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## THE BRUSH ELECTRIC COMPANY'S NEW ALTERNATING-CURRENT SYSTEM.

THE end attained in the system of long-distance transmission of electrical energy illustrated herewith has been reached by an abandonment of the long-traversed routes already familiar to the public. A glance at the dynamo (Fig. 1) shows that it is compact, simple, and symmetrical. An examination shows that it is of the alternating type; that its field-magnets are many, and carried by the shaft; that the armature is fixed, and absolutely free from any magnetic material; that its parts are easily accessible; and that

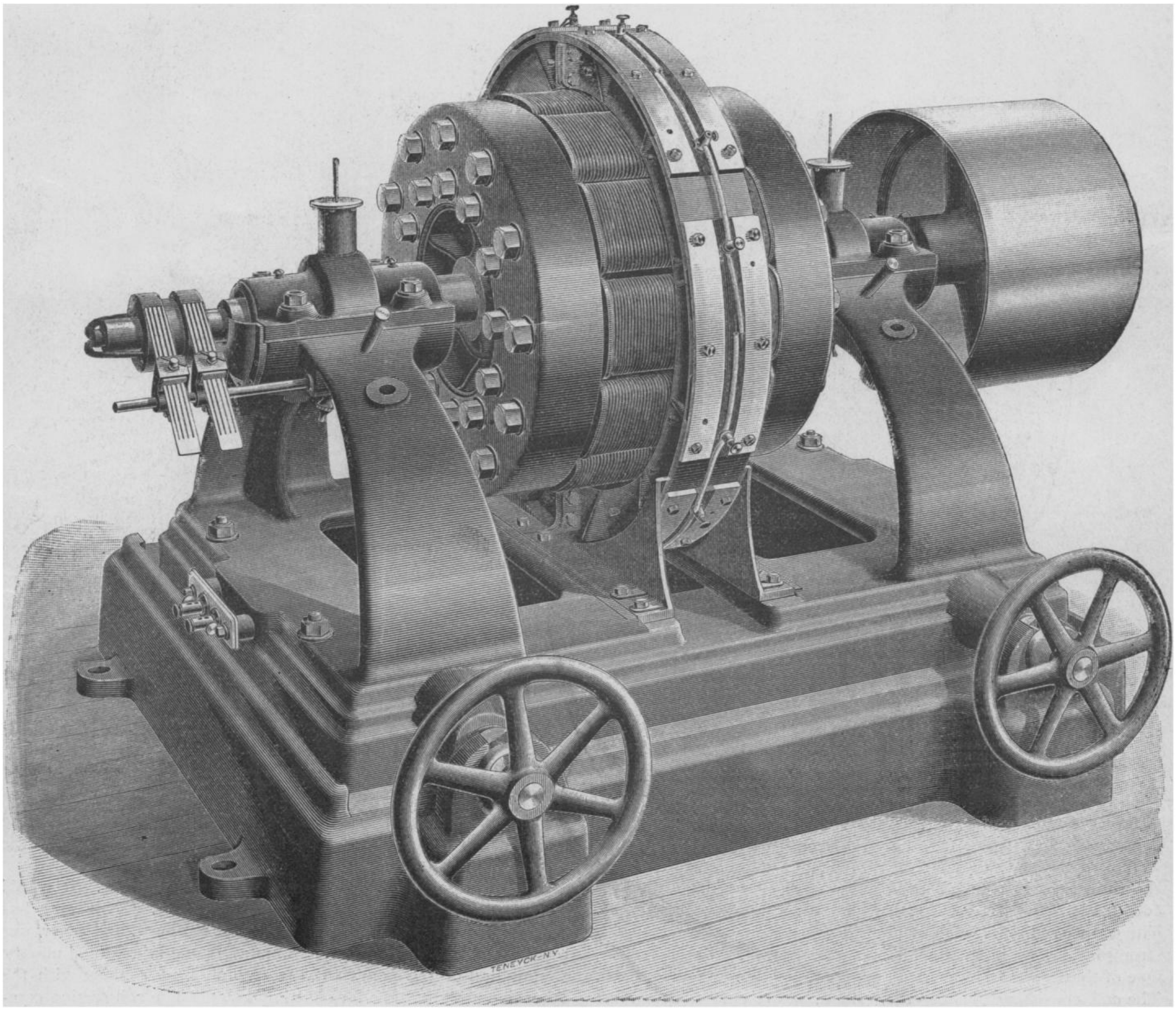
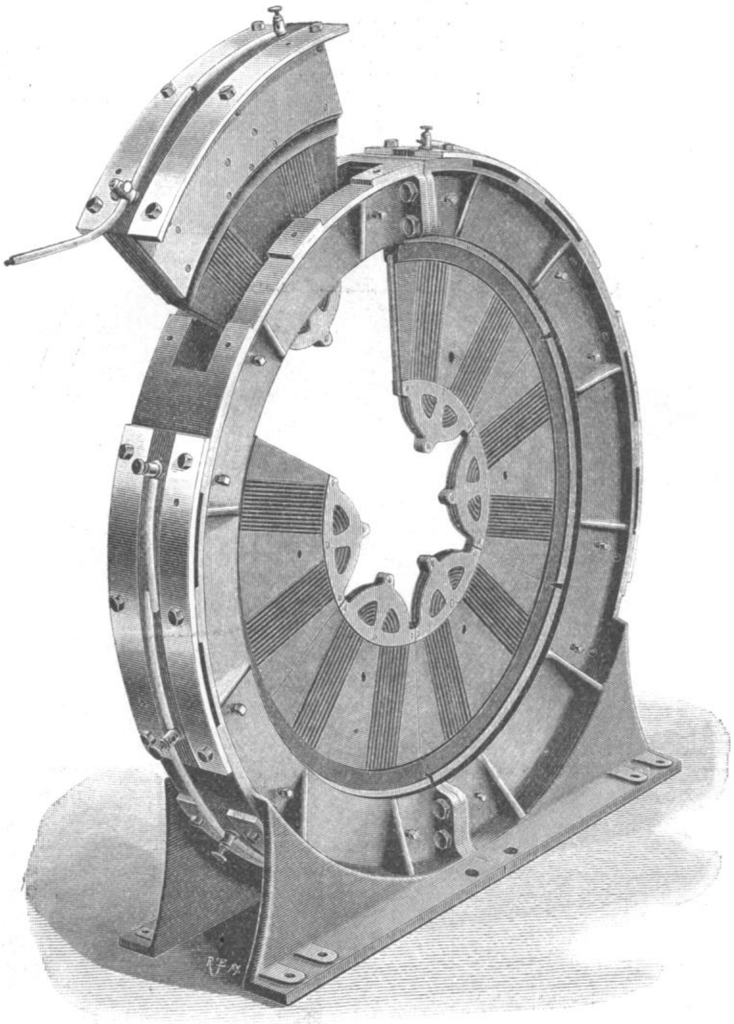


