V. A. FYNN.

SINGLE PHASE COMMUTATOR MOTOR.

APPLICATION FILED OCT. 5, 1906.

946,503. Patented Jan. 11, 1910.

3 SHEETS—SHEET 1.

Fig. 1

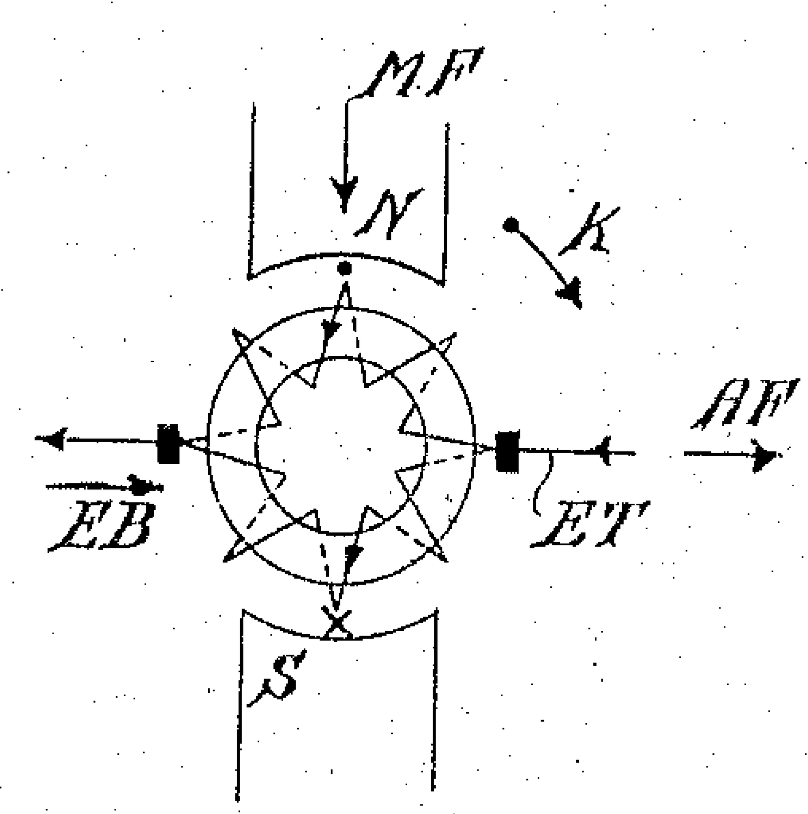


Fig. 2.

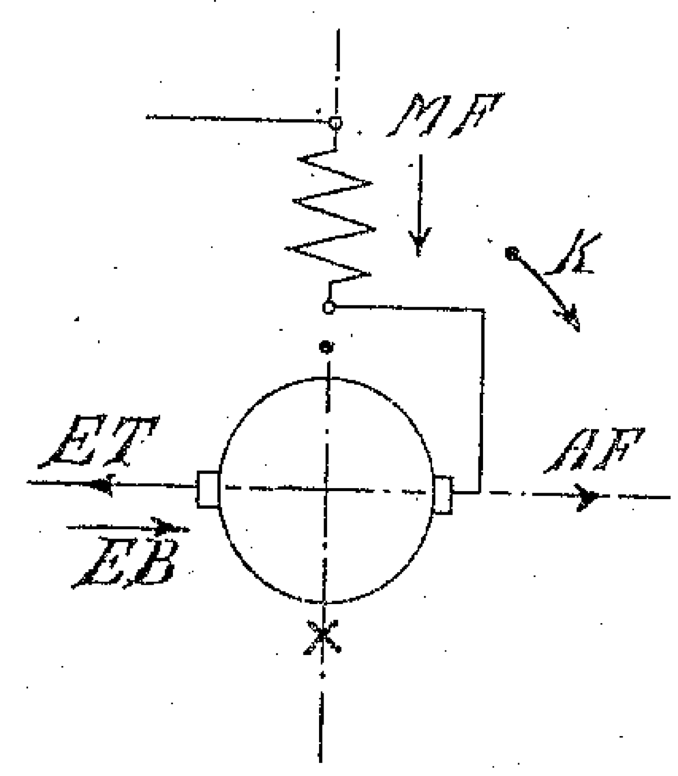


Fig. 3.

