amperes, respectively—or in each case about 40 watts. If exciting current is to be taken from a 220-volt source, No. 28 wire should be used and thin paper placed between alternate layers, extra care being taken to see that the different layers do not get intermingled by slipping over the edges of the paper. In any case of field winding the insulation required is not merely that to withstand the normal voltage, but rather that of several or even many times that value resulting from a sudden opening of the field circuit. A cautious user will always reduce a current to its smallest value before opening the switch. In central station working it is customary to equip the field switches of alternators with an additional blade and contact whereby just before opening this circuit a substitute is provided through which the self-induced electromotive force can expend itself. This precaution removes danger of puncturing insulation.

Assembling and Testing

If this is his first dynamo, the final step in the construction will be of no small interest to the builder, but if he has been able to make each part as described he need have no anxiety as to the outcome. Mechanically, the test will come when assembling the parts to see the armature turns freely. While there should be no looseness in the bearings, there should be such freedom that when the armature is spun around by hand it should continue to turn for a few moments entirely due to inertia. The ends of the armature core should match the edges of the pole pieces, and the shoulders of the shaft permit

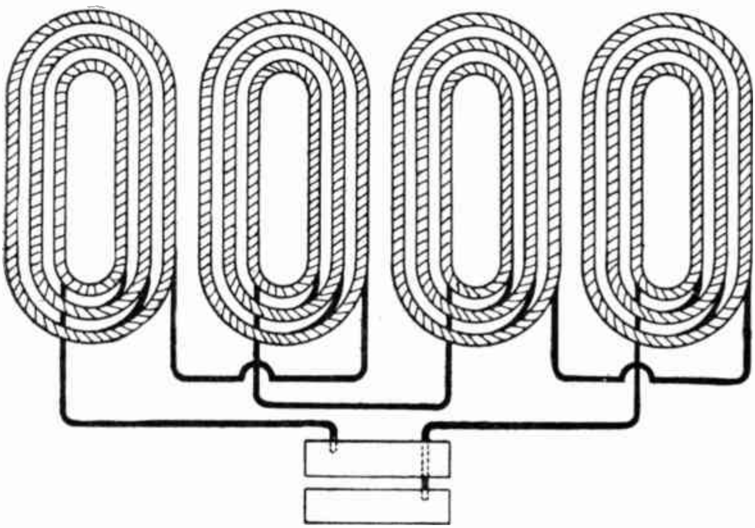


Fig. 15. Developed arrangement of armature coils and connections

about 1/16 in. of endwise motion. The construction of the bearings will permit some adjustment of this sort. Then, when tightening them in place there should be as stated, no cramping of the shaft. Such a result would be conclusive proof of inaccurate work, to be remedied, if at all, by cautious scraping, filing and shimming.

The oil to be used in the bearings should be of the ordinary thin "machinery" sort, not lard oil, for that is too thick. Pour in enough to cover the lower portion of the rings but not so much as to appear in the grooves in the outer ends of bearings. If the castings are rusty it will be a good plan to remove the oil after a few days standing, and to filter it through blotting paper. Quite properly this step should have been anticipated, and the surface of the metal already thoroughly cleaned from grit and rust. Once in good condition, the bearings will require inspection or addition of oil only once in a month or two.

In spite of observing every precaution during the construction, the first running of the machine should be with care, frequent feeling of the bearings to make sure they are not unduly heating or that any of the windings are loosening. If the armature is out of balance, it should certainly be remedied. By resting the shaft on horizontal metal strips the light side can be determined. Perhaps the most satisfactory manner of applying weights will be to wrap strips of sheet lead or wire-solder in pieces of insulation and thrust them into some of the empty slots. Only persistent trials will suffice to correct the fault.

As shown in the first view of the machine, there is provision for fitting the collector-ring end of the shaft with a pulley for driving an exciter, and any shunt machine of 50 watts or over in capacity will be suitable for the purpose. Perhaps the builder will be interested to know that the alternator and its exciter can also be utilized for another purpose, for with suitable switching and indicating devices it can serve as a highly efficient synchronous motor of about one-half horse power.

(End of the Single Phase Portion.)

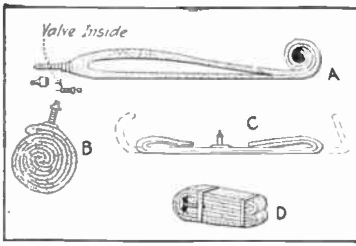
PLATINUM SUBSTITUTE

Owing to the high price of platinum, a very serviceable contact for spark coils, etc., may be made from a discarded spark plug. Break the porcelain insulator and remove the rod that runs through the center. On the end of this rod is a piece of wire from which the spark jumps to the outside casing. This wire is made to stand quite a high temperature and I have found it fairly good for contacts, being even better than silver.