FIG. 1.—NEW BRUSH ALTERNATING-CURRENT DYNAMO.

an armature-coil may be cut out, removed, or replaced without stopping the machine. The machine illustrated has an output of 60,000 watts, and supplies current for a thousand 16-candle-power lamps.

The underlying principle of the "coreless" dynamo here illustrated was discovered and applied by Mr. Brush more than ten years ago, and new demands have now called for its extended application on a regular scale.

The shaft bearings, bearing standards, base plate, and armature-slides are cast in one piece. The shaft carries two heavy cast-iron yoke-pieces 27 inches in diameter. To each of these are screwed, at equal radial and circumferential distances, the wrought-iron cores of 12 magnets of alternating polarity. Thus the whole rotating mass acts as a fly-wheel, tending to neutralize any variation in the speed of the prime generator. As the nominal speed of the machine is less than 1,100 revolutions per minute, the structural strength is more than sufficient to meet all demands made by centrifugal force. Further than this, the mechanical stress is less when the magnets are excited than when the alternator is running without load, as the lines of magnetic force between the faces of opposing poles tend to counteract centrifugal force. In machines of larger size, as usual, the speed is less, that of the 150,000-watt dynamo being not more than 700 revolutions per minute.



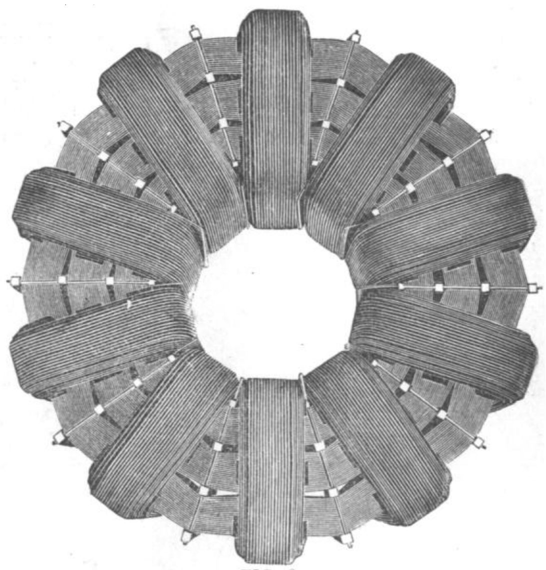


FIG. 6.

