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HOW TO BUILD A SMALL ALTERNATING CURRENT DYNAMO WITHOUT CASTINGS.

BY NEVIL MONROE HOPKINS.

Numerous small books have been published on dynamo building, but they have been mainly devoted to descriptions of direct current generators. The little machine described in the following article produces a "single phase" alternating current at 110 volts pressure, and is built without patterns and castings. The making of small dynamos is frequently given up by amateurs because patterns and castings are required. Patterns are often troublesome and expensive to make, and iron castings are not always procurable in the average town. The iron ring which forms the frame or body of the alternator described in this connection can be quickly made by almost any blacksmith, and is to be preferred to a casting if made from good soft iron. For a larger dynamo than the one described the iron ring can be very easily made by using blacksmith's rollers, known as tire benders. The little machine, when its field magnets are only feebly excited, generates the most approved kind of alternating current for medical purposes, as the voltage is steady; consequently furnishing a current which is free from the jerking or twitching sensation so common with the use of induction coils. With the fields strongly magnetized the machine, when run at about 2,000 revolutions per minute, is capable of lighting a 50 candle power 110 volt lamp. As the designing of alternate current dynamos, mathematically considered, is rather beyond the average amateur, the author merely gives the result of calculations, except in the matter of field magnet winding, where a choice of wire presents itself, in order that the field magnets made shall be suitable for any exciting current at the command of the user. The mathematical designing of alternator armatures would take up more space than our limits allow. The armature as described is readily detachable from the shaft and collector rings, leaving an excellent field for experimentation with different types of armature cores and windings.

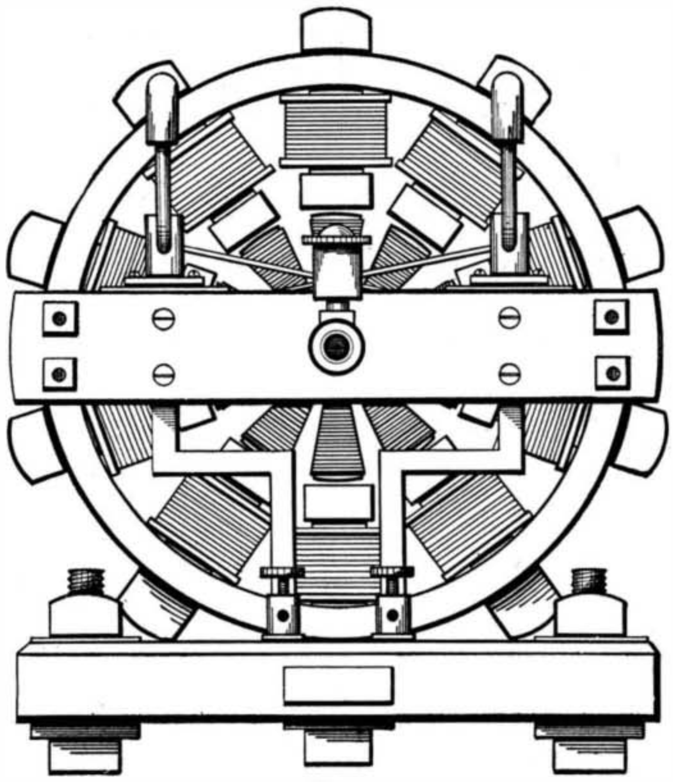


Fig. 1.

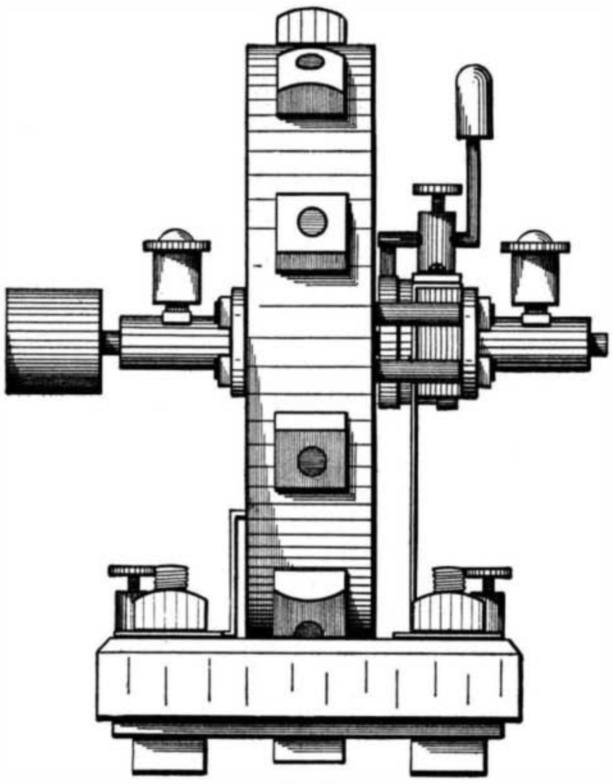
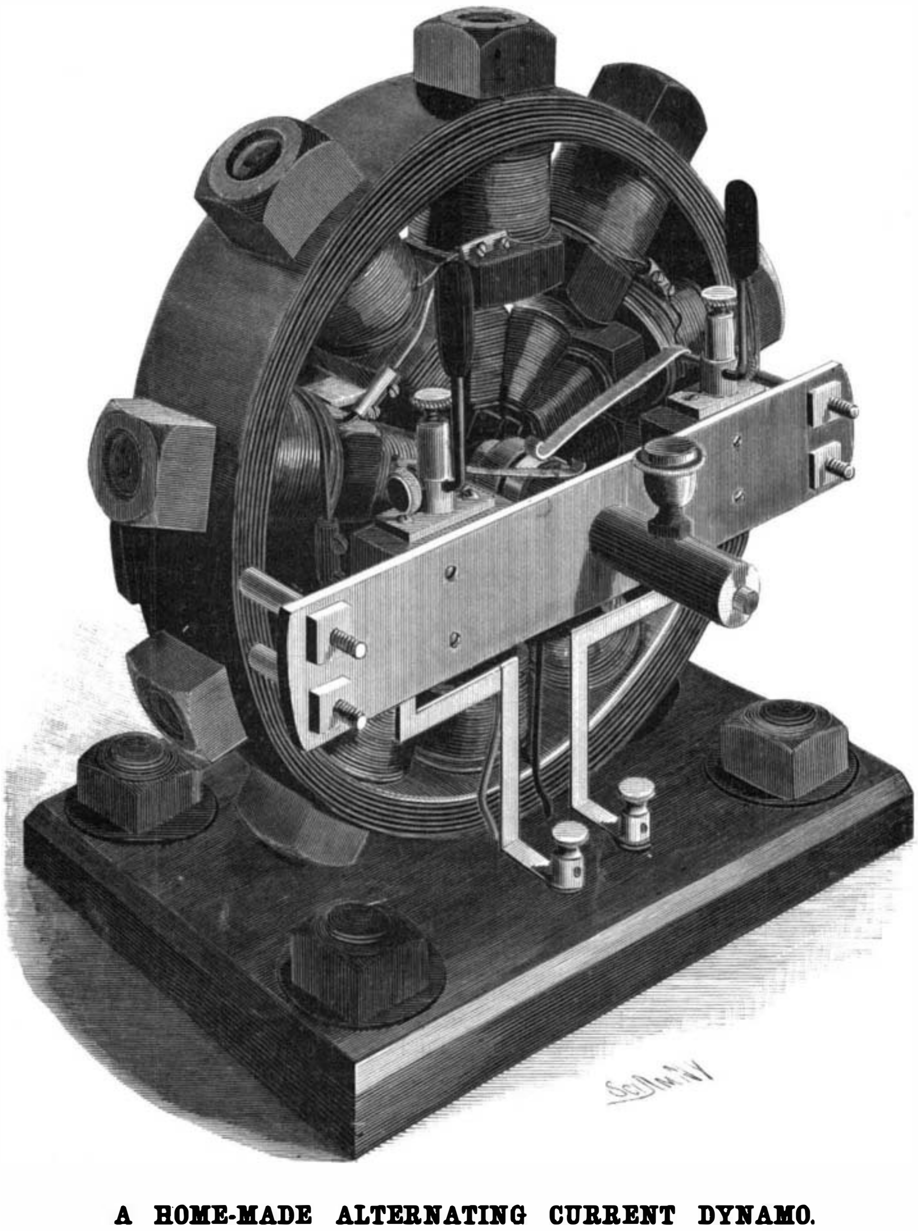


