R. V. MORSE.

HOMOPOLAR MAGNETIC CIRCUIT.

APPLICATION FILED SEPT. 13, 1917.

1,327,349.

Patented Jan. 6, 1920.

FIG. I.

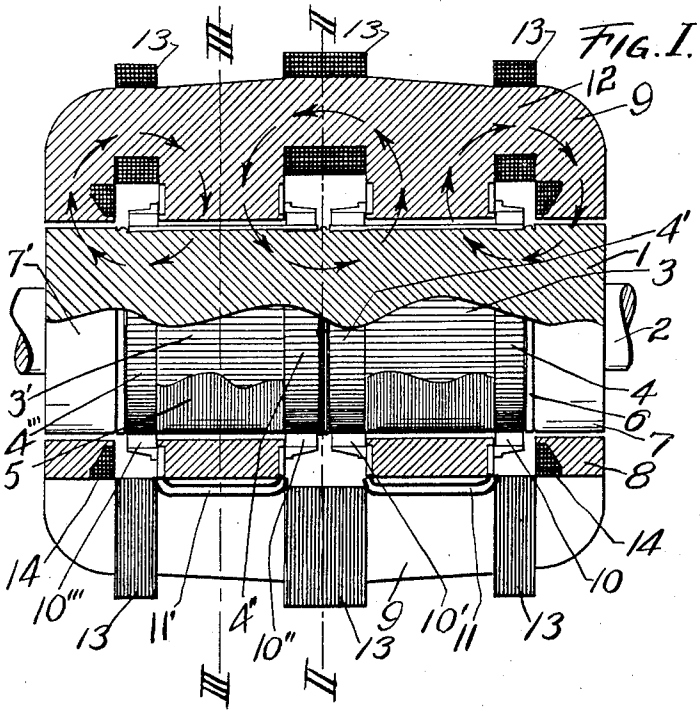


FIG. II.

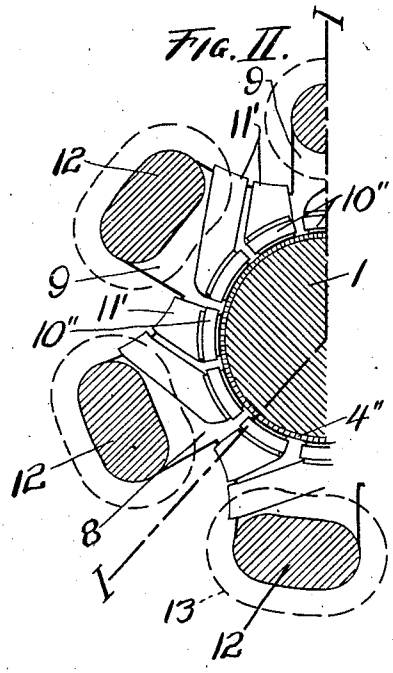


FIG. III.