FIG. 2. FIGS. 2, 6, AND 8.— BRUSH ALTERNATING SYSTEM. FIG. 8.

The most interesting part of the alternator is the fixed armature, shown in Fig. 2. The vertical disk is occupied by flat armature-coils made of insulated copper ribbon wound on porcelain cores. The copper ribbon of each coil is re-enforced on either side with strong insulating material of the same thickness as the porcelain. One of these re-enforcements is grooved, and the other tongued. The coil, consisting thus of core, ribbon, and re-enforcements, has an angular width of 60 degrees. The upper part of each face of each coil is covered with an insulating plate five-sixteenths of an inch thick. The coil thus built up and insulated is set in German-silver holders, cut from turned rings, and held together by sunk-headed screws. Each terminal of the copper ribbon connects with a binding-post, as shown.

The six armature-coils thus mounted are carried in a German-silver frame consisting of two semicircles bolted together on the line of the vertical diameter. Into the slots of the frame slip the six mounted armature-coils, the tongue on the edge of the one engaging with the groove on the edge of the next. The coils thus thrust into the intense magnetic field constitute a disk nine-sixteenths of an inch in thickness, and with an opening in the centre through which passes the revolving shaft. As there is no magnetic metal in the armature, there are no local currents to waste the energy.

The several coils are insulated carefully; and the stationary armature, as a whole, is insulated from the bed-plate on which it rests. The coils are joined in series, the binding-posts adjacent to any radial line of division between the two coils constituting fixed terminals for the main line. There is no commutator, and there are no collecting brushes to take the alternating current from the rotating parts.

The low resistance of the armature-coils is evident. It would seem impossible for one of them to burn out. None ever has burned out; but if one should, it may be removed, and a new one readily put in its place, in three minutes, or the injured coil may be shunted out of the circuit and the dynamo kept running with the other five until the time for shutting down. The coil section complete weighs only about 20 pounds. The whole armature may be removed by loosening the coupling-bolts, and sliding each half of the frame from between the field-magnets (Fig. 3).

In action, the 24 field-magnets of the alternator are excited by the direct current from a Brush dynamo of the well-known form. This exciting current is carried to the brushes that rest upon the two uncut insulating rings (shown at the left of Fig. 1), and thence through the hollow shaft to the magnets. A rheostat (Fig. 4), worked by hand or automatically, is placed in the shunt circuit around the field-magnets of the exciter; so that perfect regulation is secured without re-adjustment of the brushes, or any necessity of handling the high-tension alternating current.

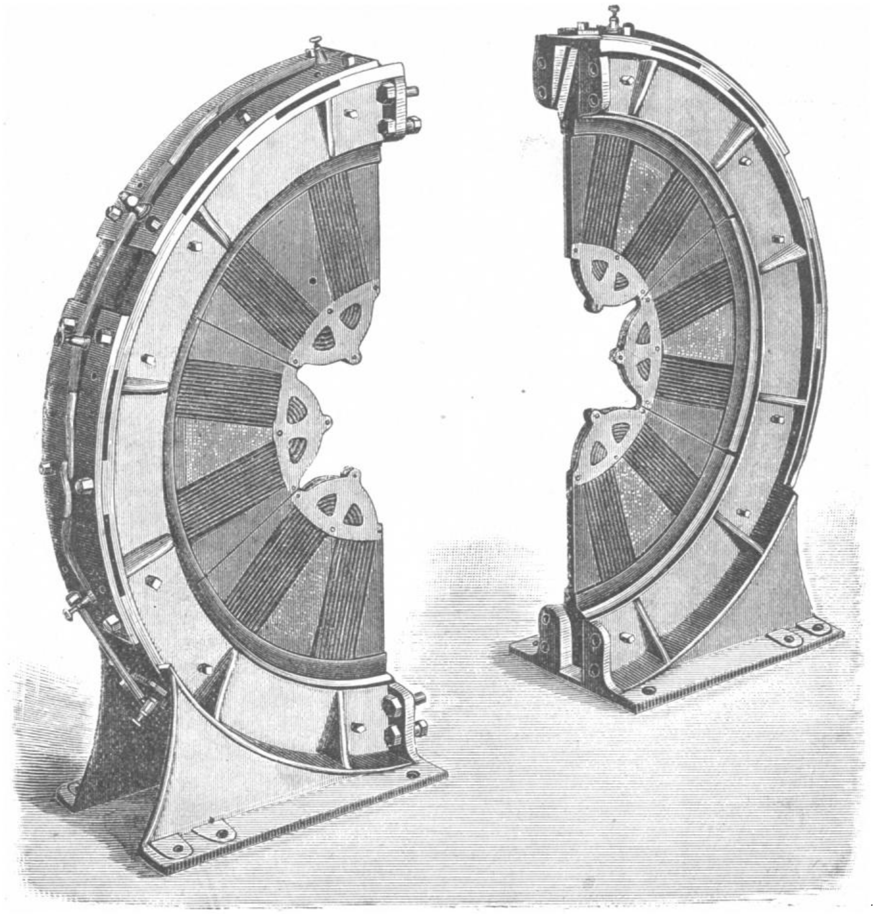


FIG. 3.—BRUSH ALTERNATING SYSTEM.