PRACTICAL MECHANICS FOR EVERYDAY MEN

How To Fold and Carry an Inner Tube

Many motorists are careless when storing spare parts in the tool box or luggage container and the parts are injured by being carried loosely with tools. The inner tube is an important spare that is often illtreated in this manner. It is jounced about and sharp edge tools such as screw drivers, chisels or files may make a hole in a perfectly good tube and render it useless when needed. Even if the tools are kept from the tube, it may chafe against the tool box sides and wear a thin place which will blow out as soon as the tube is inflated. The proper way to fold a tube to make a compact bundle that can be easily carried is illustrated. The first operation is to let out all the air by removing the valve inside, then rolling up the tube as shown at "A." After the air is expelled, the tube looks like "B." The valve inside is then replaced and tube extended on a table or bench as at "C." The ends are then folded once and brought to the valve stem. Another fold and the tube is in the compact bundle shown at "D." It may then be inserted in a special box or bag made to receive it. A wrapping of cloth or paper should be placed around the valve stem so it will not chafe through the tube, and if the tube is carried in a box, it should be well wrapped with cloth to prevent the folded edges rubbing on the box sides. No oil should be allowed to collect on inner tubes as this rots the rubber and weakens the tube. Rubber bands for keeping the tube folded can be easily made by cutting rings about ¼ in. wide from a discarded inner tube.



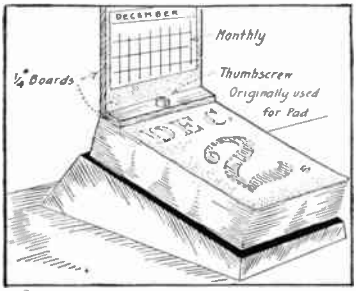
How the inner tube may be folded safely

Contributed by VICTOR W. PAGE.

To make willow and cane furniture last, give it an annual coat of oil. This, also, keeps it from becoming so dry that tiny splinters stick out.—M. SCOTT.

For Your Desk Calendar

Calendar pads are not usually made so that the user can glance at the whole month without turning to the last page. I remedied this by cutting a board slightly less than the width of the pad. This I fastened by wire



The thumbscrew holds the upright

nails to a strip of wood held in place by a thumb-screw, which passes through the pad into the iron base. To the board I fastened a small monthly calendar, thereby eliminating a cause of great annoyance.

Contributed by G. P. Lehmann.

Watching the Tail Light

Many motor cars are still equipped with oil tail lights that have the annoying and sometimes expensive habit of going out unexpectedly. This has the effect of placing the car in danger of collision from the rear and the driver in danger of arrest.

The trouble of dismounting to examine the tail light may be eliminated by mounting a small mirror on one of the rear mud guards so that the driver may determine if the light is lit by merely turning his head.

Furthermore, it is ofttimes possible to arrange the regular rear view mirror so that the reflection from the small mirror on the rear mud guard may be observed by the driver without the necessity of turning his head or removing his attention from the road ahead.

Contributed by T. W. Benson.

Printing Pictures in Winter

Unless one has plenty of spare time in the middle of the day, printing-out papers which can be used only when the sun is shining should be abandoned during the winter months in favor of the gaslight varieties. They render one absolutely independent of time of day or weather conditions, are easy to work with and so rapid that any negative may be printed near a lamp in from ten seconds to a minute, yet of such latitude that they may be safely developed only a few feet away from the printing light.

There are many different brands of gaslight papers, but practically all of them are made in two grades; one to produce softness, and the other, contrast. The former should be chosen, for the average amateur negative which tends toward under-exposure and full development; it has plenty of snap but none too much detail in the shadows, so that a soft paper is needed to make the most of it.

Of paper textures there is also a great variety, but as a rule the most pleasing results are obtained on matt and medium rough surfaces, while prints of large size and enlargements are almost invariably more beautiful on rough paper. Glossy papers should be avoided except for reproductions.

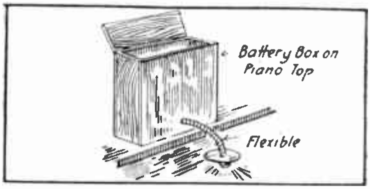
Full instructions with formulas are contained in each package of paper, as well as a hint as to the probable printing time which will be required.

