V. A. FYNN.

ALTERNATING CURRENT MOTOR.

APPLICATION FILED JULY 9, 1909.

967,363.

Patented Aug. 16, 1910.

2 SHEETS—SHEET 1.

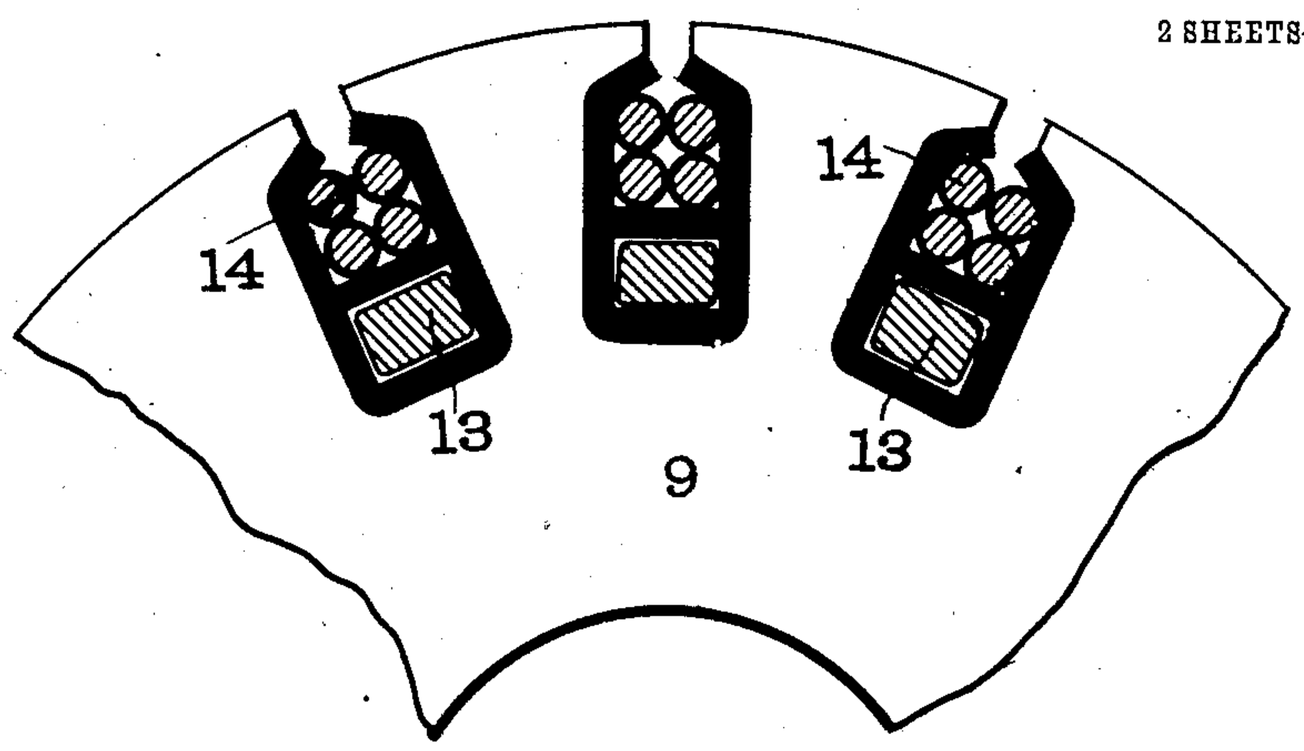

Fig. 1.