Fig. 2.


A HOME-MADE ALTERNATING CURRENT DYNAMO.

The electrical engineer whose knowledge becomes deficient when he leaves direct current dynamo machinery and deals with generators of alternating type has a very limited field for practice, as the alternating current machine has come to the front to remain, displacing the direct current generator in many important branches of electrical engineering. There are to-day many electrical men who are at home, so to speak, when dealing with the applications of current electricity, and are badly at sea when they meet with problems pertaining to alternating currents. The alternator we are about to build is the simplest form at present in actual use, being excited by a battery, or other source of direct current, and delivering, in place of the mechanical power required to drive it, an alternating current, known as a "single phase." Alternators are built for lighting and power transmission, both "single phase" and "polyphase," although the "polyphase" generators are principally employed for power transmission. In the alternating current dynamo the voltage rises and falls in a very rapid periodic manner, driving a wave of electricity first in one direction, then in the reverse, with great rapidity. The field magnets can be considered entirely apart from the armature in a separately excited machine, whether the armature is of the tooth type or ring type. The only relation which we need consider in the machine which we are building is in the number of field magnets. If we use ten field magnets and consequently ten poles, we must make the armature with ten teeth, if of the tooth type; or, should we make a ring armature, the ring must be wound with ten coils equidistant. The armature given is the tooth type, but is conveniently removed, leaving the shaft and hub to receive a ring armature, with the collector rings ready to be connected to the new and differently designed armature. The term "period" used in connection with an alternator denotes the time elapsing between one complete reversal of the current. The "frequency" is the number of double reversals of the current per second. The frequency varies in practice between 150 and 25. It will be readily seen that the greater the number of poles and the greater the speed at which the machine is driven, the greater will be the frequency. Alternators are invariably designed with more pole pieces than direct current machines, in order to get the required number of reversals of the current every second. If the frequency is not high enough, lamps, for instance, in circuit, would flicker. If only two or four poles were employed in our alternator, the armature would have to revolve at a dangerously high speed to obtain the required frequency. The number of pole pieces for alternators vary from six to one hundred and over. The largest slow speed machines which are designed for direct connection to the driving engine have over one hundred poles. Alternators for commercial use are usually designed to give a voltage between 1,000 and 3,000. This high voltage is desirable for power transmission at great distances, whether for lighting or motor work. By the use of transformers immersed in oil for high insulation, the voltage is conveniently "stepped up" to 30,000 and power transmitted one hundred miles, and "stepped down" by transformers to any voltage desired. The transformations of current and voltage without altering the actual value, or electrical horse power, are very beautiful. For example, if we have at hand 25 amperes at 2,000 volts tension, or pressure, we may exchange the 2,000 volts for more amperes and vice versa without altering the power to do work, which is the definition of energy. An armature could, of course, be wound to produce a current at 20,000 volts, but the all-important electrical term "insulation" would forbid it. Assuming the machine were wound for 20,000 volts, the amperage would only be 2·5. Again, should an accident happen to the transformer insulation, when under the tension of 20,000 volts, the primary and secondary windings might come

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HOW TO BUILD A SMALL ALTERNATING CURRENT DYNAMO WITHOUT CASTINGS.

(Continued from first page.)

together, which would throw the alternator in danger. The writer recently had charge of an insulator testing plant with alternator and transformers in combination, giving a voltage at times as high as 50,000. While the alternator laid down in the following description is rather small for very high voltage, it will be found very convenient for illustrating principles, and if successfully built, one twice the size will be all that is required to furnish light and power for commercial purposes.

