E. M. FRASER.

ROTARY TRANSFORMER.

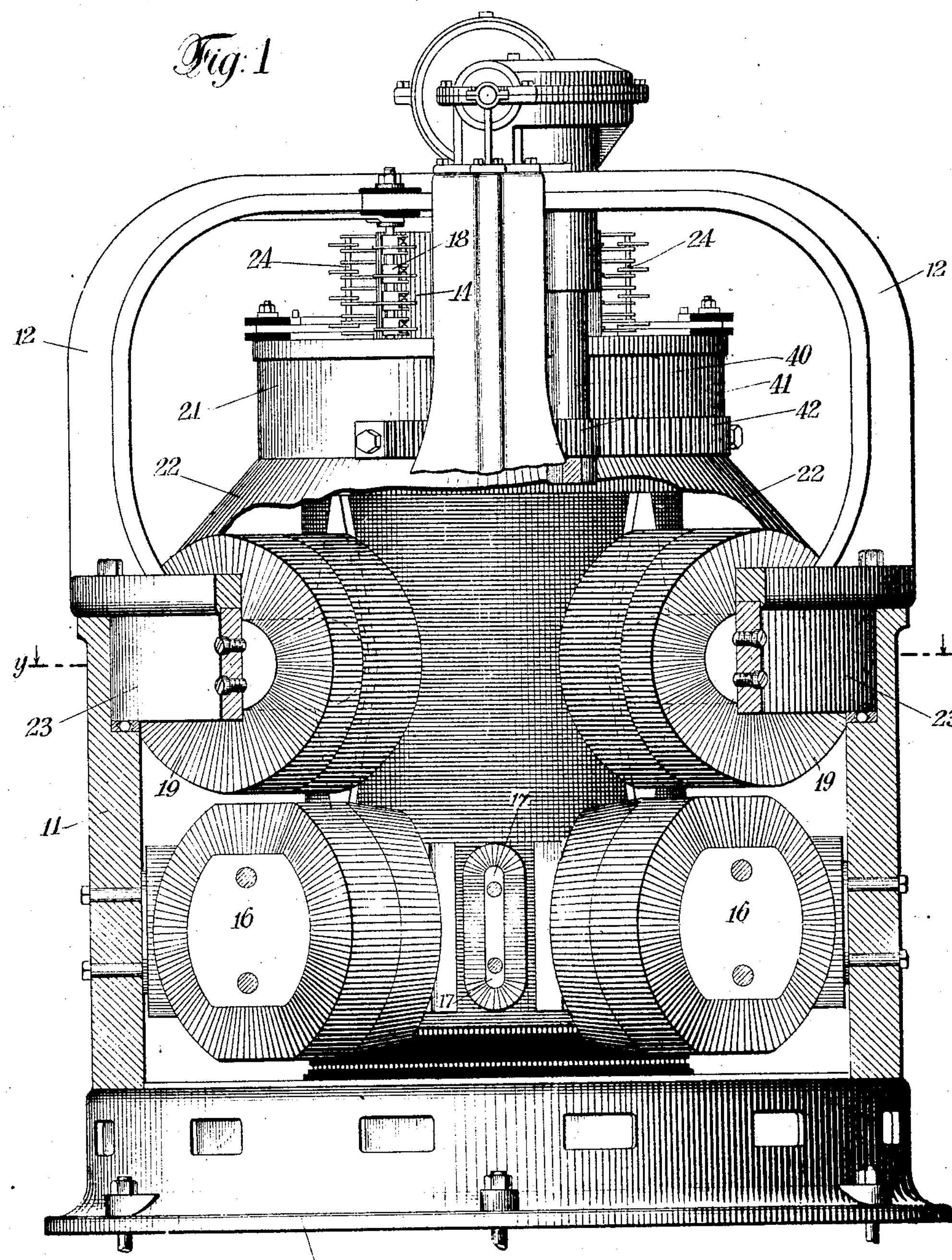
APPLICATION FILED APR. 28, 1911.

1,052,717.

Patented Feb. 11, 1913.

4 SHEETS—SHEET 1.

Fig: 1



Witnesses:
W. T. Bissing
D. Harold Bush

Inventor
Ethelbert M. Fraser
By his Attorneys
Jones, Addington, Ames & Seibold

E. M. FRASER.

ROTARY TRANSFORMER.