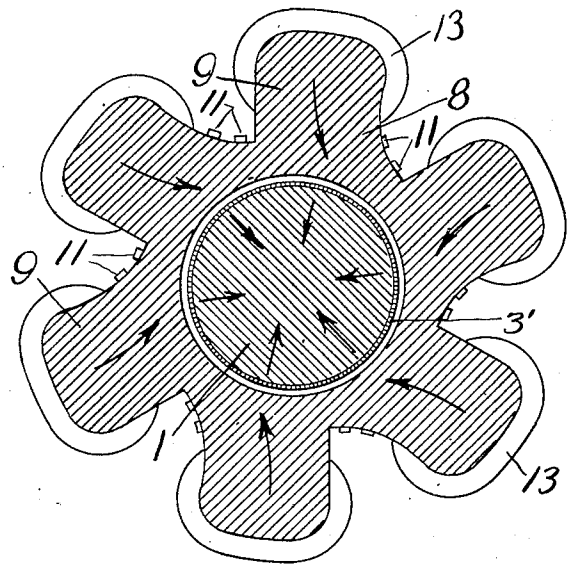
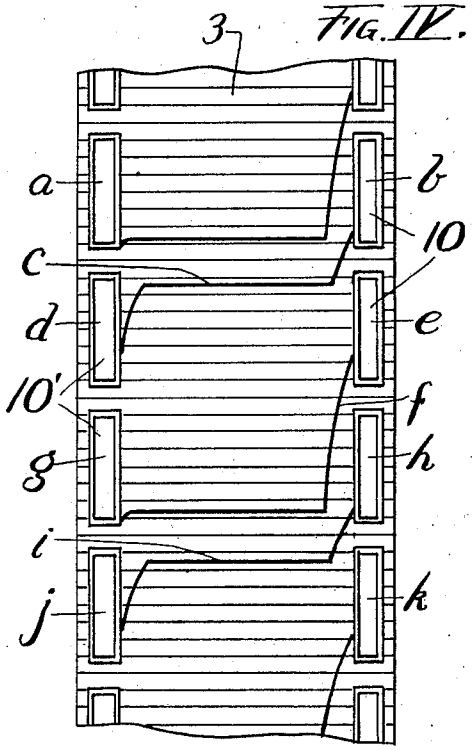


FIG. IV.



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HOMOPOLAR MAGNETIC CIRCUIT.

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To all whom it may concern:

Be it known that I, ROBERT V. MORSE, a citizen of the United States, residing at Ithaca, in the county of Tompkins and State of New York, have invented a new and useful Homopolar Magnetic Circuit, of which the following, taken with the accompanying drawings, is a specification.

This invention relates to dynamo-electric machines of the homopolar type,—particularly to the magnetic circuit in such machines,—and has for its objects the attainment of a lighter and more compact field magnet structure while maintaining a substantially uniform flux distribution in the active areas of the homopolar fields.

In the drawings forming part of this specification, Figure I is a longitudinal cross-section, partly in elevation, on the line I—I of Fig. II, showing a homopolar machine and one view of the magnetic circuit.

Fig. II is a cross-section on the plane II—II of Fig. I.

Fig. III is a cross-section, on a smaller scale, taken on the plane III—III of Fig. I,—showing another view of the magnetic circuit.

Fig. IV is a diagram illustrating one method of connecting the brushes.

As shown in the drawings, the cylindrical armature 1 mounted on the shaft 2, has on or near its cylindrical surface two belts or zones of conductor bars 3, 3′, each zone extending entirely around the armature and being made up of a large number of the armature conductors extending axially. Bordering at each side of each armature conductor zone 3, 3′ is a belt of collector segments 4, 4′, 4″, 4‴, similar in appearance to commutator segments, though the operation of the machine does not involve commutation. Each armature conductor bar 3, 3′ has at each end a separate collector segment 4, 4′, etc., all being insulated from the armature core and from each other.

The armature conductors 3, 3′ are generally concealed under binding wire 5, shown partly torn away in Fig. I in order to reveal the armature conductors beneath. The collector segments 4 are held in place by the locking means 6 which allows them to be readily replaced in case of wear without dismantling the machine. The outer ends 7, 7′ of the armature core 1 are generally left bare.

Surrounding the armature and extending substantially the full length thereof is the field structure 8. This field structure 8 is characterized by a number of lobes or risers 9 extending in the manner of large ridges or corrugations longitudinally of the machine. The machine illustrated in the drawings has for example six such risers 9. The bases of these risers 9 spread out and join each other some distance outside of the armature face, so that the armature 1 is completely encircled by the field structure in the region of the zones 3, 3′ and the end faces 7, 7′, as illustrated in the lower half of Fig. I where these encircling rings or annular pole faces of the field structure appear in cross-section. In the region of the collector segments 4, 4′, 4″, 4‴, sets of brushes 10, 10′, 10″, 10‴, are arranged,—each set of brushes encircling the armature as shown in Fig. II, the spaces between the brushes being only sufficient to prevent short-circuiting through a collector segment. Connecting the brushes 10 at one side of a zone 3 to the brushes 10′ at the other border thereof are the stationary conductors 11. Similarly for the other zone 3′ the stationary conductors 11′ connect the brushes 10″ and 10‴. These stationary conductors may be arranged to connect the brushes of a zone in series, as shown in the diagram Fig. IV. Thus for example the current might enter the armature conductors 3 through the brush *a*, pass through the armature conductors 3 to the brush *b*, and out from the brush *b* through the stationary conductor *c*; into the armature conductors again through the brush *d*, out at the brush *e*, back through the stationary conductor *f*, and so on.