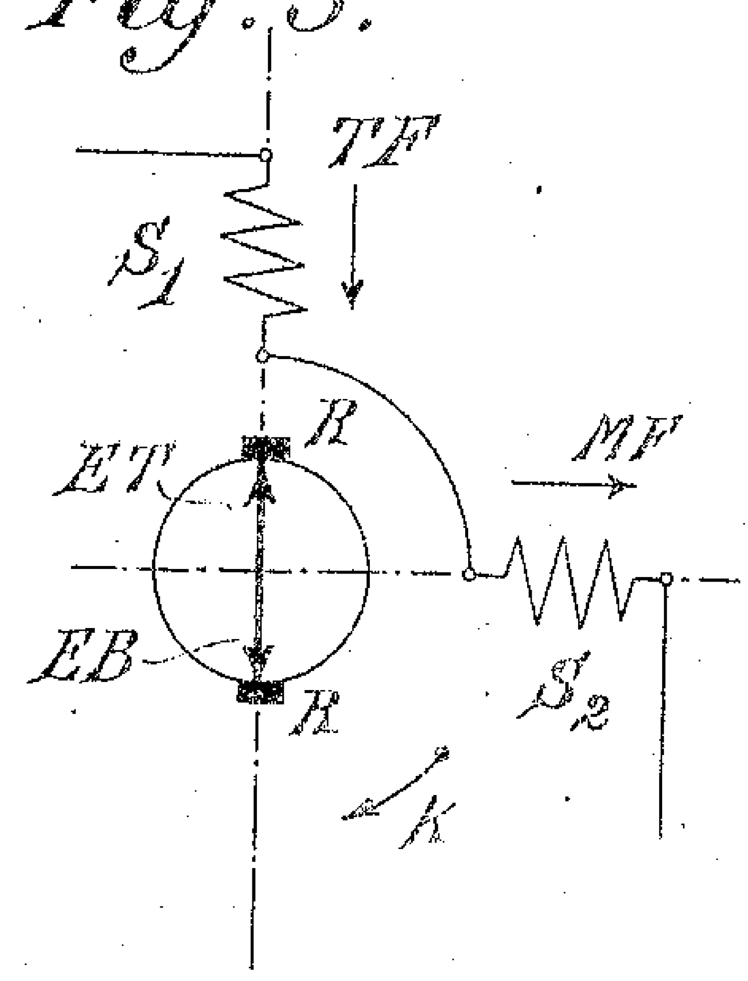


Fig. 4.

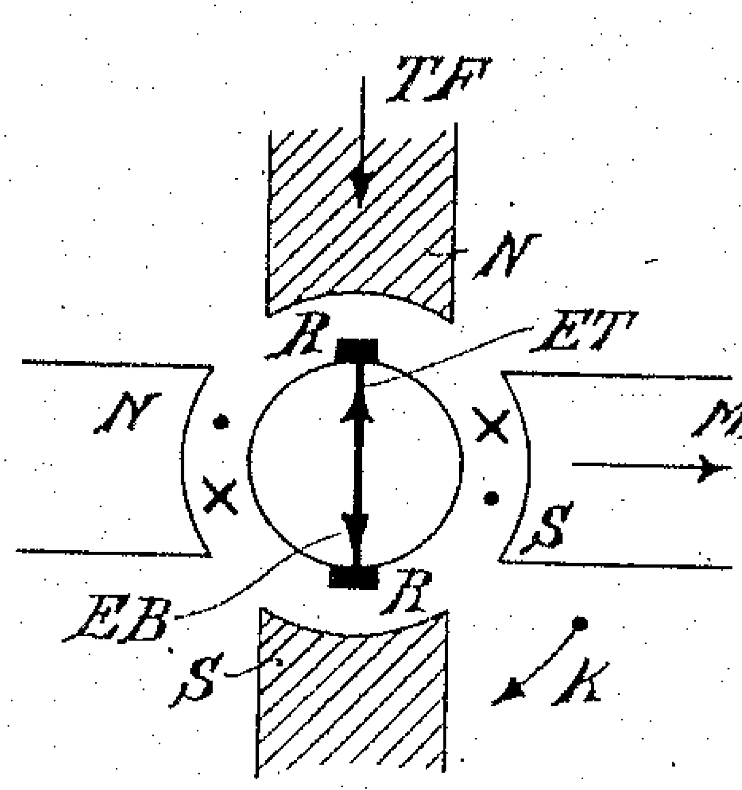


Fig. 5.