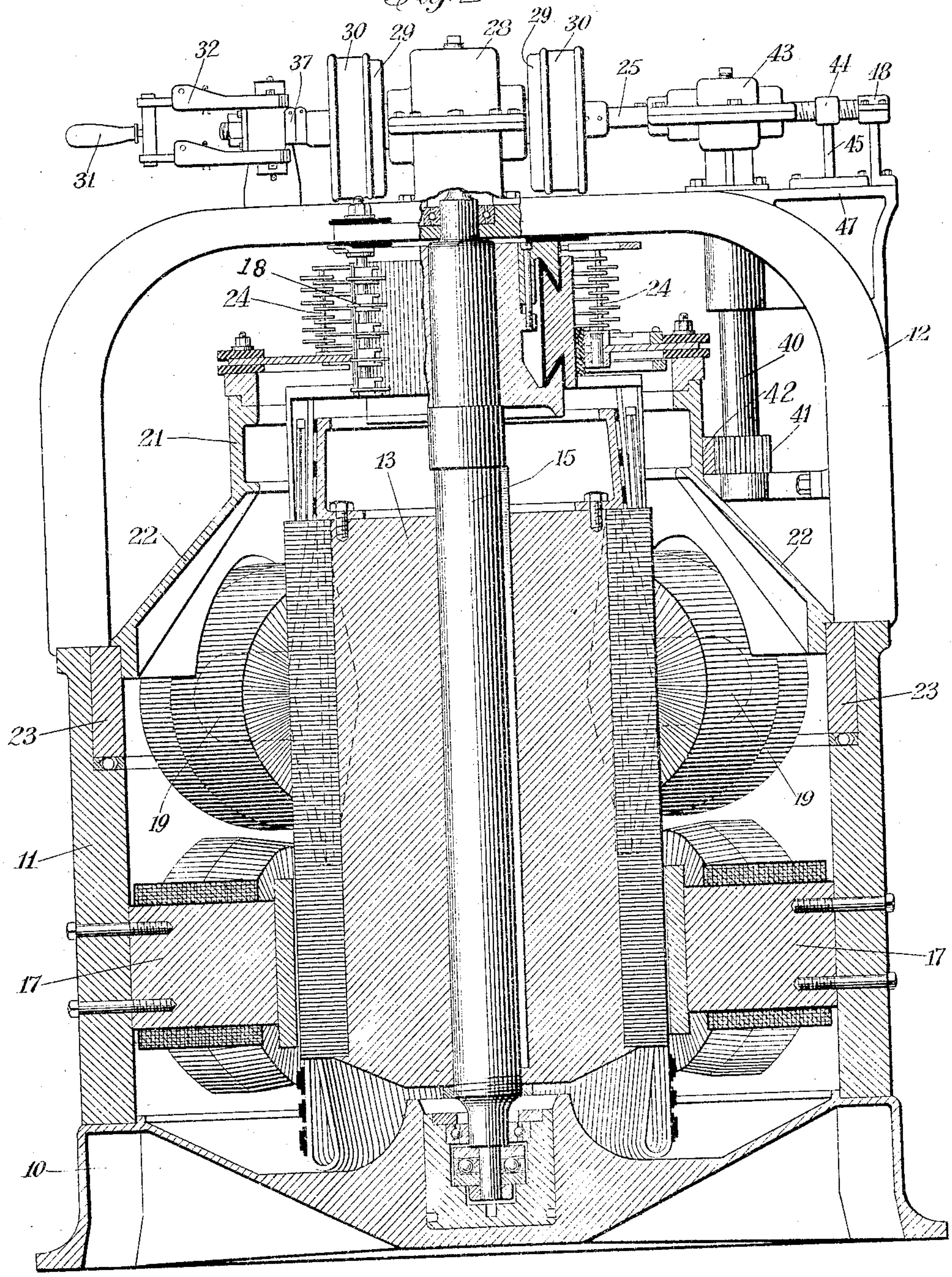
APPLICATION FILED APR. 28, 1911.

1,052,717.

Patented Feb. 11, 1913.

4 SHEETS—SHEET 2.

Fig. 2



Witnesses:
W. J. Bissing.
D. Harold Bush.

Inventor
Ethelbert M. Fraser
By his Attorneys
Jones, Addington, Ames & Seibold

E. M. FRASER.

ROTARY TRANSFORMER.

APPLICATION FILED APR. 28, 1911.

1,052,717. Patented Feb. 11, 1913.