It is important always to record the distance between printing-frame and lamp, because it affects the printing time as much as does the nature of the lamp furnishing the light. If this distance is doubled, the exposure will be four times as great; if increased three times, the exposure will be nine times as great. In other words, the printing time for a given negative at different distances is governed by the old physical law of our school days, viz.: the intensity of light varies directly as the square of the distance. Just what distance to choose depends upon the size of the negative. It is essential in securing even illumination that the distance be at least equal to the diagonal of the negative, preferably an inch or two more, but never less than seven inches.

Contributed by F. H. SWEET.

HOW TO MAKE A PIANO LAMP

This lamp is for use where houses are not wired for electric lighting. It consists of a box large enough to hold two dry



A piano lamp made at home

cells. Through a hole near the bottom is fastened a length of flexible tubing which holds the light in place. In the device described the tubing was taken from a discarded automobile horn arrangement. At the end of this is soldered a reflector which is about 2½ in. in diameter. Before soldering the reflector in place, a ⅝ in. hole should be cut so that the bulb (2.8 volt) may be held in place.

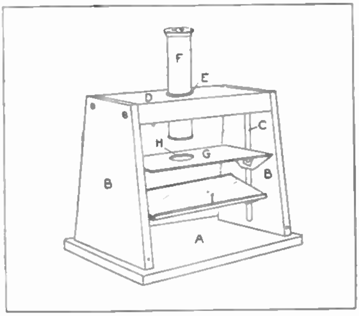
CHOCOLATE PAINT FORMULA

Mix 95 parts of Spanish Brown and 4 parts of lampblack together. Add raw linseed oil, boiled linseed oil; turpentine and drier to give the consistency required.
—H. G. FRANK.

How to Make a Microscope

To make a microscope out of the eye-piece of a spy-glass, proceed as follows:

Make the base, *A*, out of ⅜ in. board, 6 in. long by 4 in. wide. The supports, *BB*, are also made out of ⅜ in. board 5 in. long, 3 in. wide at the base, and tapering to 2 in. at the top. One of these supports should have a slot cut exactly up the center. Slot should be 3/16 in. wide and extend from ½ in. above the base to 1 in. below the top, as at *C*. The top cross-piece *D* is made of ¾ in. board 3½ in. long by 2 in. wide. In the exact center of this is drilled a hole of such size that the ferrule *E*, in which the eye-piece *F* slides, will fit firmly. When all wooden parts are made they are screwed together as shown.



This microscope may be constructed very cheaply

The stage or table, *G*, on which the object to be examined is placed, is made of a piece of stiff sheet brass, 3¾ in. long by 2 in. wide. Three-quarters in. of one end is bent down at right angles and the corners tapered off. In the center of this part a 3/16 in. hole is drilled. A stove bolt is then put through this hole and through the slot *C*, and the hole clamped tightly in place.

Now fit the eye-piece of the spy-glass into the hole in *D*, and bring it down against the stage *G* and mark around the edge of it. Cut this through with a cold-chisel or drill it out to form the hole *H*.

The reflector, *I*, is made in much the same shape and size as *G*, with the exception that it is ⅜ in. wider in order that the sides may be turned up to form clips for holding a piece of mirror, which should be forced between them.

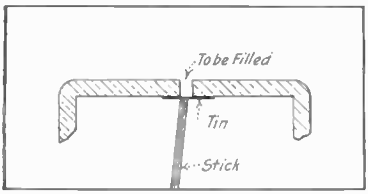
To operate the microscope, the object to be examined is placed upon a glass slide laid on the stage *G*, which can be adjusted to any height by means of the stove-bolt, the finer focusing being accomplished by sliding the eye-piece up or down. If the object is transparent the mirror is tilted to reflect light up through it.

Contributed by Frank L. Matter.

For the smoking lamp, soak the wick in vinegar and dry it well before using.—H. G. Frank.

Filling a Drilled Hole

The illustration shows a method used in plugging a hole which had been drilled about one inch off center. First it was tapped and then three or four slots were filed at right angles to these threads. A piece of tin held up with a stick prevented the type-metal used for plugging from falling out before it hardened. The slots across the threads prevented the plug from turning.



The hole was filled with type-metal

Contributed by Clarence Anderson.

Dumpling Steamer

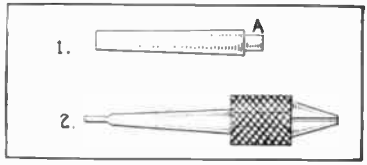
This steamer allows no water to collect about the edges, and is inexpensive.