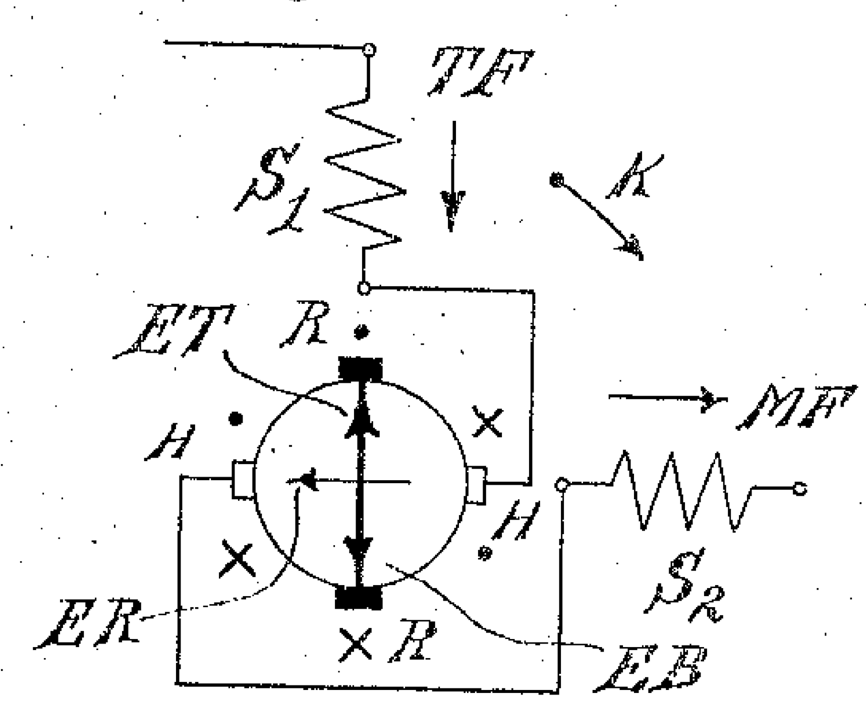


Fig. 6.

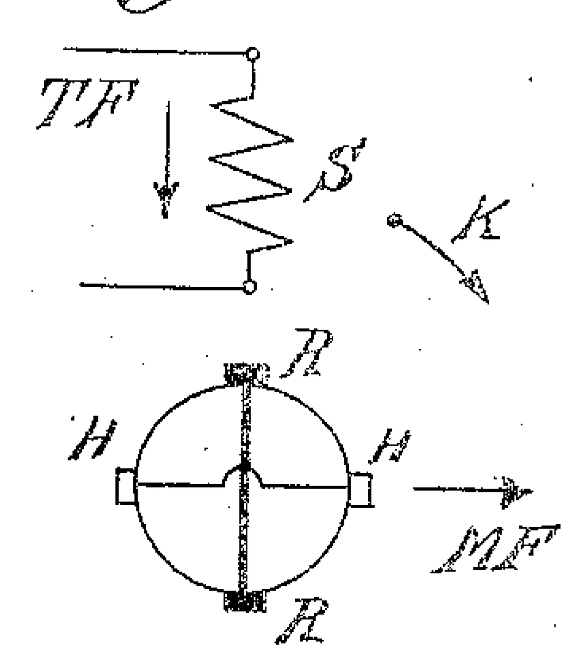


Fig. 7.