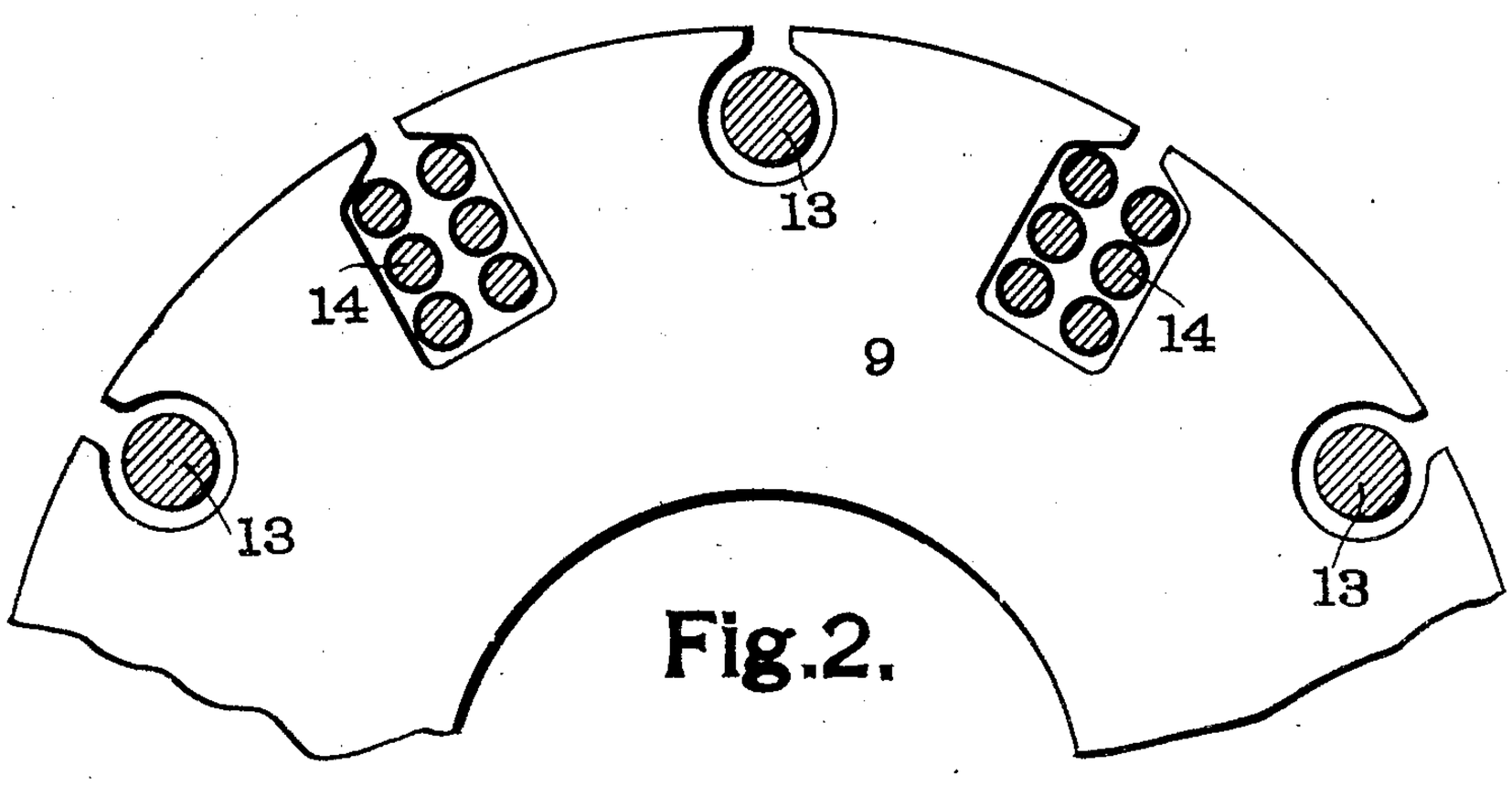

Fig. 2.

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Fig.3.