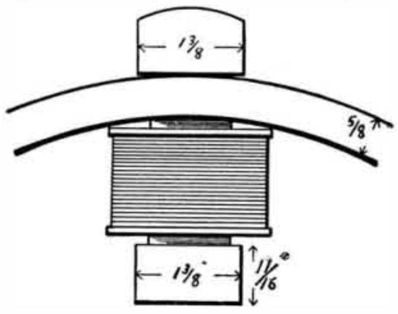

Fig. 3.

THE RING AND FIELD MAGNETS.

It would perhaps be wise for the beginner to construct the machine according to the directions and dimensions laid down before undertaking to build one on a much larger scale. The size of the largest generator it is feasible to put together on this system is somewhat limited by the largest bolts with the proper heads, and the heaviest and widest tire it is possible to bend with rollers, but it will be seen that a powerful and useful dynamo can be quickly built on this plan and at a reasonable cost. For experimentation with armature cores and windings, the ten inch ring machine will be of great assistance. Let us begin by forming the iron ring and mounting the field magnets.

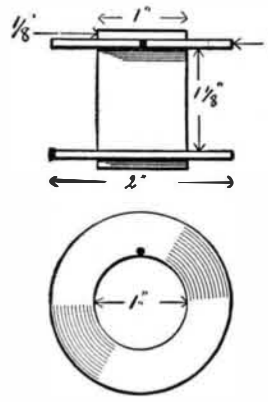

Fig. 4.

This ring should be about 5/8 inch thick and 2 3/8 inches wide, with an internal diameter of 10 inches. It can be started by using tire benders, but, owing to its small diameter, it must be helped out, so to speak, by manipulation on the mandrel and afterward welded. After hammering the ring as near a perfect circle as possible, it should be chucked on the lathe and turned perfectly true outside and inside as well as on the edges. The ring should now be carefully marked off in ten equal divisions and holes drilled radially on each mark to receive the iron bolts. Each bolt must measure 3½ inches in length from the face of the bolt head to the top of the screw. The holes must be just large enough to allow the bolts to be hammered in through the ring, as a tight fit is very desirable. By referring to Fig. 3 the size of the bolt head can be seen. If the head of the bolt were larger the field would not be as efficient, as magnetic lines of force would leak too freely from pole to pole, instead of making the circuit through the armature core.

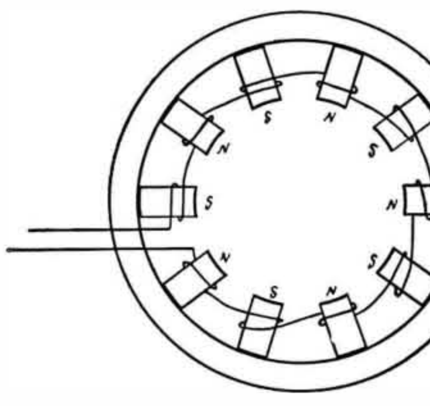

Fig. 5.

Having secured the bolts and drilled the holes to receive them, the next operation is the making of the magnet spools. These must be made from brass, as they are to answer the double purpose of holding the magnet wire and of taking up the pressure when the screws are firmly turned in place on the bolts. The dimensions of the spools are clearly shown in Fig. 4. Brass disks 2 inches in diameter are mounted and soldered on to pieces of brass tube 1½ inches long, leaving ⅛ inch top and bottom to take the pressure off the wire and ends of the bobbin when the whole is clamped firmly in place. This space between the head of the bobbin and the head of the bolt also allows the wire to come through and make connection with the next without having the insulation crushed. These disks, which form the ends of the bobbin or spool, can be turned five or ten at a time on the lathe by soldering together at the edges the required number of square pieces of brass and chucking in the lathe in order to cut the one inch hole through the center. Of course, after the hole is made the disks are mounted on a lathe mandrel and the corners and solder turned down until the disks measure 2 inches in diameter. Having made the ten brass bobbins, they should be given five or six coats of shellac, after small holes have been drilled in the disks to carry the wire out of the bobbin. Each coat of shellac should be allowed to harden before the next coat is applied, and the smallest size of rubber tubing should protect the wire where it passes through the hole. The spools should be slipped over the bolts to see that they go up well against the head. Should any of them stick before they go all the way on, the bobbin should be chucked in the lathe and one end of the tube quickly reamed out until the bobbin will easily slip up as far as the end of the bolt head. Of course, the best way to wind the bobbins is to chuck them in the lathe. Here a choice of wire is to be made. Each bolt must be wound so it can readily be made a powerful magnet without requiring a very great current strength. To powerfully magnetize one of the iron bolts used in the alternator 600 ampere turns will be required. We may get the required number of magnetic lines of force in our bolts by using any of the following windings and currents. If we wind each bolt with 50 turns and employ a current of 12 amperes, it will amount to 600 ampere turns, as well as the following: Six amperes and 100 turns; 3 amperes and 200 turns. As we expect to use our dynamo in connection with a fan motor for medical purposes, it would be well to select a winding that would be the most economical when connected through lamps to a 110 volt service. We will go still farther and wind each bolt with 300 turns of wire, requiring only 1½ amperes to bring the field up to a powerful state of excitation. With this winding, when the generator is to be used in medical treatment only, ½ ampere will be required to send around the field. Each spool will hold 300 turns of No. 20 double cotton covered magnet wire, if the wire is carefully and neatly wound on. This size of wire will go on the bobbins in 12 layers and measure 120 feet for each spool, 1,200 feet for the ten. The voltage generated in the armature will vary with a constant strength of field, with the speed at which the generator is driven giving another method for regulation. For medical treatment currents of varying character may be had by using the dynamo as follows: First, by giving the fields strong excitation and driving the machine at a low rate of speed. This will give ample voltage and current, but at a low frequency of alternations. Secondly, the fields can be only very feebly excited and the machine driven at the highest speed possible with the motor at hand. This will give the required voltage and current also, but the frequency will be extremely high. Never take the current when the fields are strongly excited and the machine is being driven at a high rate of speed, too, for this current and voltage is only intended for lighting and experimental purposes.