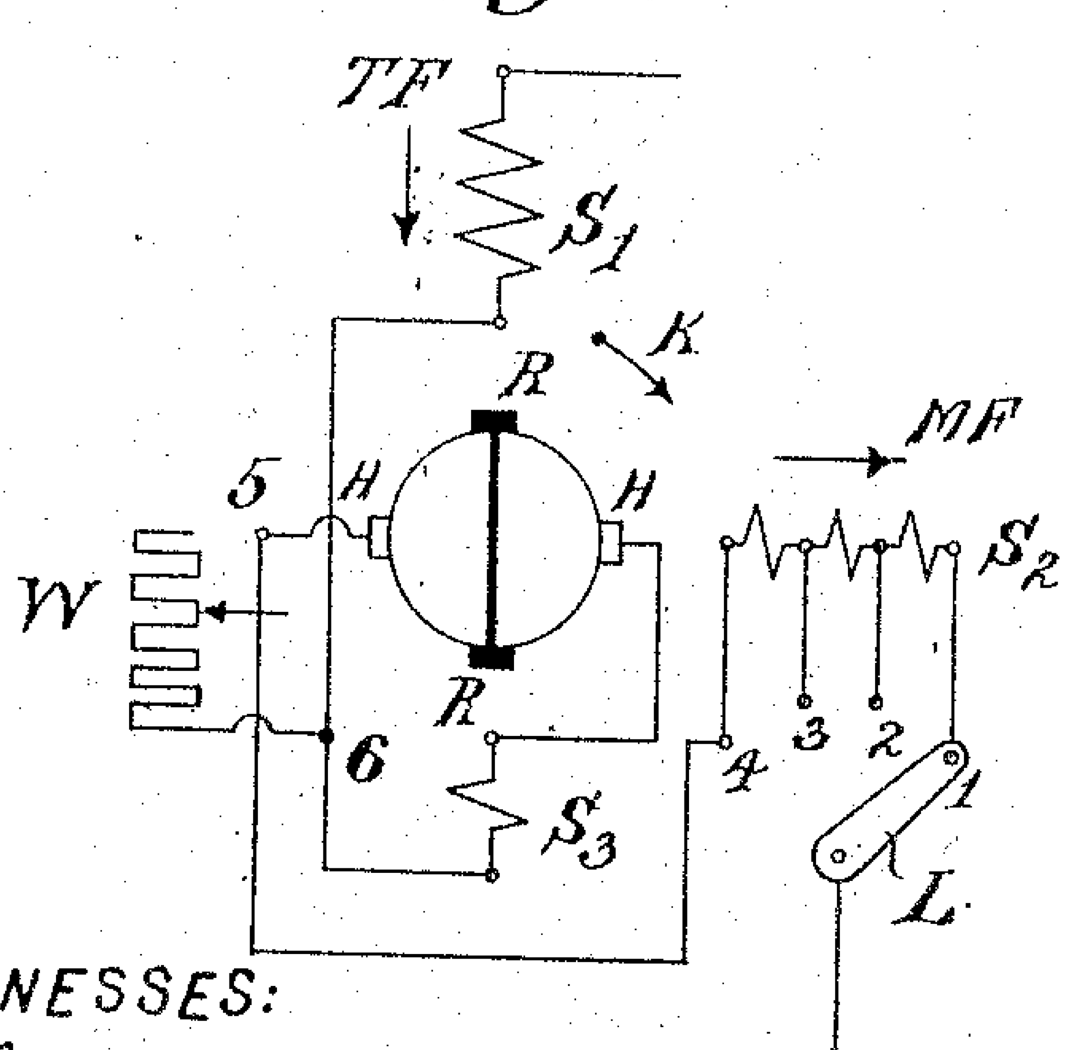
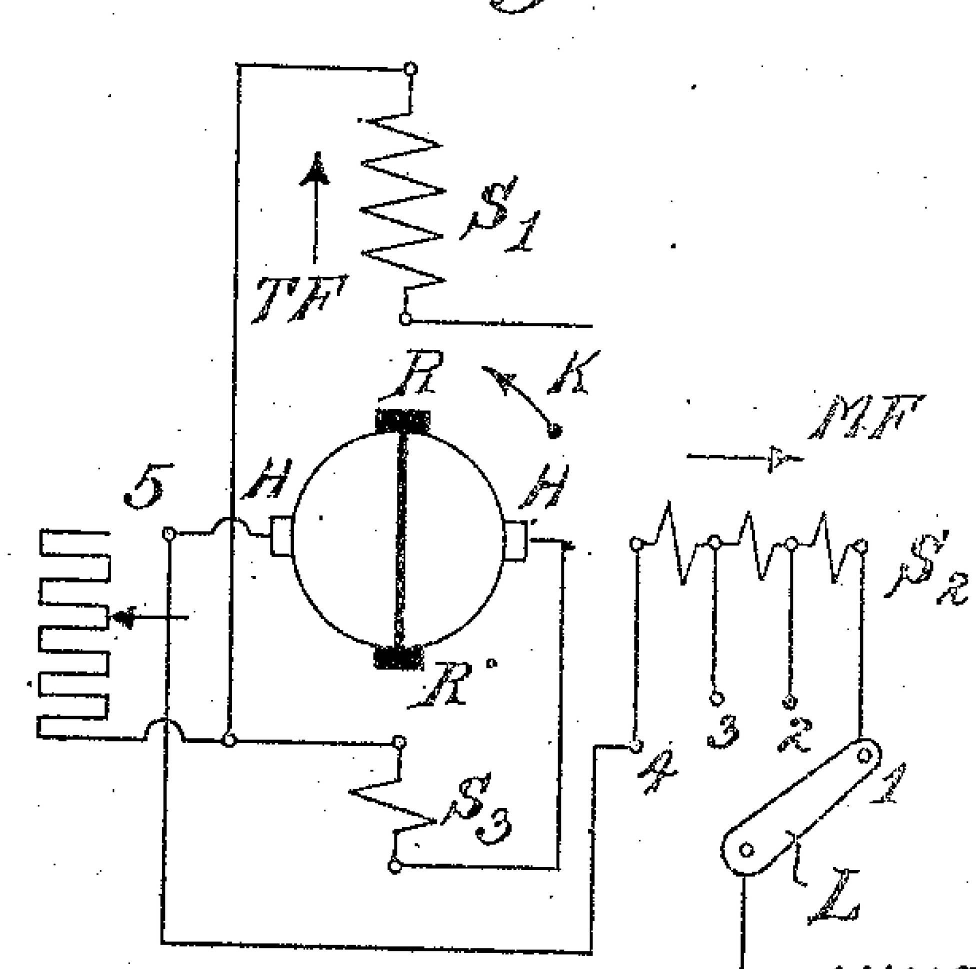


Fig. 8.



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3 SHEETS—SHEET 2.

Fig. 9.