Buy a sieve, the kind with tin sides, and use a cover with perforations. With this combination and a carefully proportioned recipe, dumplings of the best can be produced.

The sieve can be obtained in any size, and used over any dish or kettle they will fit, and they are light and easily handled. Contributed by Mary F. Scott.

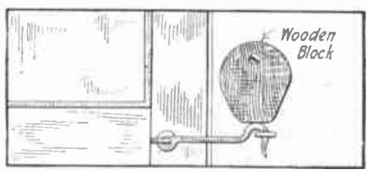
Making the Small Chuck Interchangeable

The drawing shows how a small chuck was made to fit both the speed lathe and drill press without the necessity of using a socket for either machine. In Fig. 1, the shank which fits the speed lathe, diameter A is cut to a drive fit in the chuck. Fig. 2 shows how it is used in the drill press.



The shanks were cut to fit the drill press and the speed lathe

Contributed by Clarence Anderson.



The block secures the lock

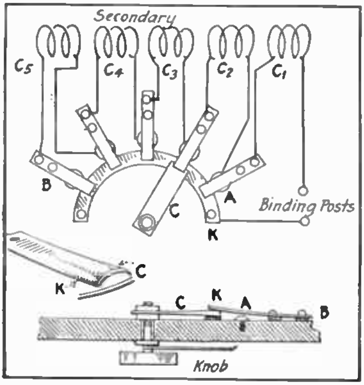
Safety Lock for Hook

A simple safety lock for ordinary hooks such as used for fastening screen doors may be made by cutting a block of wood shown in the illustration. From this, the action may be easily understood.

Contributed by Alfred W. Klein.

A Dead End Switch

To get the most out of a receiving transformer a dead end switch on the secondary is very desirable. Here is one that will repay the builder for the trouble of making it. The illustration shows the principle of operation.



Dead end losses are eliminated by using this switch

Detail B are phosphor bronze strips fastened to the hard rubber panel with machine screws. They should be raised to a height equal to the head of the machine screws A by washers M.

As the lever C slides under the strips it makes contact with them and the brass bearing K and at the same time breaks the contact with A, thus disconnecting all wire not in use.

Contributed by Leo M. Lafave.

Hints for Draughtsmen

The quickest and best way of removing pencil marks and dirt from tracings is to wipe over the surface with a piece of absorbent cotton dipped in benzine. This will clean up the drawing without affecting in the least the ink lines.

However, the above roughens the paper, which can be made glossy and waterproof by rubbing the surface with a piece of an old (cylinder) phonograph record. Ordinary pencil drawings when rubbed with the wax record will also be rendered waterproof and glossy, preserving them indefinitely.

Contributed by Thos. W. Benson.

The Construction of a Simple Electrophorous

A good electrophorous may be made which will give very good results at a very small cost.

Two pie plates and five cents worth of sulphur are all that is needed. The pie plates may be bought for five cents each. The ones with the flat bottoms and flat tapering sides are preferable. One of the pans should be a trifle smaller than the other, so that it fits into the other easily.

Heat the sulphur in the larger pan until it melts. After the sulphur has become smooth let it stand until it becomes hard. To obtain good results it is best to let it stand for about a week so that it may become very hard.

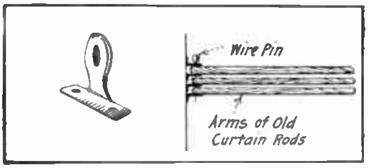
Inside the smaller pan there should be fastened an insulating handle. This handle can be turned out on any small lathe and shellacked; or a switch handle may be used. Fasten this handle to the center of the plate with sealing wax or glue.

To use: The sulphur should first be rubbed vigorously with fur. Then place the other plate, holding it by the handle, upon the sulphur very carefully. Let it stand for a few seconds, and then lift the plate up by the handle, and bring it near your knuckle on your other hand. A good sized spark will jump between the plate and your knuckle.

Contributed by M. S. Harris.

Towel Rack From Curtain Rods and Brackets

The accompanying sketch shows a strong and serviceable



A wire pin holds the rods in place

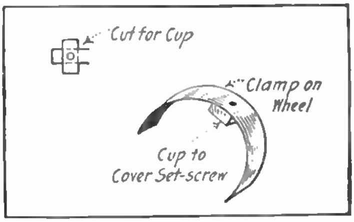
towel rack made of old window curtain rods and brackets.