4 SHEETS—SHEET 3.

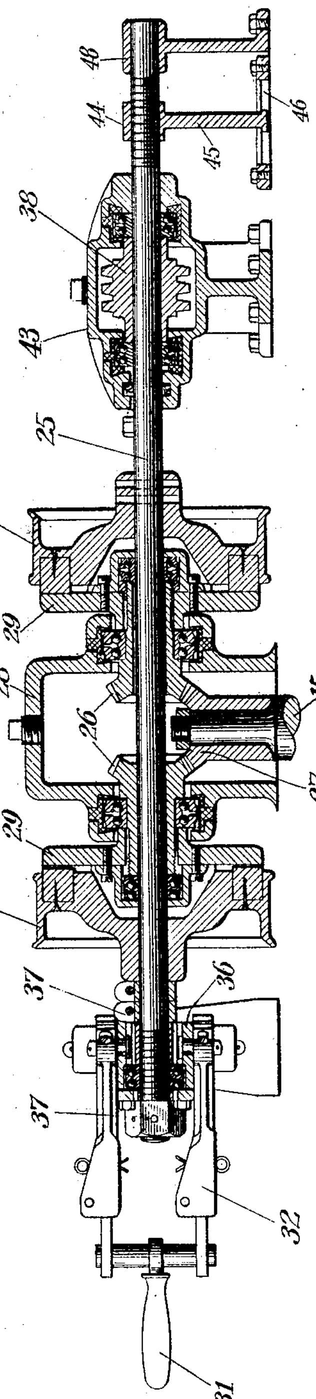


Fig. 4

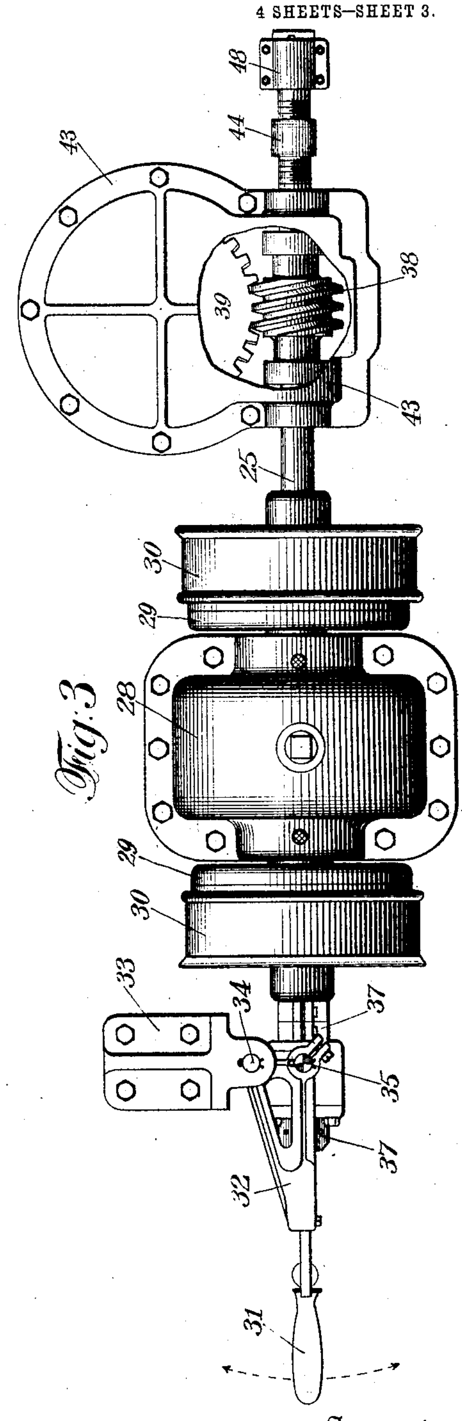


Fig. 3

Witnesses:

W. J. Bissing

D. Harold Bush

Inventor

Ethelbert M. Fraser

By his Attorneys

Jones, Addington, Ames & Seibold

E. M. FRASER.

ROTARY TRANSFORMER.

APPLICATION FILED APR. 28, 1911.

1,052,717. Patented Feb. 11, 1913.