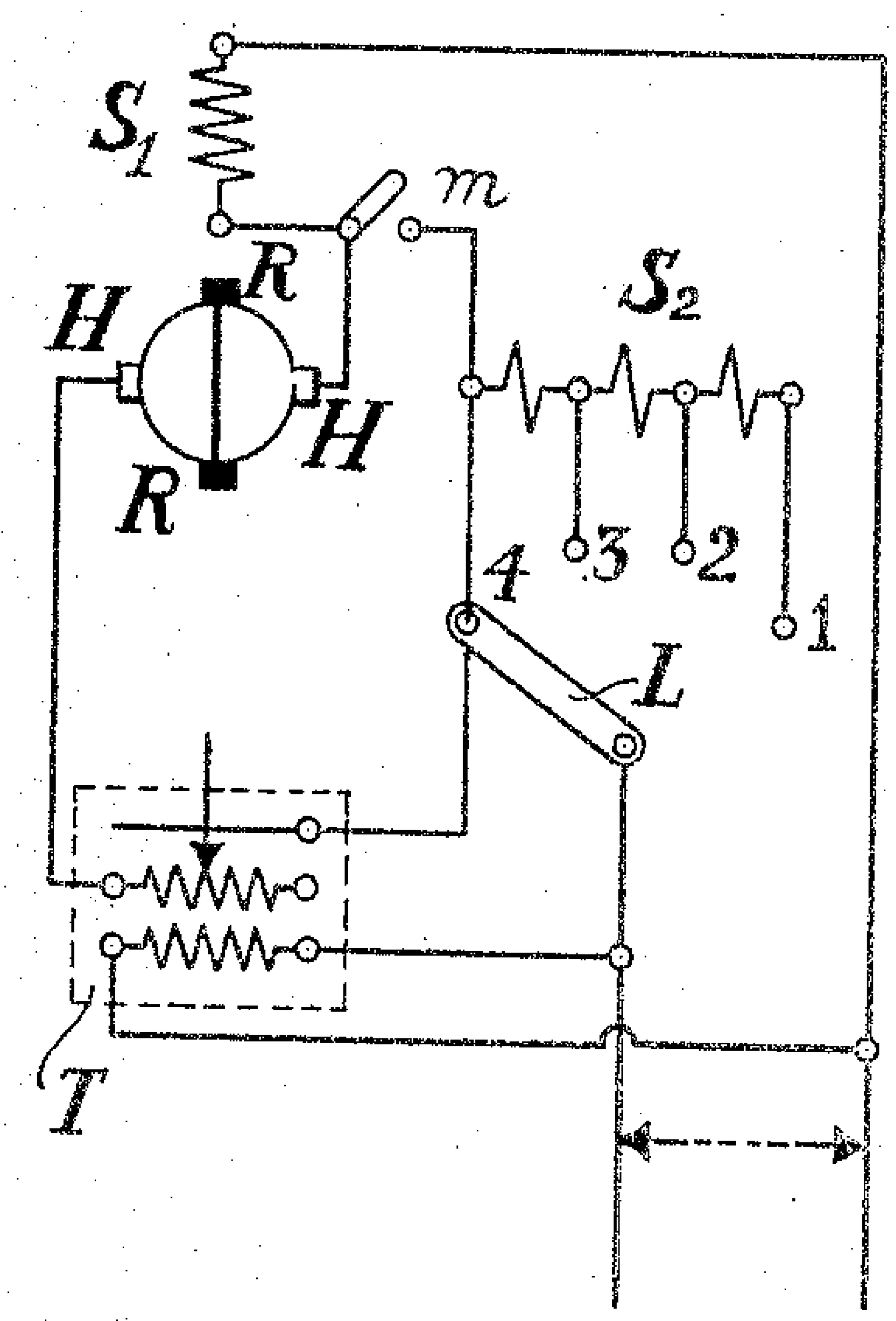
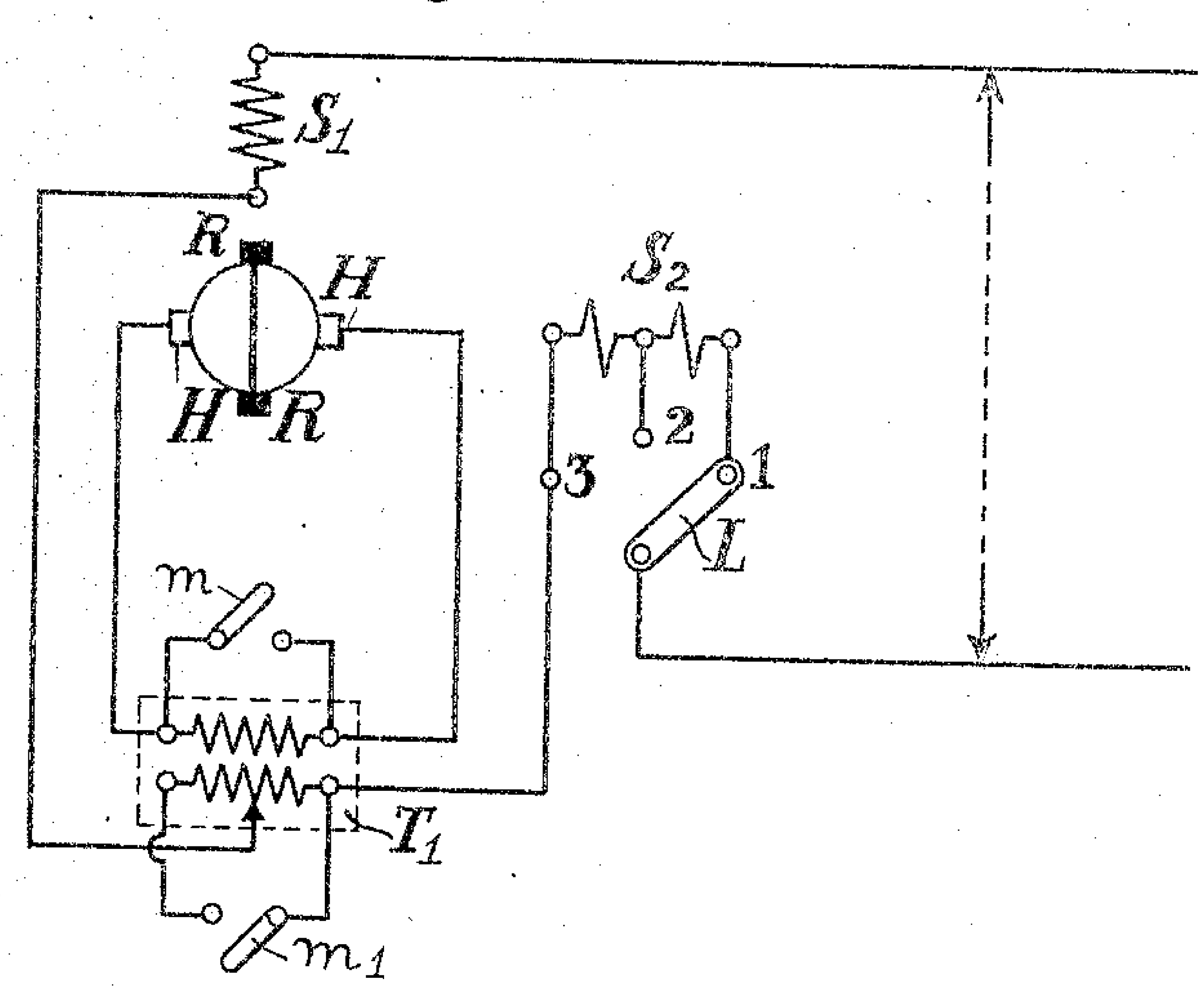