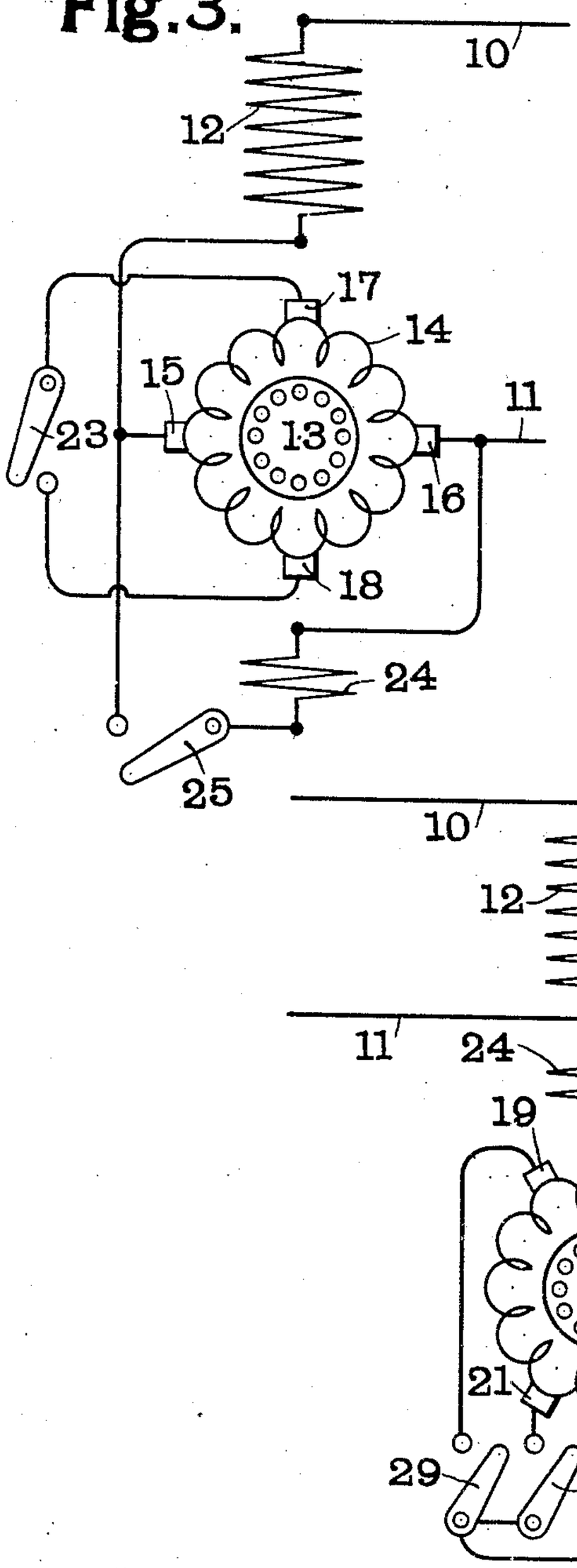

Fig.4.

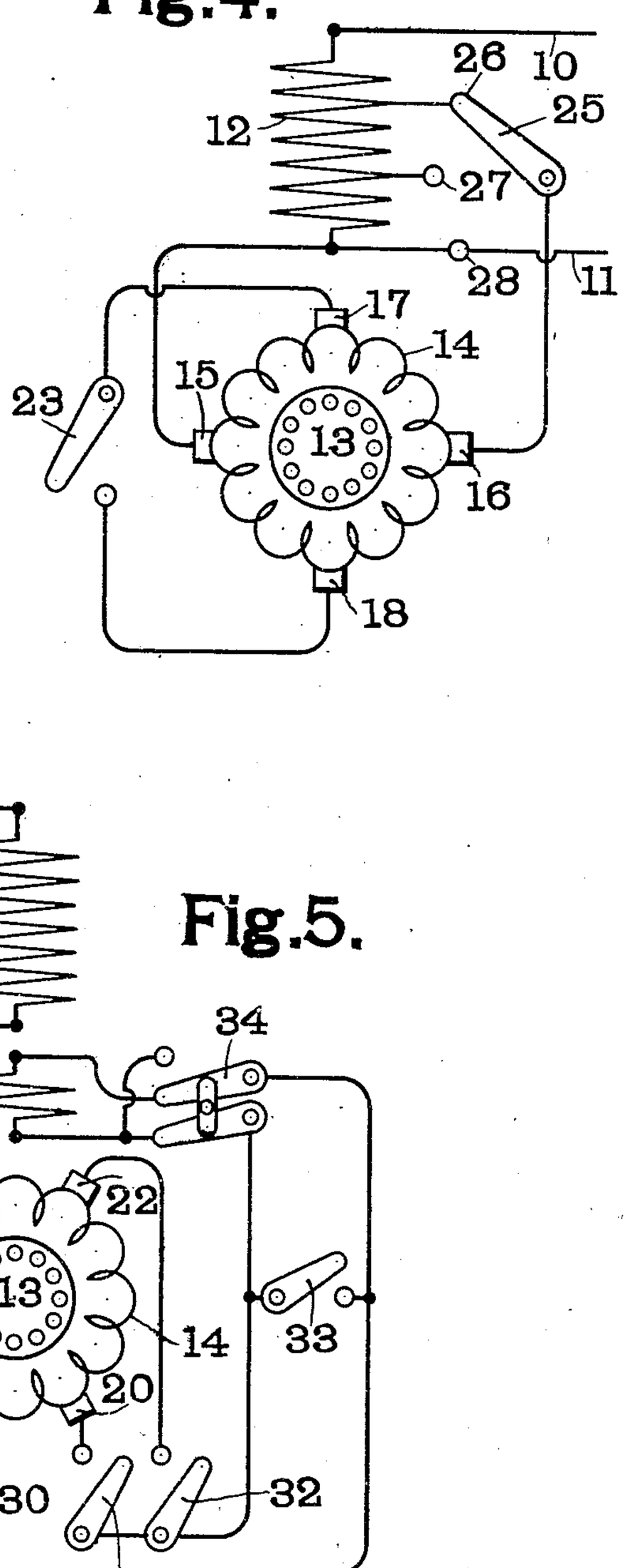

Fig.5.

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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT MOTOR.

967,363. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed July 9, 1909. Serial No. 506,731.