4 SHEETS—SHEET 4.

Fig:5

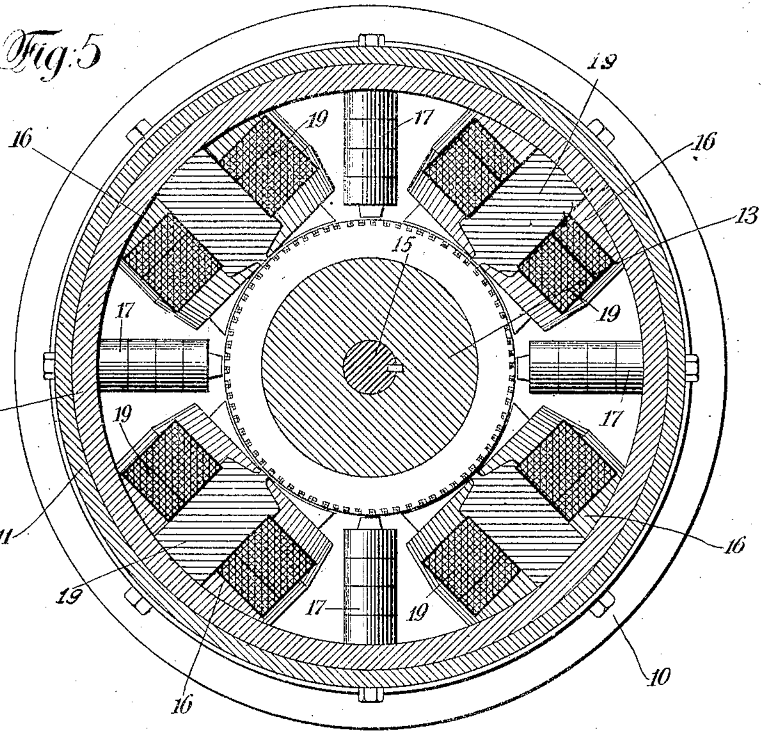
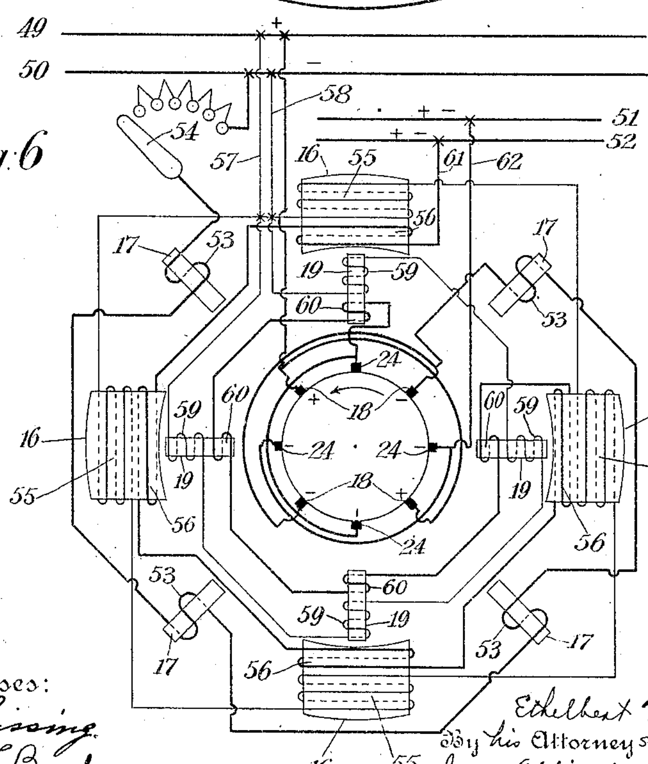


Fig:6



Witnesses:

W. J. Bissing

D. Hatred Burst.

Inventor

Ethelbert M. Fraser

By his Attorneys

Jones, Addington, Ames & Seibold

UNITED STATES PATENT OFFICE.

ETHELBERT M. FRASER, OF YONKERS, NEW YORK.

ROTARY TRANSFORMER.

1,052,717. Specification of Letters Patent. Patented Feb. 11, 1913.

Application filed April 28, 1911. Serial No. 623,838.

To all whom it may concern:

Be it known that I, ETHELBERT M. FRASER, a citizen of the Dominion of Canada, residing at Yonkers, county of Westchester and State of New York, have invented a new and useful Improvement in Rotary Transformers, of which the following is a specification.

My invention relates to a rotary transformer for obtaining a direct current of variable voltage of either polarity, without the introduction of ohmic resistance into the circuit, or using switching or pole-changing apparatus.

One of the objects of my invention is to provide a rotary transformer in which the voltage and polarity of the current delivered can be varied by simultaneously rotating the auxiliary field magnets and brushes of the transformer in either direction around the armature and commutator, respectively, without destructive sparking.