The small rods are used as arms and if of wood should be cut to taper toward the outer end. The brackets are screwed one below the other on the window casing or any other convenient place. As many arms may be added as desired. These are pivoted with a wire pin and are about 18 in. long.

Contributed by T. H. Linthicum.

Safety First

Extending set screws on revolving shafting form a menace to life and limb. The use of the little device described here will remove this danger.



This attachment prevents accidents due to extending set screws

From spring steel or brass cut a strip long enough to reach nearly all the way around the shaft or hub of the pulley, as shown in the attached illustration. Bend it to the shape shown.

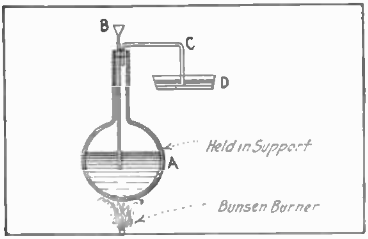
A small cup made from thin sheet iron is riveted to the middle of the long strip. The cup fits over the head of the set-screw and is held there by the gripping action of the long strip. These simple devices are easily made, and may mean the saving of a life.

Contributed by Thos. W. Benson.

Everyday Chemistry

Hydrochloric Acid

Put in flask A about 100 grams of common table salt (Na Cl.) and add enough water to cover it. Through thistle tube B pour enough concentrated sulphuric acid (H_2SO_4). to start the reaction. Heat the flask gently, and a heavy, colorless gas will escape from delivery



How the hydrochloric acid is obtained

tube C. Place C into jar D, which is half full of water, and let it remain there for a few minutes. Remove the delivery tube then, and you will have a strong solution of hydrochloric acid (H Cl). When you have the desired amount of hydrochloric acid throw the contents of flask into the sink.

Contributed by Wm. H. Nickless.

Copper-Plating Iron by Dipping

Heat a mixture of 10 gr. of bichloride of tin and 20 c.c. of hydrochloric acid until it clears up. Dilute the solution with 20 c.c. of distilled water.

On the other hand, take 10 gr. of sulphate of copper and dissolve it in 160 c.c. of distilled water. Add liquid ammonia enough to re-dissolve the precipitate formed.

Mix the two solutions and dip the iron articles, previously cleaned. The result will be an excellent coat of copper which is very adhesive.

Contributed by V. Caruso.

Coal Gas Experiment

Get a long clay pipe and fill the bowl carefully with powdered coal. Wet some sand and cover over the top of the pipe bowl with it. If the bowl is now placed in a clear fire, gas will in a short time issue from the stem of the pipe, and may be readily ignited. This is an illustration of the principle upon which gas is made for ordinary illuminating purposes.

Tool Marking Acid

Mix one part of nitric acid, one part of muriatic acid, and four parts of water. Coat the tool with wax and then scratch design in.

Contributed by H. G. Frank.

A Chat With the Editor

THE WIRELESS INDUSTRY

That's what it is—an industry. An old story, is it not, when you look back upon the career of amateur, rather than commercial, radio telegraphy?

In 1910, a handful of genuine manufacturers and another handful of "wireless companies," turned out some excellent and much inferior apparatus. All made money with more or less ease. Then came the shadow and finally the crash of Federal regulation. The real manufacturers stood the blow and courageously continued to get out their line, carefully checking the weak points, and, in an astonishing short space of time revising their entire product to conform to the letter of the law. The "wireless companies" went under.

The early part of 1914 marked the real opening of the so-called "wireless boom." Actually, I believe it might better be termed the awakening of amateur radio telegraphy. Both consumers and manufacturers were brought up to a round turn and made to face—not so much the fact that Uncle Sam was both wise to them and interested in them, but that amateur radio telegraphy had become an institution in the United States; that it deserved respect and serious consideration; that the "wireless amateur" was not to be relegated to the "nut bowl"; and that the manufacture of amateur radio telegraphic apparatus justified and demanded an exercise of thought, capital, and engineering ability in a pronounced degree.

Today we have literally hundreds of manufacturers, both real and —shall we call them—amateur. From the apparatus we have tested and examined in the *Experiment Station*, I believe the average may be said to be of high quality. Certain it is that many pieces of alleged amateur apparatus today are superior in nearly every particular to the commercial instruments of the yesterdays. This is encouraging.

However, in my study of the situation as it stands today, I am confronted with one pertinent fact that is of serious import, not only to the consumer, but to the manufacturer as well. If we glance through the catalog of any manufacturer, large or small, we cannot but note the perfectly amazing line or series of "numbers" built by that manufacturer. Actually, some small wireless concerns make and sell a larger line than their million-dollar contemporaries in the general electrical field!