Having wound and mounted the field bobbins and screwed the field bolts firmly in place, the free ends of the wire should be joined by means of small brass screw sleeves known as connectors. The ends must be connected up so the current will go around one spool in one direction and around its neighbor in the reverse, in order to get north and south poles. By referring to Fig. 5 the idea will be understood. Having connected according to the diagram the polarity should in all cases be tested by exploring the field with a compass needle, to make perfectly sure the poles alternate in polarity all the way around the ring. Should this connecting be neglected, no alternating current will result. In testing the fields with the compass needle, the fields had better be excited with a battery, if at hand; otherwise the spools can be connected to the 110 volt mains, but in each and every case with a 110 volt lamp in series with the field. Should the field winding ever be connected directly with the 110 volt circuit, an accident would surely result. The fuses in the building should blow out, but, in case they failed, the wire on our machine would have to blow out instead. The ring should now be mounted on its base board. This had better be made from oak and be one-half inch thick. Figs. 1 and 2 show the method of making feet for the base, by using bolts and nuts like the ones used on the fields. Heavy pieces of iron should be bolted across the grain on the bottom of the base board to prevent it from warping or buckling in any way, as well as to add weight to the base. The base measures 8 by 12 inches. One of the bolts, namely, the bottom one in the ring, is substituted for a longer one, capable of going through bobbin, ring, and base board, carrying an iron washer and having its bolt head screwed on firmly.

It will be noticed how conveniently the two adjacent bolt nuts come in position against the oak base, being forced in the wood a little way, when the lower bolt is strongly turned with a wrench. These serve to keep the dynamo straight on the base and prevent wabbling or turning. Brass binding posts must now be mounted on the base and connected with the two free ends of the field winding, a second pair being mounted on the base in front to be connected to the brush holders, collector rings, and armature. Before painting the ring and bolts, the ring must have four holes drilled through the edge to receive the bolts which carry the bearing cross pieces, brushes, armature, etc. These holes must be most carefully marked off, for the bearings, when mounted, must be exactly in the center of the ring and pole pieces, or else it is very evident that the armature will not revolve freely, but collide with the pole pieces.

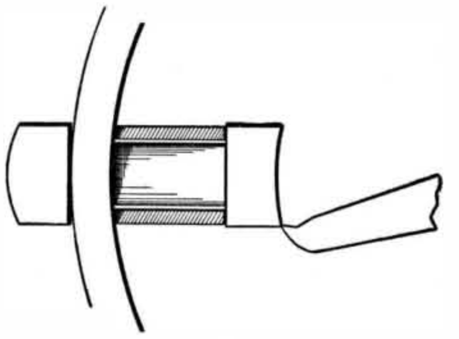

Fig. 6.

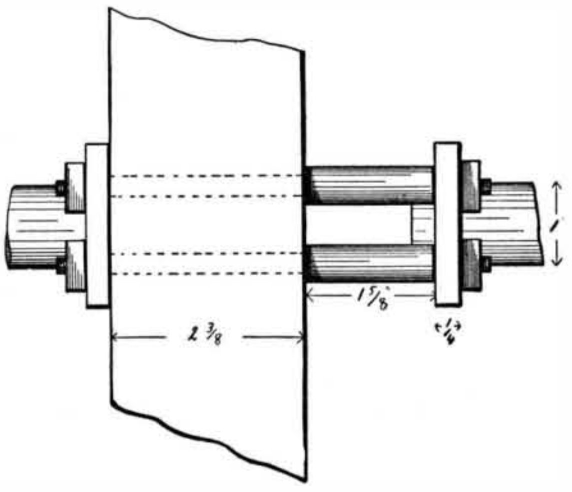

Fig. 7.

To lay off the marks for these important holes, the ring should be marked off exactly in half, by measuring with mechanic's dividers. Having proved that you have found the exact center of the ring, by the most careful measurements, a tiny hole should be made to mark the place, a similar hole marking the spot on the opposite side of the ring on the same surface. The four holes which are to carry the bolts go through the ring on each side of the marks exactly one-half inch from them, top and bottom. In drilling these holes do not attempt to drill all the way through from one side, but reverse the ring and carefully carry the marks around to the other side and go through and meet the partially completed hole. Should this not be done, the drill will surely travel a little out of the line intended for it, and trouble will surely result. The ring and bolts will have a good appearance if painted with black bicycle enamel, looking very well in combination with the brass trimmings. The base board should be given four or five coats of orange shellac, applying it top as well as bottom, in order to keep out all dampness and prevent warping tendency. The bolt heads can to advantage be cut out a little on the lathe as illustrated in Fig. 6. This will add to the efficiency of the generator for lighting and experimental purposes but is not abso-

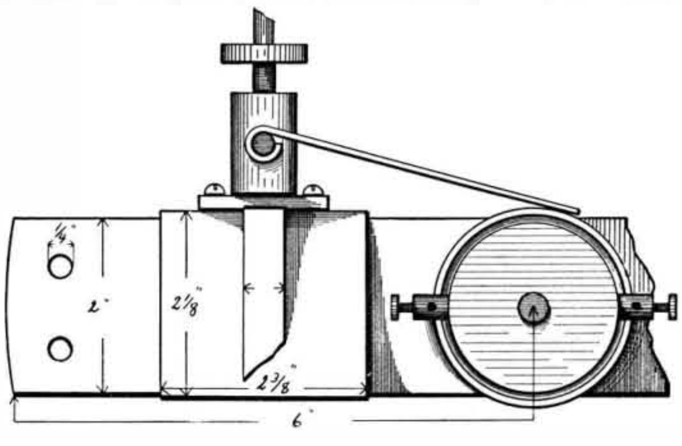

Fig. 8.

lutely necessary for medical purposes. Should a larger machine be constructed, the writer would advise the cutting out as shown. As will be readily seen, the iron bolt is passed through a piece of heavy iron pipe the exact length of the brass tube in the bobbin. The iron pipe should be as large as possible, in order to better take up the heavy strain due to the tool cutting in the lathe. They had perhaps better be all cut at the same time, using ten pieces of the pipe slipped on in the place of the bobbins. The armature described in this connection is intended for the simple smooth bolt heads, and must be cut a trifle larger than the one in the diagram if the bolt heads are to be cut out in the lathe. In cutting the bolt heads it will be evident to every mechanic that light cuts must be made, in view of the manner the work is held. Be sure each bolt head is turned perfectly square before cutting out, or the resulting curved cut will be everything but attractive in appearance.