Another object is to provide a rotary transformer in which the main field magnets are provided with coils which neutralize the armature reaction.

Another object is to provide simple yet positive means for simultaneously rotating the auxiliary field magnets and brushes of the transformer.

Another object is to provide means for automatically limiting the rotation of the auxiliary field magnets and brushes to a predetermined amount.

With the above and other objects in view, my invention consists of the construction, arrangements and combinations of parts hereinafter described and claimed.

A structure embodying the features of my invention is illustrated in the accompanying drawings, forming a part of this specification, in which,

Figure 1 is a view in elevation of the transformer with part of the outer casing broken away, and showing an end view of the controlling mechanism on top of the transformer. Fig. 2 is a front sectional view of the transformer, showing in full a side view of the controlling mechanism. Fig. 3 is a top view of the controlling mechanism with part of the housing or casing broken away to show some of the gears within. Fig. 4 is a central sectional view of the controlling mechanism. Fig. 5 is a sectional view of the transformer taken on the line y—y of Fig. 1. Fig. 6 is a wiring diagram.

In the drawings, similar letters of reference refer to similar parts throughout the several views.

Referring to the drawings, the rotary transformer comprises any standard form of motor or dynamo frame consisting of the base 10, the circular casing 11, and yokes 12, inclosing the armature 13 and the commutator 14, the armature and commutator being mounted upon the shaft 15 which is suitably journaled in the base 10 and the yokes 12. Secured to the casing 11 are the stationary field magnets 16, preferably wound with shunt and series coils (shown in Fig. 6), and the stationary inter-pole magnets 17 located between the field magnets 16. The transformer may have any number of field magnets, but for purposes of illustration, I have shown a transformer provided with four stationary field magnets and a corresponding number of interpole magnets. I also provide stationary brushes 18, secured to the yokes 12, so that the said brushes will bear upon the commutator 14. As illustrated in the drawings, there are preferably one-half as many sets of stationary brushes as there are stationary poles, each set comprising a positive and a negative brush.

The armature 13 is preferably made sufficiently long to accommodate auxiliary field magnets 19, which are also preferably wound with shunt and series coils (shown in Fig. 6). These auxiliary field magnets are secured to a rotatable member 20, comprising a ring 21, a spider 22 and a bearing ring 23, which is so mounted within the casing 11 that it may be rotated in either direction carrying with it the ring 21. As illustrated in the drawings, the auxiliary field magnets 19 are secured to the bearing ring 23, the number of auxiliary field magnets preferably corresponding to the number of stationary field magnets. Suitably secured to the ring 21 are the auxiliary brushes 24, adapted to bear upon the commutator 14, for collecting the secondary or variable voltage of the transformer.

In the preferred form of my invention, as illustrated in the drawings, I provide one-half as many sets of auxiliary brushes as there are stationary poles, each set comprising a positive and a negative brush. The stationary and auxiliary brushes are arranged alternately. The positive and negative stationary brushes always maintain a fixed relation to each other, and the positive and negative movable brushes likewise maintain a fixed relation to each other. By reason of having positive and negative brushes in fixed relation to each other, the current distribution in the armature will always be symmetrical.

In accordance with my invention, the auxiliary brushes and auxiliary field magnets are rotatable simultaneously in either direction with relation to the stationary brushes and stationary field magnets. This rotation may be accomplished by any suitable operating means, either mechanical or electrical. In the embodiment of my invention, herein shown, said means comprise the controlling mechanism secured to the top of the transformer, whereby the rotation of the armature shaft can be utilized to rotate the auxiliary field magnets and auxiliary brushes in either direction. As illustrated, said controlling mechanism comprises a shaft 25 on which is rotatably mounted a pair of gears 26, which are always in engagement with a meshing gear 27 secured to the end of the armature shaft 15. The gears 26, which always rotate in opposite directions, are held against longitudinal displacement by being suitably mounted in the housing or casing 28. Each of the gears 26 carries a friction plate 29, which is adapted to be thrown into frictional engagement with an accompanying friction disk 30, rigidly secured to the shaft 25. The engagement of either friction disk 30 with its respective friction plate 29 is accomplished by means of the handle 31 secured to the bell-crank lever 32 which is fulcrumed to the support 33 by the pin 34. The lever 32 is secured by the pin 35 to a thrust collar 36, which is loosely mounted upon the shaft 25 and retained between the two collars 37, 37, rigidly secured to the shaft 25.