The Brush "coreless" alternator is built at present for an electro-motive force of 2,000 volts, although it would be easy to develop a much greater difference of potential. It is confidently expected that the necessity of long-distance transmission with a line of moderate cost will soon call for currents of higher tension, as economy of power as well as economy of copper point in this direction.

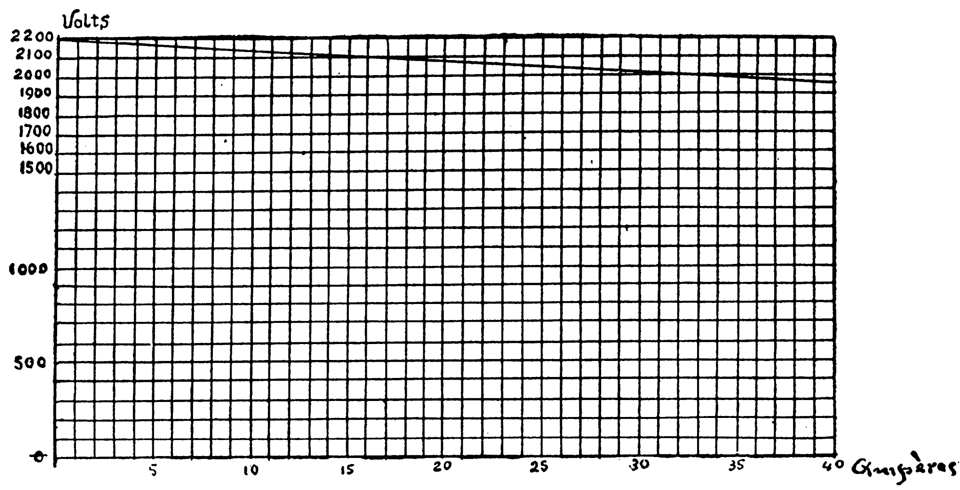



FIG. 5.—BRUSH ALTERNATING SYSTEM.

The fall of the potential in the machine from no load to full load is less than ten per cent, as is shown in the curve, Fig. 5, which represents a diagram taken from one of the first machines. All this is accomplished without compound winding or artificial regulation of any kind,—a result which, it is claimed, has not been approached by any alternator with an iron core in its armature. All the regulation needed is applied at the exciter, as already described. This results in a more even distribution of potential in the feeders and at the converter terminals, and a more even pressure at the terminals of the lamps beyond.

Though the high-tension current of the alternator is well adapted for economical carriage to distant points, it is not of the kind most desirable for introduction to the household, or for use in the lamp. Having brought electric energy from the place where it is developed to the place where it is to be used, the form given to it for economy of transportation may be changed so as to adapt it fully to the uses for which it is intended. High tension may be exchanged for greater current, volts for ampères. This transformation is accomplished by the converter shown in Fig. 6. In this converter, the core consists of a polygonal ring made of insulated iron wire, so wound as to leave several concentric air-spaces in the core. In the converters of the smaller sizes, the core is built up of

FIG. 4. — BRUSH ALTERNATING SYSTEM.

perforated thin iron plates (Fig. 7). In either case, the iron is so divided that the efficiency of the converter is little less with half than with full load. Upon each side of this core or iron ring is wound a single layer of heavy copper wire. The four or five single-layer coils carried by each half of the core are joined in series; and the two groups, borne by the two halves of the core, are joined in multiple, the whole constituting the secondary coil. The terminals of this secondary coil connect with the secondary main line running into houses and supplying current for the lamps. Most of the converters are wound so as to give a secondary current of