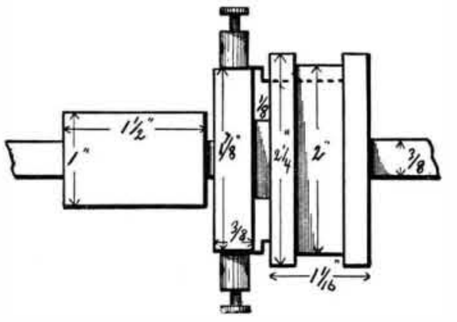

Fig. 9.

THE BEARINGS AND COLLECTOR RINGS.

The machine is now ready for the bearings, the cross pieces which support them and the collector rings. Figs. 7 and 8 show the dimensions and enlarged portions of the bearing supports. Bolts 5½ inches long are driven through the holes in the ring, leaving just enough room on the back to go through the rear bearing plate, so it may be bolted securely in place. Four brass tubes carefully cut to measure 1⅝ inches are put on the bolts in front and the second bearing support firmly clamped against them. Fig. 7 shows plainly the principle. The bearings are to be next made from solid brass rod and bored through on the lathe. Brass rod one inch in diameter is cut in two pieces 2½ inches long each and a ⅜ inch hole bored through on the lathe. The bearing plates are now taken off and placed in the lathe, in order to cut an inch hole through to receive the bearing. The bearings are to be soldered or brazed to the plates. As it is of utmost importance that the bearings should be "in line," they must not be soldered to the plates until the shaft is put through, throwing the bearings in perfect line. Should this be overlooked and the soldering or brazing be done, the chances are that the shaft would not go through the bearings at all, or else turn with a cutting and binding resistance. Having mounted the bearings to satisfaction, they can be bored through on top in order to receive small brass oil cups, which come ready made of just the size required. They can be screwed right on the bearing and are as useful as ornamental. The wooden hub which supports the collecting rings can now be made and is illustrated in Fig. 9. It is best turned from hard wood, and. being of the form shown, enables one to readily detach the armature from the shaft.

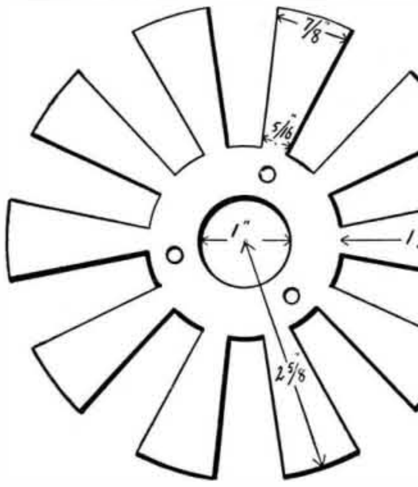

Fig. 10.

The sliding rings are easily made by sawing off the end of a piece of large seamless brass or copper tubing. The rings are smoothed down with a file and driven on each side of the hub, which must be turned on the lathe to receive them and make a good, tight fit. The binding posts are screwed in the flange turned for the purpose and are connected to the rings as illustrated. The wires had better be soldered to the rings as well as to the binding posts, to insure a perfect electrical contact and prevent their working loose when the armature is driven at the high speed of two thousand revolutions per minute. The hub shown on the extreme left of the shaft is of brass and is designed to carry the armature. The shaft is to be cut from a piece of ⅜ inch steel machine shafting. The brass and wooden hubs should go tightly on the shaft, using a mallet if necessary to drive the shaft through. Small washers will in all probability be found necessary, as no lateral movement of the shaft, armature and collector rings is desirable. The front bearing plate is now ready to be drilled to receive the little screws which support the blocks which mount the brushes and their supports. The dimension and position of the blocks is clearly shown in Fig. 8. They should be about an inch thick and have several coats of orange shellac. The brush holders are easily made from large binding posts and heavy brass wire bent at right angles where the end goes through the binding post. With a combination of a binding post and heavy wire bent as illustrated, a varying pressure of the brushes on the collector rings can be had by simply moving the long arm of the wire back and forth, or the brushes may be raised from the rings altogether, which is a very desirable thing. The connection between the brush posts and the binding posts on the front of the base is best made by using copper ribbon about ½ inch in width. The ribbon is cut and soldered together again at right angles when a change in direction is necessary. The use of copper ribbon gives a much neater appearance to the generator than connections of wire, and is to be seen on most fine dynamos. A pulley can now be turned from hard wood and have a diameter of about 2 inches and be about 2 inches in length. A couple of layers of lineman's insulating tape wound around the pulley in even layers makes the most excellent surface for the belt to run on, as there is the proper friction for the belt, and the cushion formed adds to the machine's easy and noiseless running. The brass work, if polished with the finest emery cloth, had better be protected with lacquer if the machine is to be ornamental as well as useful. Little handles of hard wood are to be turned to go on the long end of the brush rockers and be lacquered. This brings the machine to the armature, and another choice in type or construction presents itself.

THE ARMATURE.