If the handle 31 be moved in the direction of the dotted lines (Fig. 3), the lever 32 will, through the medium of the thrust collar 36, cause the shaft 25 to move longitudinally in either direction, according to the direction of movement of the handle 31. The longitudinal movement of the shaft 25 will cause one or the other of the friction disks 30 to engage its respective friction plate 29. The rotation of the armature shaft 15, through the gear 27, will cause the rotation of the gears 26 and the attached friction plates 29, and thereby the rotation of the shaft 25 in either direction, according to which friction plate is in engagement with its respective friction disk.

In order that the rotation of the shaft 25 in either direction can be utilized for the rotation of the auxiliary brushes and auxiliary field magnets, I provide suitable mechanism intermediate of the rotatable ring 21 and the shaft 25. As illustrated in the drawings, said mechanism consists of the worm 38 in mesh with a suitable worm gear 39, which is secured to the end of the shaft 40, carrying at its lower end a pinion 41 which engages the rack 42 secured to the rotatable ring 21. The worm 38 is suitably mounted upon the shaft 25 so as to permit of the longitudinal movement of the shaft therethrough, but to be rotated by the rotation of the shaft. The worm 38 and gear 39 are inclosed within a suitable housing 43.

The movement of the auxiliary field magnets and auxiliary brushes around the armature and commutator respectively in either direction can be controlled and stopped by bringing the handle 31 back to central position. By so doing, the engagement of the friction disk 30 with its accompanying plate 29 is relieved, thereby preventing further rotation of the shaft 25.

As illustrated in the wiring diagram (Fig. 6) the numerals 49 and 50 indicate the line wires or power circuit furnishing a direct current of substantially constant voltage, and the numerals 51 and 52 the wires of the secondary circuit. In series with the armature 13 through the stationary brushes 18 are the inter-pole magnet coils 53, which are shown connected to the line wires 49, 50. Inserted in this armature circuit is the starting rheostat 54, the resistance of which is cut out during the normal running of the transformer. The stationary field magnets 16 are wound with two sets of coils 55 and 56—the coils 55 being shown connected in shunt across the line wires 49 and 50 by the conductors 57 and 58, while the other coils 56 are shown connected with the secondary circuit, as hereinafter explained. The auxiliary field magnets 19 are likewise wound with two sets of coils 59 and 60—the coils 59 being shown in shunt across the line 49, 50, by the conductors 57 and 58, while the coils 60 together with the coils 56 of the main field magnets are in series with the armature through the auxiliary brushes 24 and connected with the line wires 51, 52 of the secondary circuit by the conductors 61, 62. The main and auxiliary field magnets are, therefore, provided with coils which are separately excited by a current of substantially constant voltage, and with coils which are excited by the secondary current.

In Fig. 6, the auxiliary brushes are shown midway between the stationary brushes, and the auxiliary field magnets on the central line of the stationary field magnets. So placed, the auxiliary field magnets and auxiliary brushes are in the position of zero or minimum potential. If the auxiliary field magnets be moved in one direction to the line of the edges of their respective stationary field magnets, the auxiliary field magnets and the auxiliary brushes will then be in the position of maximum potential. If the auxiliary field magnets should be moved in the other direction to the line of the other edges of the stationary field magnets, the auxiliary field magnets and auxiliary brushes will be in the position of maximum potential, but the secondary current will be of reversed polarity.

The principle of operation of the rotary transformer herein shown and described is as follows: When the brushes of any dynamo are moved away from the neutral point or position of maximum voltage, the voltage generated is less than the maximum, the field strength remaining unchanged. The farther away from the neutral point the brushes are moved the less the voltage until a point is reached where the voltage is zero. If the brushes are kept moving in the same direction the voltage gradually increases until the brushes again reach a neutral point where the voltage is once more at the maximum, but the polarity has now been reversed from what it was originally. The polarity will also be reversed if the brushes are moved from the neutral point in the opposite direction. It is thus quite possible to obtain a variable voltage from any dynamo and also to reverse the polarity by simply moving the brushes. The great objection to shifting the brushes on motors or dynamos used in connection with constant potential is the excessive and destructive sparking. The cause of sparking is that when the armature coils, short circuited by the brushes, move away from the neutral point they enter a strong field, thereby creating a difference of potential and causing a current to flow in these coils and through the brushes. When this current is broken as the forward bar leaves the edge of the brush there is a spark. The self induction in the armature coils also causes sparking, but not as serious as the above-mentioned cause.