The spaces occupied by the four sets of brushes, 10, 10′ and 10″, 10‴, form three continuous channels in the field structure encircling the armature,—the two brush sets 10′, 10″ in the middle lying in a channel of double width. These brush channels are accessible through where they open into the hollows between the risers 9, and the brushes may thus be inspected and adjusted. The risers 9 themselves, or the outer parts thereof, bridge over the brush channels as shown in the upper part of Fig. I, forming the bridges 12,—shown in cross-section in Fig. II. These bridges are necessary to complete the magnetic circuit, which goes in general from the armature to the pole face, then up through the riser 9, across through the bridge 12, down through the

riser 9 to the pole face, and into the armature again at the other zone, and then longitudinally through the armature core to the zone from which we started. The magnetic circuit is the same in each of the risers 9 of Fig. II all around the armature, and is indicated by the circles of arrows in the upper half of Fig. I. This gives a homopolar field (*i. e.*, of the same polarity all the way around the armature), at the armature zone 3, and a second homopolar field of opposite polarity for the zone 3′. The direction of the magnetic flux on the plane III—III is shown for example in Fig. III,—where the arrows pointing inward from all sides indicate the magnetic flux in the zone 3′. Conversely, the flux would be outward at all parts of the zone 3. The flux in the armature core lies in general in axial planes as is charactertistic of all homopolar machines,—instead of in radial planes as in the ordinary bi-polar or multi-polar types. The two outer magnetic circuits indicated in Fig. I supplement the middle magnetic circuit, combining with it to give broad homopolar fields permitting longer armature conductors in the zones 3, 3′ than would otherwise be desirable. The magnetic circuits may be energized by the exciting coils 13 around each of the bridges 12, or by single coils 14, 14 embedded in the field structure 8 and encircling the armature 1.

As the armature is rotated, the conductors of the armature zones 3, 3′ cut the magnetic flux of the homopolar fields, generating an electro-motive force which is constant in direction throughout each zone. When an external circuit is completed, the current then flows through the armature conductors, brushes, and stationary conductors, in the manner described.

The arrangement of the field and armature circuits described are treated more particularly in the Patent No. 1,271,061, for dynamo-electric machine, granted to me July 2, 1918, and the particular improvements herein claimed relate to the field structure of the machine. Since an exciting coil encircling the armature will produce homopolar fields, the leads from the brushes can also be made to act as an exciting coil, by inclining or extending the leads so that the current in them flows in the same general direction as in the exciting coil. Such an inclination of the leads is shown for example in Fig. II, all extending in the same way because the current flows in the same direction in them all. The leads going down to the brushes at the other side of the armature zone extend the same way, since the current there flows to instead of from the brushes, thus giving the opposite flux direction there desired.

It has been known that the leads of a homopolar machine, if extended in the direction of an exciting current, would make the machine to some extent self exciting, thus aiding or supplanting the regular exciting coils. My invention herein described goes further and utilizes, not only the inclined leads which extend in planes generally transverse the machine as in Fig. II, but also uses the stationary conductors 11 extending longitudinally of the machine and connecting the inclined leads,—that is, the conductors which extend in general parallel to the axis of the machine from one brush channel over to another brush channel.