Fig. 10.



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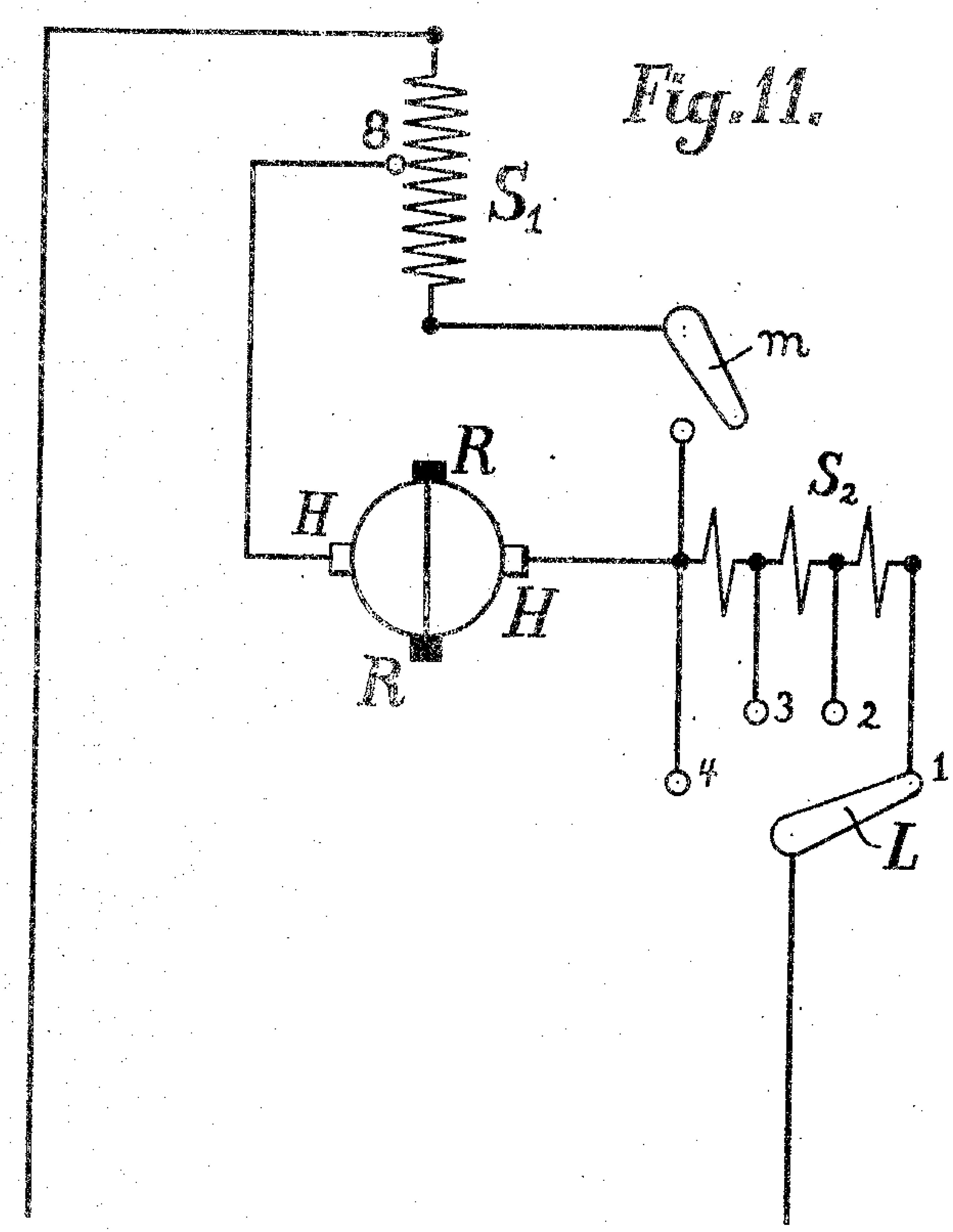
3 SHEETS—SHEET 3.