In the rotary transformer herein shown and described, I overcome sparking by generating a counter-electromotive force in opposition to the voltage being generated in the short-circuited coils. To this end, I provide the auxiliary field magnets with two sets of coils, as hereinbefore described—the shunt coils to create a counter-electromotive force in the portion of the armature under the auxiliary poles in opposition to the electromotive force created in the main portion of the armature by the main poles; the series coils to oppose the armature reaction and to create a counter-electromotive force to oppose the reactance voltage in the coils short circuited by the auxiliary brushes.

By using inter-pole magnets, the armature reaction, or the field created by the armature winding is neutralized. These magnets also generate a counter-electromotive force in opposition to the reactance voltage in the coils short circuited by the stationary brushes. Moreover, by providing the main field magnets with series coils, excited by the secondary current, the field created by the armature winding due to the secondary current is neutralized.

In the embodiment of my invention herein shown and described, if the auxiliary field magnets 19 move beyond the main field magnets 16, they affect that part of the armature not influenced by the main magnets—that is, they generate an electromotive force in the short-circuited coils. In order, therefore, to prevent the auxiliary magnets moving beyond the main magnets, I provide automatic means for limiting the rotation of the rotatable member 20 in either direction. Said automatic means comprises a traveling nut 44 on the shaft 25, the nut 44 being held against rotation by the stem 45 which engages the slot 46 in the extension 47 of the yoke 12. The shaft 25 is suitably threaded along the portion traversed by the nut 44, so that as the latter moves along the shaft, due to its rotation, it will move up against either the bumper 48 or the casing 43 thereby relieving the pressure of the friction disk and plate which are in contact, and preventing further longitudinal and rotatable movement of the shaft 25. The movement of the rotatable ring 21, and consequently the movement of the auxiliary field magnets can thus be limited to a pre-determined amount by regulating the amount of travel of the nut 44.

It will be obvious that numerous omissions, substitutions and changes may be made in the various parts, arrangements and wiring herein shown and described, without departing from my invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. In a rotary transformer, the combination with an armature, of a commutator therefor, a stationary field magnet, a movable field magnet, and two independent sets of brushes, one set of brushes being movable.

2. In a rotary transformer, the combination with an armature, of a commutator therefor, stationary field magnets, a set of stationary brushes, auxiliary field magnets, and a set of auxiliary brushes, said field magnets and auxiliary brushes being mov-

able simultaneously in a path around the armature and commutator respectively in either direction.

3. In a rotary transformer, the combination with an armature, of a commutator therefor, stationary field magnets having two sets of coils, one set excited by a direct current of substantially constant voltage, the other set by a current of variable voltage of either polarity, rotatable field magnets, and two independent sets of brushes, one set of brushes being rotatable.

4. In a rotary transformer, the combination with an armature, of a commutator, positive and negative stationary brushes, positive and negative rotatable brushes, and stationary and rotatable field magnets, each field magnet having two sets of coils, one set of coils being shunt-connected to a source of current supply of substantially constant voltage, the other set being in series with the armature through said rotatable brushes.

5. In a rotary transformer, the combination with an armature, of a commutator, stationary field magnets, interpole magnets, a set of stationary brushes, a set of auxiliary brushes, and auxiliary field magnets, said auxiliary field magnets and auxiliary brushes being movable simultaneously in a path around the armature and commutator, respectively, in either direction.

6. In a rotary transformer, the combination with an armature, of a commutator, stationary field magnets having shunt and series coils, a set of stationary brushes, a set of rotatable auxiliary brushes, interpole magnets, and rotatable auxiliary field magnets having shunt and series coils, the series coils of said auxiliary field magnets being in series with the series coils of said stationary field magnets and with said auxiliary brushes.

7. In a rotary transformer, the combination with an armature, of a commutator therefor, stationary field magnets, stationary positive and negative brushes, movable field magnets, and movable positive and negative brushes, said movable field magnets having coils to neutralize the effect of the resultant poles in said armature.

8. In a rotary transformer, the combination with an armature, of a commutator therefor, positive and negative stationary brushes, positive and negative movable brushes, stationary and movable field magnets, said magnets having coils to neutralize the armature reaction for every position of the movable brushes.

9. In a rotary transformer, the combination with an armature, of a commutator therefor, stationary and movable field magnets, said movable field magnets having coils which neutralize the armature reaction, and stationary and movable sets of brushes, the brushes of each set arranged alternately around the armature and maintaining a fixed relation to each other.