To all whom it may concern:

Be it known that I, VALÈRE ALFRED FYNN, a subject of the King of England, residing at London, England, have invented a certain new and useful Alternating-Current Motor, of which the following is such a full, clear, and exact description as will enable any one skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to alternate current motors having a permanently short-circuited winding such as a squirrel-cage and a commuted winding on the induced member.

It has been proposed to provide the rotor of such motors with a commuted winding for the purpose of starting the machine. If the squirrel cage in such a motor has a sufficiently low resistance for the motor to give an output commensurate with its size and have the necessary overload capacity then the starting performance is very poor. In other words, the torque per ampere at starting is very low rendering the machine useless in practice. If the squirrel-cage has a sufficiently high resistance to allow of a good torque per ampere at starting then the output of the machine under normal operation is unreasonably reduced as compared to its size. Increasing the size of the motor only raises its cost without increasing the torque per ampere. It has been suggested to place the squirrel-cage in separate slots disposed within the zone of those carrying the commuted winding and separated from the latter by a certain radial depth of the rotor laminations thus allowing the magnetic flux or part of it to thread the commuted winding without threading the squirrel-cage. Although this arrangement increases the torque per ampere at starting yet it also unreasonably decreases the output of the machine under normal operation for the above described magnetic shunt which is introduced in order to improve the starting is equally effective in normal operation and always gives the flux an opportunity of missing the squirrel cage winding. I overcome these difficulties in my improved motor by disposing of my squirrel-cage winding, or speaking more generally, my permanently short-circuited winding and my commuted winding in such a manner that there will be no appreciable magnetic shunt between the two. In fact, I preferably place the two windings in the same or in adjacent slots. I further make the resistance of my permanently short-circuited winding high enough to secure a sufficiently good starting torque but not high enough to deprive this short-circuited winding of the power to keep the motor within narrow limits of its synchronous speed.

In order to raise the output of the motor under normal operation to a reasonable and commercially acceptable figure commensurate with the size of the machine I so dispose a number of brushes on the commutator connected to the commuted winding that said commuted winding can not only be used for starting the motor but also for operating same with a shunt characteristic, the arrangement of the brushes holding the motor under normal operation within narrow limits of its synchronous speed and causing the commuted winding to carry part of the load current. I may also make use of said commuted winding for compensating or improving the power factor of the machine. In this manner all the rotor copper is made fully effective under normal operation and a sufficiently large torque per ampere is secured at starting.

In a previous application filed May 8, 1909, Serial No. 494,905, I have indicated means for improving the load characteristics of motors in which a magnetic shunt is provided between the commuted and the permanently short-circuited winding, the present arrangement is however much better. The copper of the permanently short-circuited winding, when the latter is placed in the same slots as the commuted winding is clearly much more effective as far as the production of a useful torque under normal running conditions is concerned. Furthermore, it is also much more effective in preventing sparking. Tests have shown that a saving of squirrel-cage copper amounting to about 100% can be effected without impairing the full load efficiency or the starting performance, by placing the squirrel-cage in the same slots as the commuted winding instead of in other magnetically shunted slots, provided the brush arrangements here described are made use of. By the present arrangement I, therefore, not only save copper on the rotor without decreasing the motor efficiency but I also greatly simplify the rotor stampings for I only require one set of slots, thus cheapening the machine

while improving its performance. The present arrangement further allows of a large starting torque per ampere being secured without the aid of such auxiliary windings as have been disclosed by me in my previous application Serial No. 474,983.

In the accompanying diagrammatic drawings which show several two-pole embodiments of my invention, Figure 1 indicates an arrangement of the commuted winding 14 and the permanently short-circuited winding 13 when placed in the same slots of the induced member. Fig. 2 indicates an arrangement of said windings in adjacent slots. Fig. 3 is a motor adapted to be started by connecting the commuted winding in series relation with the main inducing winding. Fig. 4 is a motor adapted to be started by connecting the commuted winding in parallel to the main inducing winding or in parallel to the mains. Fig. 5 is a motor adapted to be started by short-circuiting the commuted winding along a stationary axis displaced with respect to the axis of the main inducing winding.