It has long been an axiom in the manufacturing business that concentration is the secret of success. The man who makes one thing and makes it better and cheaper than anybody else is the man who makes the most money, serves the public best, and has the keenest degree of enjoyment from his little gold mine. That is not my opinion, especially; it is the positive knowledge of any well-informed business man.

Granting this, where is the newly-born radio industry to end up when every last man in it is making the same thing his neighbor is making, and doing it no better and no cheaper, perhaps? There are literally hundreds of condensers, receiving transformers, detectors, *et al.* on the market. One may be as good as the other. *They all cost their manufacturers more to make than the consumer by rights should be asked to pay!* Why? Because, notwithstanding the really tremendous sale, there is not enough demand for the product of any one manufacturer to enable him to build his instrument in great quantities.

Is there not a message in this little resumé for you who are most vitally interested in the welfare of the radio industry? It is not about time for the various manufacturers to *get together*, as business men should, in an effort to stamp out this insane and throat-cutting competition which entails a hardship upon consumer and manufacturer alike? Is it not possible that some agreement might be reached whereby each manufacturer might specialize and concentrate upon the one line of goods in which his facilities or experience enable him to excel? Could not each one still continue to *sell* the complete line as heretofore, using his great mailing lists and sales facilities for the marketing of a superior line of goods at lower prices and greater profits than is at present possible?

I, personally, am vitally interested in this issue. My magazine is the go-between for manufacturer and consumer. My duty is impartially to both. I believe in the soundness and the value of amateur radio telegraphy and I also believe that there is something missing in the industry. That missing link is really co-operation.

To show how seriously interested I am, I hereby make this an open letter to all legitimate manufacturers and publicly offer one week of my personal time and the use of the magazine offices and clerical and executive staff of EVERYDAY, for the purpose of holding a convention of radio manufacturers in the endeavor to adjust the differences, wipe out the unnecessary and unwise competition, and set the material side of amateur radio on a sane and sensible footing. May I hear from you?

WHEN YOU BUY FROM OUR ADVERTISERS

You, nearly all of you, buy goods from advertisers in Everyday at some time or other. They, the advertisers, tell us so! That is, most of them do.

Our Advertising Manager is Mr. Stephen Roberts. His job is to introduce Everyday to concerns that should be advertisers in your magazine but are not, for some reason best known to themselves.

Now, Mr. Roberts is just as much interested in you as I am. It is within your province to help him just as you have helped me time and again. You know, of course, that the advertising section of any magazine is what supports it. The more advertising we carry, the better your magazine can be and will be. We can buy material and delve into laboratory work that would be out of the question otherwise.

In view of this, do you not think it a good idea for you and Mr. Roberts to get together just as you and I get together? When you send an order to an advertiser, Mr. Roberts will be mighty glad if you will write him and tell him of the fact. Such letters will help him to show others who are not advertisers *why they should be*. If you think of a firm, not advertising at present, that you think would find Everyday profitable, tell your story to Mr. Roberts. Not only will you earn our sincere appreciation thereby, but you will be helping us to make for you a greater magazine than we have been able to give you in the past.

PATTERN MAKING FOR THE AMATEUR MECHANIC

Mr. H. H. Parker has written for you a clean-cut and understandable article under this title which speaks volumes to the veteran amateur. Possibly in no one particular is the average handicrafter so "hazy" as in the making of patterns and the general use of castings.

This contribution of Mr. Parker's, which you will find as the feature in the February issue, will open your eyes to the simplicity and peculiar utility of castings for your work, and it will tell you also how to make patterns of all kinds in order that you may shoulder a goodly portion of your burdens upon the nearest foundry.

Sincerely,

Thomas Stanley Curtis

Your Editor.

THE TECHNICAL ADVISER

The object of this department is to answer the questions of readers who may experience difficulty in the construction or use of apparatus described in the magazine. The columns are free to all readers whether they are subscribers or not, and questions pertaining to matters electrical or mechanical will be answered in the order in which they are received. If the reader cannot wait for an answer to be published he may secure an immediate answer by mail at a cost of 25 cents for each question.

In order to insure prompt attention, readers should adhere closely to the following rules which have been formulated with a view to expediting the handling of the mass of correspondence. Questions should be written on one side of the paper, enclosed in an envelope addressed to The Technical Adviser, care of Everyday Mechanics, Æolian Hall, New York City. The letter should state plainly whether answer is to be published or sent by mail; in the latter case the fee of 25 cents per question should be enclosed in coin, one-cent stamps, check or money-order. The envelope enclosing questions should not contain matter intended for any other department of the magazine.