Either a ring or toothed armature will give good results with the field just built, if only very thin soft iron is allowed to enter into the construction. The author will give only one type of armature completely worked out, and has selected the tooth type because, on the whole, it will be found the easiest to make, and prove, perhaps, a little more efficient, because the grade of Russia iron that comes in sheets is softer than the band iron used in the construction of the ring type of armature. If, after completing the toothed armature, the builder cares to experiment with a ring type, no great difficulty will be met, if band iron is procurable that has not been bent every few feet, as this seems to be the custom in packing band iron for shipment, etc. If the iron cannot be had without these sharp bends, it can be hammered out fairly well and made to answer the purpose. The band iron should be about one inch wide and as thin as possible. A wooden block should be turned in the lathe to form a drum to wind the iron on and be such a size that the iron, when wound on about ⅝ inch thick, will revolve in the field, clearing the pole pieces by ⅛ inch. The iron should be bound with small iron wire and, after giving a coat of shellac, be wound with insulation tape. The ring must be wound with ten coils of wire equidistant, each coil having a reverse direction from its neighbor. One drawback in making an armature of this type is the mounting of it on the shaft, but this can be accomplished fairly well for experimental purposes by using a turned wooden hub and mounting that. By referring to Fig. 10 the toothed type of armature can be seen. The core for this armature is made by cutting out single pieces from the thinnest Russia iron, about 60 sheets to the inch. Thirty pieces will be all we require for the present type. Copy the diagram exactly by cutting with tinner's shears, all but the center hole, which is cut afterward on the lathe. Cut out the first toothed disk very carefully, for this is to be the guiding pattern for the rest. An easy method of getting out the remainder of the disks is as follows: Cut 30 small pieces, preferably squares, from the sheet iron just large enough to make one disk, and put one disk at a time in the screw vise under the carefully cut iron pattern. It will be found a very easy method if a good sharp pair of tinner's shears are to be had. The chief care necessary is in turning the pattern and half cut blank around in the vise in order to get at the rest of the teeth. If the different disks are laid on top of each other as they were cut, no difficulty in making a smooth and symmetrical armature core will be met. That is to say, a tooth on a disk, cut from a given tooth on the pattern, should be laid on its neighbor's which was also cut from the same tooth on the pattern. This is important and must not be overlooked. The core is now ready to receive shellac. Each disk must have a coat, and a piece of tissue paper pressed on before it has become hard, before the disks are permanently put together. Two iron washers must be placed on each side of the core to act as cheeks and stiffen the pack of disks when the whole is bolted together. Fig. 11 shows one of the iron washers in place. Having placed the disks and washers as evenly as possible, they should be firmly clamped in an iron machinist's vise and the holes for the bolts put through. After bolting together and screwing up as tightly as possible, the core must again be placed in the vise and all unevenness smoothed down with a flat file. The core is now ready to have the hole cut through the center by chucking the core by the ends of the teeth in the lathe. The core must be perfectly centered, and all usual centering tests must be made before a single cut in the center is made. Use a sharp tool and cut out a one inch hole through the cheeks and disks.

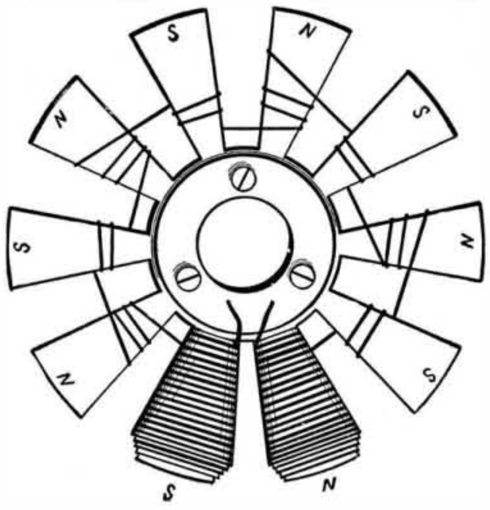

Fig. 11.

The core must now be mounted on a lathe mandrel and the edges of the iron washers turned up true. The ends of the teeth are too thin to stand the strain of cutting or truing in the lathe, and must be carefully made of equal length by filing with a flat and fine file. The armature should not be cut away on the teeth any more than possible, as the nearer the ends of the teeth approach the field poles, the more efficient will be the machine. A keyway is made in the brass hub by chucking in a metal planer, if possible to have the use of one. The keyway in the hub to receive the locking key is easily made with the file. The core is now given five or six coats of shellac, each coat being allowed to thoroughly harden before the next coat is applied. This is a matter of extreme importance, as a poorly insulated armature is worse than none at all. Just before the last coat of shellac becomes set, each tooth of the core is covered with heavy pieces of cotton or silk remnants. This is also very necessary in order to keep the insulation of the wire away from the sharp turn made at the edge of each tooth. This silk covering is given a final coat of shellac before the operation of winding on the wire begins. Wind on the wire carefully and neatly as follows: Commencing from the bottom of any tooth on the core, wind No. 22 double cotton wrapped magnet wire on in four even layers. Each layer must be closely wound and a coat of shellac applied between each layer. Having completed one tooth, its neighbor must be wound in the reverse direction as illustrated in Fig. 11. No bobbins or spools are necessary to hold the wire on this core, as the shellac, after hardening, is all that is necessary to keep everything in place. The shape of the teeth, in addition, tends to keep the wire in place, and will prevent its flying off when under the centrifugal strain. Each layer on a given tooth is a trifle shorter than the one under it. The reason is obvious, not to speak of the neat appearance it gives. When the winding is completed, give the whole three or four coats of shellac and do not test the armature under high speed until the shellac has become perfectly hard in every sense of the term. The author had the misfortune to try the armature when the shellac was nearly hard, and, on stopping the machine, found long needles of shellac that had made their way to the surface oozing out in all directions. This armature when in condition to run without disturbing the shellac

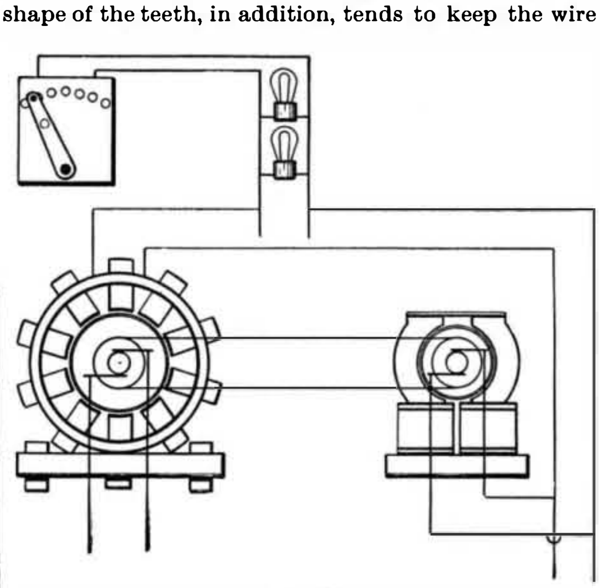

Fig. 12.