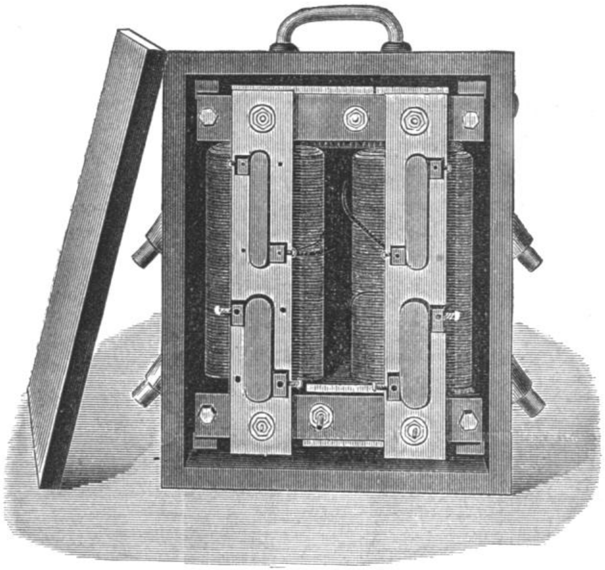


FIG. 7. — BRUSH ALTERNATING SYSTEM.

about 100 volts, but may instantly be connected to give 50 volts and twice as many ampères as before. They are made in sizes that supply each from 5 to 250 16-candle-power lamps, or more.

Between the fine iron wire of the core and the heavy copper wire of the superposed secondary coil, insulating pads one-eighth of an inch thick are placed at the corners of the core. Between these insulating corner-pieces are insulating air-spaces. Thus the copper and the iron are separated from each other at the corners of the core by their respective coverings and the insulating pads, and at all other points by their respective coverings and open air-spaces, the latter affording ample ventilation and facility of examination.

Over each of these single-layer parts of the secondary coil are bound a few layers of smaller copper wire to form a corresponding part of the primary coil. These corresponding parts of the secondary and primary coils are separated from each other by insulating pads at the corners and intervening air-spaces in the same manner and with the same advantages as previously described.

The ventilation of these converters is specially provided for, and the insulation resistance is exceedingly high. It is impossible to so overload the wire of the primary circuit as to force its current into the secondary circuit: in other words, the high-tension current cannot pass the converter. The converters are tested at the factory with double load, and, though no one has ever given out, overloading is made impossible by the use of safety-fuzes for the primary coils. These are extra long, and so mounted on slate or porcelain strips that they may be removed or replaced with the fingers merely, and without touching any metallic part of the converter.

The converter-coils, with safety-fuzes, etc., are placed in wind and weather proof cast-iron boxes of pleasing design (Fig. 8), and may be placed wherever most convenient; the governing

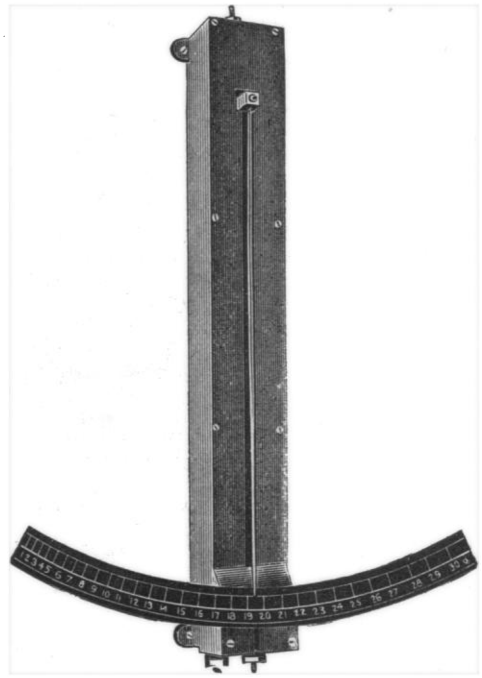


FIG. 9. — BRUSH ALTERNATING SYSTEM.

principle being to do as much work as possible with the less expensive primary wire, and to shorten the more costly secondary main. These converters are now made in sizes ranging from 2-lamp to 250-lamp capacity. With converters, as with dynamos, the larger sizes are the most economical. With a 100-volt converter fed by a 2,000-volt primary current, it is more easy and profitable to run a short secondary main to supply several consumers than to provide a converter for each consumer.

Fig. 9 represents the ammeter, which is placed in the main or feed circuit, wherever it is desirable to measure the strength of the current. It is a compensated expansion device, acting on the principle of one type of Brush arc lamp. It is free from any magnetic action, the simple compensating arrangement insuring the normal working of the apparatus at all temperatures. It is equally efficient with direct and with alternating currents.

The alternating-current apparatus of the Brush Electric Company here described is based on the patents of Charles F. Brush and Gustav Pfannkuche, the latter having the supervision of this branch of the Brush Electric Company's business.

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THE heat in Russia and other parts of northern Europe has been intense of late. The Central Observatory at St. Petersburg has not recorded such a high temperature at the same time of the year since 1774.