58. **G. N. D., Honolulu,** asks (1) about the size of resistance wire for a rheostat with a motor on 110 volts. Ans. (1) Since you did not give the power of the motor, we cannot tell the current-carrying capacity required of the wire.

(2) How many turns for the primary and secondary of a pancake type oscillation transformer in a ¼ k. w. set? Ans. (2) Such a transformer should have five turns, in the primary, of copper or brass ribbon, 1/32 in. thick and ⅜ in. wide; the secondary, 10 turns of the same size ribbon. The inside turns of both coils should be 5 in. in diameter, with a space of ½ in. between the succeeding turns. Several of the wireless companies advertising in EVERDAY supply this strip.

(3) How many sheets of tinfoil must be used for a condenser for a ¼ k. w. transformer? The dielectric is of mica. Ans. (3) Since you did not give the constants of your transformer, it is hard to tell you the proper size. However, a capacity of about 0.01 mfd. is about right. The formula for the area of tinfoil is:

$$A = \frac{4{,}452{,}661 \times t \times C}{k}$$

where A = area of tinfoil in sq. in.
t = thickness of dielectric in in.
c = capacity required in mfd.
and k = dielectric constant, which is 6 for mica.

The mica should be about 0.05 in. thick.

(4) Should I use paraffin for the sealing compound? Ans. (4) Better use beeswax and rosin in equal parts.

59. **L. W. K., West Roxbury, Mass.,** wants to know (1) if a No. 34 K. and D. motor will run a 3-ft. model submarine at a good speed. Ans. (1) A motor of this size will give you plenty of power if you use 4 to 6 volts.

(2) How can I fix the submarine so that it will automatically head toward a vessel and

sink it? I have a mechanism which will discharge a shot sufficient to sink a 3-ft. wooden vessel. The submarine is too small to install a wireless control, and I want it to submerge quite deep. I also want it to return to me automatically. Ans. (2) There is no method of automatic control which can be placed in such a small model. You could, however, arrange a mechanism to steer the submarine, actuated by a coherer as in the original model submarine described in EVERYDAY. Instead of a wireless control, you can run a fine annunciator wire from the submarine to the shore, insulating it from the water where it enters the hull. This is the ground connection. A metal plate on the bottom of the hull will serve as the aerial. If you connect the annunciator wire to one side of a wireless sending set on the shore, and the other side to a small metal plate in the water, you can use this as a "wireless" control. The only other method is to run two wires from the boat to the shore, and use a selective or progressive control, actuated by batteries on the shore.

(3) Will a No. 45 K. and D. motor run a Goodell-Pratt Co.'s bench lathe? Ans. (3) You should use a 1/6, or better, a ¼-h. p. motor, to get the best results from the lathe. No rheostat is necessary with such a motor. If you wish to control the speed of the lathe, you should do it by means of a countershaft.

60. **W. H. B., South Boston, Mass.,** wants instructions for making a storage battery. Ans. On page 437 of the September, 1916, issue of EVERYDAY you will find instructions for building a storage battery. There is a further discussion in the November number which may help you. The Circulation Department will furnish these copies if you want them.

61. **E. A. S., New Orleans, La.,** wants to know (1) the wavelength of an aerial 200 ft. long and 50 ft. high. Ans. (1) A four-wire antenna of these dimensions has a wavelength of approximately 400 meters. If a single wire is used, this may have a wavelength of only 300 meters.

(2) What is the wavelength of an antenna 90 ft. long and 50 ft. high? Ans. (2) If you use four wires the wavelength will be about 250 meters. These estimates are taken from a table made from actual tests. It is practically impossible to calculate the wavelength of any but a single wire aerial.

(3) Which is more sensitive, the E. I. Co.'s Radioson detector or the type AA Crystaloi? Ans. (3) No comparative tests have ever been made of these two instruments. However, we can say that the Radioson detector is of the sealed point electrolytic type, which has been discarded as impractical and insensitive, while the Crystaloi has been used in commercial ship stations to receive signals from a distance of over 1,500 miles.

62. **N. H. C., Montpelier, Vt.,** asks if it is practical to use a four-cylinder automobile engine, mounted on skids, for operating shafting and machinery. Ans. There have been so many uses of old engines for doing work of this class that we cannot enumerate them. An engine, mounted as you suggest, has innumerable applications wherever machinery is to be driven. The idea is entirely practical.