will be found efficient for lighting lamps and for furnishing a delightfully even and, if one may say, smooth current for the treatment of patients. It is hardly necessary to point out the connections between the two free ends of the armature and the collector rings before going to the method of connecting the generator to the electric lighting mains. Fig. 12 illustrates the plan of connections. As each lamp is added between the mains the field of the generator becomes more strongly magnetic. For some cases where the machine is desired for medical use the current delivered when one lamp is in circuit will be too strong. This represents a current strength of about one-half ampere going around the fields. If two lamps are put in series across the mains and connected with the fields, a much weaker current will be delivered from the machine. If a rheostat is introduced into the field circuit having a greater resistance than several lamps as a maximum, the current from the generator can be regulated to a nicety. There is absolutely no danger of the current from the electric lighting circuit getting into the armature of the generator and doing any damage to patients, but it must be remembered that the generator just completed is capable of shaking one up just as effectually as the main line, if a strong field and a high speed are put in combination.

Honey and Bee Keeping.

BY GEORGE E. WALSH.

Half a century ago honey was considered a luxury, and the market was supplied by the professional bee hunters, who made a precarious living in locating the natural hives of the bees in some old rotten tree right in the midst of the thick forest; but to-day, 30,000 bee keepers vie with each other to supply us with all the varieties of delicious honey that we are willing to pay for, and at prices within the reach of every one. To the average consumer, probably, there seems to be no difference in the honey that comes to the market, but, if he should enter a large grocery store and examine the stock, he would find that modern beekeepers have created just as many grades and kinds of honey as the pomologist has produced varieties of apples or pears. There is, first, the great division between comb honey and extracted honey; then comes white clover honey and buckwheat honey, one dark and the other light in color; and between these two extremes in color come half a dozen intermediate shades. Another distinction is made in the relative thickness and specific gravity of the honey. One variety will be light and thin, while another will be thick and heavy as old molasses. Some of the honey is labeled as fruit blossom honey, another class will be honey made from basswood and linden blossoms, and other varieties as early spring honey, summer honey, late fall honey, diluted honey and pure strained honey. In this classification of honey there is an attempt to separate honey made at certain seasons of the year from that made later or earlier, and also to keep the honey made largely from one kind of blossoms from all other grades. It is a notorious fact that buckwheat blossoms do not make as fine, delicate and aromatic honey as the white clover blossoms, and some consider the honey produced from the fruit blossoms of early spring superior to that of white clover. Of course, men of many tastes will differ, and probably there will never be a time when all will agree upon the best variety of honey.

Bee keeping has become an interesting and extensive business in this country, and in the spring and summer of the year there is widespread activity among these professional apiarists. California leads all the other States in the number of its bee keepers and in the quantity of honey raised for market; but many of our Northern States follow close behind her. The South is just awakening to the advantages of her climate and products for bee keeping. Florida sends a fair amount of honey to market, but it does not equal in quality or quantity the honey that is raised in the North or on the Pacific coast.

In our Northern States the bees gather most of their nectar from the white clover blossoms, the basswood tree, goldenrod, fruit blossoms and buckwheat. In California the fruit blossoms, wild flowers, white sage, sumac blossoms and alfalfa clover supply the bees with most of their sweets. In the great middle West the sage brush furnishes limitless food for the bees and makes bee keeping profitable.

In regions where bee keeping is being overdone, the apiarists even plant crops for their colonies to live on, and it is not unusual to see farmers raising fifty acres of white clover in the spring and buckwheat in the fall to supply their bees with nectar, the crop of grass, hay and grain being only an incidental feature of the harvest. Fruitgrowing and beekeeping go together so well that most apiarists are now planting fruit orchards on their bee farms, and, in seasons when one fails, the other is pretty sure to yield some profit.

The bees have luxurious quarters to-day compared with those of twenty years ago, and the bee keeper, by means of modern improvements, can handle more colonies successfully and obtain more honey from each one than the pioneers in the industry ever dreamed of. In 1852 a clergyman named Langstroth, living in a small town in Ohio, invented and patented a hive which revolutionized bee keeping. The hive, after all, was quite simple, and it seemed strange that nobody had hit upon the idea before. It consisted of a square box with eight movable frames inside and a movable cover on top. By means of this patent hive the apiarist could look in and see what the bees were doing any time, and the whole thing could be easily taken apart and cleaned. Then somebody invented an artificial comb. It usually took the bees about half the honey-producing season to make the comb, but by making artificial combs and inserting them into the hive, the insects began to fill them with honey immediately. Then when one comb was full it could be removed, and a new one put in its place. The honey extractor came next. This would extract the honey from the combs, without loss, in a few minutes.

One invention after another followed, but these three important ones were the direct means of increasing the yield of an ordinary hive from 50 pounds of honey to 100, and even to 500 pounds in one season. In California it is quite common to get 500 pounds of extracted honey from one hive, and the bees are kept busy all through the long season in filling the combs with nectar just as fast as they are emptied. In addition to this large marketable yield, the bees generally raise enough to keep them through the winter.

The methods of keeping and handling the bees have all changed in recent times. In the matter of wintering the bees, the change has all been for the best. Formerly half of the colonies died in winter, but to-day very few deaths occur in the hives that are properly prepared for the cold weather. In the South the bees can be kept in the summer stands through the winter; but in the North they are wintered in cellars, caves, sheds, and occasionally in winter-protected hives in the orchard. The favorite method is to construct a bee cellar, where several hundred hives can be kept at once. These hives are stacked in tiers, one upon another. A thermometer in the cellar enables the apiarist to keep an even temperature in the room, and all through the winter he carefully watches the condition of his bees.

In the early spring the bee keeper goes from hive to hive and counts up the losses that have been inflicted upon his little hosts during the winter. In spite of his utmost care in wintering them, there will be many to die from bad ventilation, diseases, and even the cold. Like a general after a battle, he does not know his losses until the roll has been called. If the queens are all right, he is greatly relieved in mind; but if the queen is missing in any colony, there is danger at once. A new queen must be introduced in the colony, or the colony must be united to another with a queen.