Referring to Fig. 3 which discloses the starting connections in one form of my improved motor, the main stator inducing winding 12 is connected in series relation with the commuted winding 14 by way of the brushes 15, 16 and across the mains 10, 11. The rotor winding closed on itself is shown at 13 and is by way of example supposed to be of the squirrel-cage type. Although a squirrel-cage winding is shown in all the figures yet it will be understood that any known form of permanently short-circuited winding will answer the purpose; a squirrel-cage will generally be perferred on account of its simplicity. The preferred relative disposition of the commuted winding 14 and the permanently short-circuited winding 13 is shown in Fig. 1 where 9 represents part of a rotor stamping. The machine shown in Fig. 3 starts something like a series conduction motor, although not entirely so, owing to the presence of 13, and the commuted winding generally tends to raise the speed beyond the synchronous. As soon as a sufficient speed has been reached I close switches 23 and 25. As soon as this is done the commuted winding tends to give the machine a shunt instead of a series characteristic thus eliminating all antagonistic action from the motor, increasing its efficiency and its capacity, definitely limiting its speed and also limiting its speed variation under load. In Fig. 3 the circuit of the brushes 15, 16 is closed over a compensating winding 24 here disposed on the stator; this arrangement increases the power factor of the motor and also improves its general operation. This compensating E. M. F. can be derived from any convenient source and need not be taken from a motor winding as shown in Fig. 3. In a modification I could directly short-circuit the brushes 15, 16 after a sufficient speed has been reached, thus securing all the advantages I have enumerated except those contingent on the use of a compensating E. M. F. This motor can also be started something like a series induction machine; for this purpose the brushes 17, 18 should be short-circuited at starting thus simplifying the switching operations. When up to speed the commuted winding is preferably but not necessarily closed along another axis with or without the inclusion of a compensating E. M. F. In order to reverse the direction of rotation in either of the cases just described it is necessary either to reverse the current through 12 or through 14 adjusting the compensating feature to suit.

Fig. 4 shows a machine which starts something like a shunt conduction motor, although not entirely so owing to the presence of 13. The commuted winding may tend to drive the motor beyond synchronism or keep it below that speed according to the proportions chosen. The switches are shown in the starting position, 12 is directly connected to the mains 10, 11 and an E. M. F. of about the same phase as that of the supply is impressed on the commuted winding 14 by way of the brushes 15, 16 and in parallel with 12. The E. M. F. impressed on 14 is by way of example derived from 12 itself at point 26. When the motor has reached a sufficient speed switch 23 is closed and switch 25 moved on to point 27 or 28. Point 27 may be so chosen as to derive from 12 the desired compensating E. M. F. If 25 stands on 28 then the compensating feature is cut out, but the improved motor still retains the other advantages I have previously enumerated. In order to reverse the direction of rotation it is necessary either to reverse the current through 12 or through 14 adjusting the compensating feature to suit.

Fig. 5 shows a machine which starts something like a series induction motor although not entirely so owing to the presence of 13. The commuted winding generally tends to drive the motor beyond its synchronous speed. The switches are all shown open and 12 alone is directly connected to the mains 10, 11. In order to start the motor say in a clockwise direction, switches 30 and 32 are closed together with switch 33. If the motor is to be started in the opposite direction then switches 29, 31 and 33 must be closed. Instead of closing 33 it is also possible at starting to close the reversing switch 34 in the one or the other direction, and according to this direction the starting torque will be either increased or decreased by the inclusion of 24 in the brush circuit. Supposing switches 30, 32 and 33 have been closed at starting then as soon as the motor has reached a sufficient speed switches 29 and 31

should also be closed thus eliminating all antagonistic actions from the motor while still making use of the commuted winding to carry part of the load current. If it be desired to compensate the machine then switch 33 must be opened and 34 closed in the correct direction.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, short-circuited brushes on the commuted winding in the axis of the inducing winding, and means for directing the flow of current in the commuted winding along another axis.

2. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, said commuted winding being closed by way of brushes along two axes, one of which approximately coincides with the axis of the main inducing winding.

3. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, said commuted winding being short-circuited along one axis, and means for impressing a compensating E. M. F. on said commuted winding along another axis.

4. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, said commuted winding being closed by way of brushes along an axis approximately coinciding with that of the main inducing winding and connected to the source of supply along another axis.

5. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, said commuted winding being closed by way of brushes along an axis approximately coinciding with the main inducing winding and connected in series relation with said inducing winding along another axis.

6. In an alternating current motor, the combination with a stator provided with a main inducing winding, of a rotor provided with a commuted winding and a second winding closed on itself, said rotor windings both lying on the periphery of the rotor, said commuted winding being closed by way of brushes along an axis approximately coinciding with the main inducing winding and connected in series relation with said inducing winding along another axis, and means for impressing a compensating E. M. F. on the commuted winding.

In testimony whereof I have hereunto set my hand and affixed my seal in the presence of the two subscribing witnesses.

VALÈRE ALFRED FYNN. [L. S.]

Witnesses:

ELIZABETH BAILEY,

E. E. HUFFMAN.