WHERE TO BUY MATERIALS

This is a new department in EVERYDAY. It is an enlargement of the Service Department now well established. The aim is to show the reader where he may obtain any part, material or finished instrument needed for the construction of apparatus described in each issue. Wherever possible, the reference is made to an advertiser. If the material needed is not carried by any advertiser, the Experiment Shop, conducted by the Service Department of EVERYDAY at 104 Fifth Avenue, New York City, will supply you.

Aeroplanes and Supplies (Model)
Ideal Aeroplane & Supply Co.

Arch Supporters
Smi-Dor Arch Cushion Co.

Armature Punchings
The Experiment Shop

Audion Bulbs
The Experiment Shop

Automobile Accessories
Manhattan Electrical Supply Co.

Bakelite
The Experiment Shop

Books, Technical
The Audel & Co.
Spon & Chamberlain
Technical Press Association

Brass Stock
The Experiment Shop

Cardboard Cylinders
The Experiment Shop

Castings
The Experiment Shop

Contact Points
M. K. Burckett

Core Iron
The Experiment Shop

Detectors (See Wireless)

Diamonds
James Bergman
Sweet & Co.

Draftsmanship (Course In)
Chief Draftsman Dobe

Dry Batteries
Manhattan Electrical Supply Co.

Dynamo Castings
The Experiment Shop

Educational
Chiropractic—American University
Correspondence—International Correspondence
Draughting—Chief Draftsman Dobe
Electrical—New York Electrical School
Wicks Elec. Institute
General—International Correspondence Schools
Music—U. S. School of Music
Physical Culture—Lionel Strongfort

Gasoline Engines
Frisbie Motor Co.

Gasoline Engine Castings
The Experiment Shop

Gears, etc.
The Experiment Shop

Gibraltar Cloth
The Experiment Shop

High Frequency Apparatus
The Experiment Shop

Insulating Materials
Oiled Paper—The Experiment Shop
Oiled Linen—The Experiment Shop
Red Rope Paper—M. W. Dunton Co.
Tape—Mechanical Rubber Co.
Tape—M. W. Dunton Co.
Vaseline—The Experiment Shop
Wax—The Experiment Shop

Kerosene Engines
Frisbie Motor Co.

Knobs (Hard Rubber)
The Experiment Shop

Lathes and Lathe Tools
Goodell-Pratt Co.

Lead
The Experiment Shop

Litzendraht
Manhattan Electrical Supply Co.

Machine Steel
The Experiment Shop

Mercury
The Experiment Shop

Nuts—Hexagonal
The Experiment Shop

Oiled Paper and Linen
The Experiment Shop

Paints—Waterproof
The Experiment Shop

Patents
Chandlee & Chandlee
J. R. Kelly
Lancaster & Allwine
Munn & Co.
R. B. Owen
Robb & Robb
L. L. Sargent
A. M. Wilson

Phonographs
F. K. Babson

Pipes—Smoking
S. M. Frank

Propellers
The Experiment Shop

Razors
Week

Receivers—See Wireless Apparatus

Rubber Panels
The Experiment Shop

Silicon Steel
The Experiment Shop

Soldering Paste
M. W. Dunton Co.

Soldering Irons and Kits
M. W. Dunton Co.

Storage Batteries
Manhattan Electrical Supply Co.

Tape
M. W. Dunton Co.
Mechanical Rubber Co.

Taps and Dies
Smith & Hemenway

Tesla Coils
The Experiment Shop

Tools
Smith & Hemenway

Transformer Iron
The Experiment Shop

Transformers
Wm. B. Duck

Typewriters
Galesburg Writing Machine Co.
Metro Typewriter Co.
Royal Typewriter Co.
U. S. Typewriter Exchange

Variometers
Wm. B. Duck

Variometer Parts
The Experiment Shop

Wireless Apparatus

Receivers
Brandes
Wm. J. Murdock Co.

Detectors
Lenzite Crystal Corp.
Micropho Detector Co.
Nat. Elec. Mfg. Co.
Eugene Turney

Wireless Magazines
QST

Wireless Sets
M. K. Burckett
Wm. B. Duck Co.
Handel Elec. Co.
Manhattan Elec. Supp. Co.

Wireless Parts and Materials
M. K. Burckett
Wm. B. Duck
Manhattan Elec. Supp. Co.

For Transatlantic Set
The Experiment Shop

White Lead
The Experiment Shop