It will be observed that the flux which passes as a unit through the armature core in the plane II—II for example, is split up into say six parts in passing back through the bridges 12, since these bridges are necessarily separted from each other in order to allow access to the brushes. The bulk of the flux naturally tends to take the shortest iron path and so has a tendency to make the magnetic field stronger directly under each bridge 12 than it is under the hollows between bridges. Such an unbalanced flux tends to cause unbalanced currents in the armature conductors and eddy currents in the armature core. Hence it is desirable that the flux be of substantially uniform density at all points of the armature circumference. If the annular pole faces are sufficiently thick the flux will spread out uniformly in them; but it is desirable to have the bridges as near the armature as possible, and to have the pole faces limited in thickness, in order to reduce the size and weight of the machine. The primary object of this invention is to aid the flux in spreading out in the pole faces, in order to thus reduce the size of the machine.

It will be noted on inspection of Fig. II and Fig. III that the risers 9 are curved or tapered outward on the side where the stationary conductors 11 pass,—while on the other side the risers extend in comparatively straight. It has been seen that the inclined leads from the brushes strengthen the magnetic flux,—for example, may tend to send the flux inward; in which case the current flowing longitudinally in the stationary conductors 11 creates a local flux around said conductors tending to throw the main flux to the right, so as to fill out the spreading portion at the base of the riser 9. In other words, by suitably curving one side of the risers 9 and throwing the stationary return conductors 11 across that side, the resulting flux is given a somewhat oblique path from the risers to the pole faces,—as shown in Fig. III,—and thus the tendency of the flux to unduly concentrate directly under the bridges is obviated and a more uniform flux distribution is obtained in a compact machine. In this manner the local field

existing around the longitudinal return conductors 11 is utilized to assist in distributing the magnetic flux of the main fields,—so that substantial uniformity results even when the field structure is made quite compact. It will also be seen that the whole stationary conductor between brushes, consisting of the two inclined leads and the longitudinal conductor 11, form three sides of a rectangular exciting coil around the base of each riser,—thus aiding excitation.

Another advantage of extending the return stationary conductors along the sloping side of such a riser or corrugation 9 will be seen if the density in the magnetic circuit is followed through, inch by inch. It will be seen that the maximum flux density will generally occur in the neighborhood of the base of the risers 9. This is the point then where it is most desirable to spread out the flux through all the available iron so far as possible.

The arrangement of the magnetic circuits disclosed above has been described by way of illustration in connection with a bihomopolar machine having supplementary unipolar fields; but it will be obvious to those skilled in the art that similar arrangements may be used on any homopolar or unipolar machine, regardless of the number of bridges or of the number of effective fields involved. Hence the invention should not be understood as limited to the precise form of machine shown, nor to that precise arrangement and contour of the field structure.

I claim as my invention:

1. In a homopolar dynamo-electric machine, an armature of the cylindrical type, a zone of armature conductors, belts of collector segments bordering the zone, a band of closely spaced brushes extending around each belt of collector segments and bordering the zone of armature conductors, a field structure providing a homopolar pole face for said zone and having annular channels in which the brushes are located, the field structure having a number of ridges and hollows extending in a substantially axial direction, the hollows communicating with the brush channels, the ridges bridging over the brush channels and merging into the homopolar pole face, and stationary conductors connecting the brushes bordering one side of the zone to the brushes bordering the other side, said stationary conductors extending longitudinally in the hollows of the field structure and being inclined at each end in such a direction as to excite the homopolar field.

2. In a homopolar dynamo-electric machine, a field structure having a number of ridges and hollows extending in a longitudinal axial direction, the ridges having substantially straight faces on one side and faces extending outwardly from the base on the other side, and electrical conductors extending longitudinally in the hollows between the ridges.

In witness whereof I have hereunto set my hand this 7th day of September, 1917.

ROBERT V. MORSE.

Witnesses:

ELMER H. WANZER,

J. S. BARR.