Fig. 11.



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SINGLE-PHASE COMMUTATOR-MOTOR.

946,503. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed October 5, 1906. Serial No. 337,511.

To all whom it may concern:

Be it known that I, VALÈRE ALFRED FYNN, of 18 Blessington road, Blackheath, in the county of London, England, electrical engineer, have invented certain new and useful Improvements in or Relating to Single-Phase Commutator-Motors, of which the following is a specification.

This invention relates to single-phase commutator motors which at least start as "repulsion motors." I have made use of this term "repulsion motors", but although universally employed I consider the term a misleading one and will hereinafter call the motors to which this invention relates "series induction motors".

The objects of my invention are, firstly, to improve the starting torque of such motors for a given terminal voltage both at the very moment of starting and also during the rest of the starting performance; secondly, to enable the starting torque and the speed of such motors to be conveniently controlled preferably without the use of expensive auxiliary apparatus such as transformers and the like; also, providing means for easily converting the characteristic of these motors from a series to a shunt characteristic while compensating (improving their power factor) them or not.

I achieve these objects broadly speaking by combining in one motor the action of a series induction motor with that of a series conduction motor or to put it differently by disposing the field exciting winding of a series induction motor partly on the stator and partly on the rotor, the two parts being connected in series relation.

The views as to the operation of these machines seem to differ widely even at the present time and that is why I explain what I propose to do in different ways so as to make my objects and the manner in which I attain them clear to all.

The arrangement indicated so far will help to increase the torque with a given terminal voltage after the first instant of starting, *i. e.* when the motor is in motion.

In order to regulate either the starting torque or speed of the motor or both, I provide that part of the field winding which is disposed on the stator with tappings which enable the useful number of turns in that winding to be varied either by cutting out more or less of the total number of turns or by grouping these turns differently.

In order to convert the characteristic of this motor from a series to a shunt characteristic, I gradually or suddenly short-circuit the armature along the field axis including in that circuit or not an E. M. F. of a phase suitable for compensating the motor, said E. M. F. being derived from the motor itself or from an outside source.

In order to increase the initial starting torque for a given terminal voltage I include the E. M. F. used for compensating the motor in circuit with the armature and field windings in such a way as to "boost" the voltage impressed on the motor.

I will now proceed to describe the invention more fully with the help of the accompanying drawings.

Figures 1, 2, 3, 4 and 6 show known forms of continuous and alternate current motors and are made use of for the purpose of roughly indicating the theory on which the invention is based and explaining the meaning of the lettering and signs used in the drawings. Fig. 5 shows a simple form of the improved motor forming the subject matter of this invention. Figs. 7 and 8 show another form of the improved motor, indicate means for converting same into a compensated shunt motor the compensating E. M. F. being derived from a winding disposed on the stator, for regulating its speed, and also show the necessary alterations in the connections in order to reverse the direction of rotation. Fig. 9 shows a means for obtaining the compensating E. M. F. from a transformer connected in parallel with the mains. Fig. 10 shows an arrangement where the rotor field winding is connected in series relation with the stator windings S_1 and S_2 by means of the series transformer T_1. Fig. 11 shows a motor in which the auxiliary or compensating voltage is derived from a part of the main stator winding.

In Fig. 1 is shown diagrammatically an ordinary continuous current motor. By way of example the armature is shown as a Gramme ring wound in a certain direction. All the other figures are supposed to be provided with such Gramme rings. The brushes in all cases rest directly on these windings. Assuming the current to enter the armature at the right hand brush and leave it at the left hand brush, the distribution of current obtained is shown by the little arrows along the armature winding, but it can also be shown and more conveniently by the dot and cross placed in the air gap; these indicate the direction of the current along the active part of the winding without making it necessary to show the winding itself. This simple method of indicating the distribution of E. M. F. or current will hereinafter be used. In this figure, with the given direction of the motor field M F and the armature current, the motor will revolve as indicated by arrow K; the direction of the field due to the current flowing through the armature is then shown by arrow A. F. A back E. M. F. will now be developed opposing the working E. M. F. (E T) impressed on the armature brushes and also opposing the current flowing through the armature. This back E. M. F. (E B) is indicated by an arrow which shows that this back E. M. F. enters the armature by the left hand brush thus acting against E T.