10. In a rotary transformer, the combination with an armature, of a commutator, stationary and movable field magnets having coils to neutralize the armature reaction, and stationary and movable sets of brushes, the brushes of each set having a fixed relation to each other whereby the current distribution in the armature is symmetrical.

11. The combination with an armature, of a commutator therefor, stationary and movable field magnets, stationary and movable sets of brushes, and means operated by said armature for simultaneously moving said movable field magnets and brushes.

12. The combination with an armature, of a commutator therefor, stationary field magnets, a set of stationary brushes, movable auxiliary field magnets, a set of movable auxiliary brushes, means for simultaneously moving said auxiliary field magnets and auxiliary brushes around the armature and commutator respectively in either direction, and means for preventing said auxiliary field magnets from moving beyond said stationary field magnets.

13. The combination with an armature, of a commutator therefor, stationary field magnets, a set of stationary brushes, movable auxiliary field magnets, a set of movable auxiliary brushes, means for simultaneously moving said auxiliary field magnets and auxiliary brushes around the armature and commutator respectively in either direction, and means for controlling said movement.

14. The combination with an armature, of a commutator therefor, stationary field magnets, positive and negative stationary brushes, movable field magnets, positive and negative movable brushes, means for simultaneously moving said last-mentioned field magnets and brushes in either direction around the armature and commutator respectively, and means for limiting said movement to a pre-determined distance.

15. The combination with an armature, of a commutator, stationary field magnets, positive and negative stationary brushes, movable field magnets, positive and negative movable brushes, means for simultaneously moving said last-mentioned field magnets and brushes around the armature and commutator respectively from substantially either position of maximum voltage to substantially the position of minimum voltage, or vice versa, and means coöperating with said first means for controlling said movement.

16. The combination with an armature, of a commutator, stationary field magnets, positive and negative stationary brushes, movable field magnets, positive and negative movable brushes, means for simultaneously moving said last-mentioned field magnets

and brushes around the armature and commutator respectively from substantially either position of maximum voltage to substantially the position of minimum voltage, or vice versa, and means for automatically stopping said movable field magnets and brushes at the maximum voltage position.

17. The combination with an armature, of a commutator, stationary field magnets, positive and negative stationary brushes, movable field magnets, positive and negative movable brushes, means for simultaneously moving said last-mentioned field magnets and brushes around the armature and commutator respectively from substantially either position of maximum voltage to substantially the position of minimum voltage, or vice versa, and means for automatically stopping said movable field magnets and brushes at any desired point.

18. The combination with an armature, of a commutator therefor, brushes, compound-wound main field magnets, auxiliary compound-wound field magnets, said auxiliary field magnets and said brushes being movable, means for simultaneously moving said auxiliary field magnets and brushes in a path around the armature and commutator respectively, and means for automatically limiting said movement.

19. The combination with an armature, of a commutator therefor, positive and negative stationary brushes, positive and negative movable brushes, stationary and movable field magnets, each field magnet having two sets of coils, one set being shunt-connected to the source of current supply, the other set being in series with the armature through said movable brushes, interpole magnet coils in series with said armature through said stationary brushes, and means for simultaneously moving said movable field magnets and movable brushes around the armature and commutator, respectively, in either direction.

20. The combination with an armature, of a commutator therefor, positive and negative stationary brushes, positive and negative movable brushes, stationary and movable field magnets, each field magnet having two sets of coils, one set being shunt-connected to the source of current supply, the other set being in series with the armature through said movable brushes, interpole magnet coils in series with said armature through said stationary brushes, and means operated by said armature for simultaneously moving said movable field magnets and movable brushes around the armature and commutator, respectively, in either direction.

21. The combination with an armature, of a commutator therefor, positive and negative stationary brushes, positive and negative movable brushes, stationary and movable field magnets, each field magnet having two sets of coils, one set being shunt-connected to the source of current supply, the other set being in series with the armature through said movable brushes, interpole magnet coils in series with said armature through said stationary brushes, means operated by the armature for simultaneously moving said movable field magnets and movable brushes around the armature and commutator respectively in either direction, and means for automatically stopping said movable field magnets and brushes at any desired point.

In testimony whereof, I sign this specification in the presence of two witnesses.

ETHELBERT M. FRASER.

Witnesses:
W. C. MARGESON,
D. HAROLD BUSH.