Queen bees are introduced now in a novel way. There are regular queen cages, into which the queens are placed, and one end is stopped up with sugar. The cages are put into the hives next the bees just over the cluster. In a short time the bees discover the presence of the queen, and they begin to eat through the sugar paste to liberate her. They deceive themselves then into the belief that they have hatched out a new queen and joy follows in the hive. If the apiarist attempts to force a queen into the colony in any other way, the bees are very likely to resent the intrusion and sting her to death.

The bee cage was invented to transport the queens through the mails, and also for the purpose of introducing foreign queens among our ordinary bees.

A number of years ago it was found that our semi-wild bees could be greatly improved by introducing among them pure Italian or Carniolan queens. Italianizing our common black bees has gone on apace ever since, and most beginners are advised to begin with these queens. They produce much larger bee workers, and in some respects they show great improvements upon the common insects. The pure German or Carniolan queens are the gentlest, hardiest and most industrious of all bees; and there is just at present as widespread an attempt to Germanize our common black bees as to Italianize them. There are followers of both schools, and neither one will admit that the other is as good as the one they represent.

The cost of establishing a colony of bees depends a good deal upon the kind of bees one secures. A good colony of pure Italian or Carniolan costs from $6 to $8; but our common black bees can be obtained for half this price. It is a question, however, whether, in the end, they would not be more expensive than the improved bees.

Like poultry and eggs, the most of our honey comes from small farms, where the apiarist owns from one to five colonies. But, on the other hand, there are many big bee farms in this country. It is not uncommon to find farms in our Northern States where 500 to 1,000 hives are kept. From one of these farms 20,000 to 50,000 pounds of honey will come in one season. In California, a few bonanza bee keepers own as high as 5,000 colonies each, and they will ship nearly 75,000 pounds of honey from the place in one year. One man in San Diego County, last year, shipped 150 car loads of honey.

Bee keeping has been called the poor man's business, because, no matter how poor one is, he can always keep bees and make a little extra money.

The bees gather their nectar from far and wide, and, as they are no respecters of neighbors' rights, they will rob the honey from the fruit blossoms of the next orchard to put money in the pocket of the poorest farmer. They require little labor and less expense to keep them, and, in return, they store away enough honey to supply the table with many delicacies.

There are regular bee keepers' associations and clubs established all over the country, and at their regular meetings they read papers of a practical and semi-scientific nature. There are several weekly and monthly papers devoted exclusively to the business, while nearly every agricultural journal gives some space to a bee department.

The apiarists have had their share of trouble, and it is only in co-operation that they obtain their rights. Adulteration of honey has been one of the obstacles in their path, and they have persisted in exposing such tricks to the consumers. The comb honey cannot well be adulterated, but strained honey, sold in glass jars, has been widely and extensively adulterated. The adulterations are made of cheap sweets, such as glucose and cane sugar, and in some instances, only 25 per cent of the mixture was honey.

The Agricultural Department, working in the interests of the bee keepers, made searching investigations, and disclosed the fact that the adulterations were done largely by wholesale dealers, and not by the apiarists. Some law to prevent adulteration of honey is now passed in nearly every State.

A few years ago the honey interests of the country were threatened with injury by the reports that poisoned honey had been placed upon the market. The honey in question was said to have come from the regions around the Allegheny Mountains, where the mountain laurel, or Kalmia latifolia, abounds. The bees gathered most of their nectar from the flowers of these plants, which are said to be poisonous. If the bees were so indiscriminate as to gather their honey from poisonous flowers, it would be a pretty serious matter. But the fact is, there has never yet been an authentic case of death due to eating poisonous honey. There have been cases of sickness caused by indulging too freely in this sweet article of diet; but that is nothing more than can be expected. Over-indulgence in candy or any other sweet thing will cause similar sickness. Taken in moderate quantities, honey is considered by most physicians as a desirable and healthful article of diet, and its increased supply and cheapness are really benefits to the human race.

Mr. Eddy's Vistascope.

Mr. William A. Eddy, who has a well deserved reputation for his experiments in kite making and flying, has devised what is termed a "vistascope"—an instrument which enables persons on the ground to view the surrounding country with almost the same effect as if they were at the elevation of the kite. The vistascope looks something like a huge magic lantern. It is designed on the lines of the ordinary camera obscura, but the pictures are thrown from a mirror set in the top upon a sheet of semitransparent paraffine paper. This does away with the reversed effect of the ordinary camera obscura.

By lying on his back with his feet toward the view to be seen, the observer sees the landscape stretched before him in its proper condition. There is, moreover, a peculiar effect of being in the air on a level with the vistascope and looking out over a level stretch of country. The apparatus recently used by Mr. Eddy measured 5 × 2½ feet and was carried up by a team of Eddy kites reinforced by a Hargrave box kite. The vistascope was sent up to a height of 150 feet. Mr. Eddy lay flat on his back with a powerful field glass and looked up at the reflector of the camera obscura. He was able to see objects with great clearness; houses and trees a mile and a half distant were distinctly seen. The kite cord was let out until the vistascope was 300 feet in the air, but the trials were less satisfactory, because of the swaying of the kite line, which rendered it extremely difficult to follow the motion of the apparatus with the field glass.

Return of the Jackson Expedition.

The steamer Windward from Franz Josef Land was spoken off the coast of Scotland on August 28, and it was reported that all were well. This expedition was fitted out by Mr. Harmsworth and was commanded by Mr. Jackson. The vessel sailed three years ago. The first two years' work of the party was very successful, although it did not succeed in making the Franz Josef Archipelago a basis for a dash on the North Pole. This was a part of Mr. Jackson's provisional programme—to prove that the existing map of that Arctic outpost is very erroneous; and his work, together with the drift of the Fram, proved that the islands do not extend as far toward the pole as it was formerly surmised. The collections made the first two years of the expedition were important, and it was Jackson who met and succored Nansen and Johannsen when they were on their way to Spitzbergen over the ice a year ago.