Taking now Fig. 2 which represents a series conduction motor it will be seen that for the conditions shown the direction of rotation will be clockwise as indicated by arrow K. The dot and cross in the air gap show the distribution of the armature current and of E T, while the direction of E B is also shown by an arrow. If the distribution of E B were shown in the same manner as that of E T the cross would be at the top and the dot at the bottom since E B is opposed to E T.

In Fig. 3 is shown a series induction motor. In this case there are two fields to take into account, the transformer field T F (due to the main or transformer winding S_1) in the armature axis along which the rotor is short circuited by means of the brushes R R and the motor field M F displaced by $\frac{180}{n}$ degrees with regard to the latter. The working E. M. F. (E T) is impressed on the rotor along the armature axis by induction with the help of T F, the back E. M. F. (E B) is nearly opposed to it and is generated in the rotor along R R by rotation in M F. For the direction of the fields as shown in Fig. 3 the direction of rotation will be clockwise as shown by arrow K and will be evident from a comparison with Fig. 1.

Fig. 4 shows the same case as Fig. 3 but as the distribution of the various fields and E. M. F's is shown in the same manner as in Fig. 1, this needs no further comment.

In Fig. 5 the series conduction motor of Fig. 2 has been combined with the series induction motor of Fig. 3 and as the direction of rotation of the combination must obviously be the same as the direction of rotation of the component parts, it will therefore be clockwise as indicated by arrow K.

Fig. 6 shows the well-known induction motor in which the armature current flows along axis R R and the field or exciting current along axis H H. It is seen therefore that the rotor winding in the axis H H can be made use of as a field winding. Bearing this in mind and referring to Fig. 5, it can be said that the latter represents a series induction motor the field winding of which is partly disposed on the stator and shown at S_2 and partly on the rotor and included between the brushes H H; it is immaterial whether these brushes bear on the same winding as is short-circuited by the brushes R R or on a separate winding disposed on the same rotor.

The reason why a motor connected as shown in Fig. 5 exerts a great torque after it is in motion is as follows:—By taking the primary or stator current through the rotor along the motor field axis, an E. M. F. (E R) generated by rotation in the transformer field T F is included in the primary circuit; the said E. M. F. is according to the direction of rotation either in phase with T F or of opposite phase to it. Now the primary current is always taken through the rotor in such a direction that the E. M. F. (E R) helps to counteract the various E. M. F's of self-induction in the primary circuit and which are due to S_1, to the rotor winding in the motor field axis, and to S_2. The result is that a given impressed E. M. F. will drive a much greater current through the motor when E R is thus taken advantage of.

I am aware that a motor such as shown in Fig. 5 but without the addition of the winding S_2 has been proposed before now, although its action may have been explained differently, but such a machine could not be regulated without the use of external devices. One of my objects is to do away with the use of these external devices and this I accomplish by adding this winding S_2 and arranging it as shown in Figs. 7 and 8 with or without the other improvements shown in these figures. In these Figs. 7 and 8, by means of the winding S_2 and the lever L the current taken by the motor when it is switched on to the mains can be reduced to any desired extent, the motor can be started as smoothly as desired, the torque increasing as the lever is moved toward point 4.

A winding S_3 disposed on the stator coaxially with S_1 is connected in series with S_1 and S_2 and in such a way that the voltage generated therein will be added to the total voltage impressed on the motor, the line voltage being kept constant; in this manner the maximum torque of the motor is increased. It is not necessary to derive this auxiliary voltage from a winding such as S_3 disposed on the motor itself; it can be derived from a separate transformer, in which case the secondary of the separate transformer will be connected in series with any of the motor windings already referred to any in place of S_3, the primary of such transformer being at the same time connected in parallel with the supply. This arrangement can be carried out whether the separate transformer has distinct primary and secondary windings or whether it is of the auto type. The auxiliary voltage supplied by S_3 is practically co-phasal with that of the supply and is made use of to compensate the motor after the latter has been converted into a shunt induction motor. For this purpose this auxiliary voltage can also be derived from a separate transformer T as shown in Fig. 9 or from the winding S_1 for instance at the point 8 as shown in Fig. 11, for it is seen in Figs. 7 and 8 that winding S_1 is co-axial with S_3 and the E. F. F's which can be derived from these two windings or any part of them must be practically co-phasal.

In order to convert the motor into a shunt induction motor I short circuit the points 5 and 6 automatically or by hand and gradually over a resistance such as W or suddenly. The resistance W can also be used for the finer adjustment of the speed of the motor when working as a series machine. If the speed is below synchronism a reduction of the value of W will raise the speed; if it is above synchronism a reduction of W will lower the speed.

I may or may not make use of the winding S_3 or its equivalent, but I prefer to do so.

When higher voltage is used I may take the current through the rotor in the direction of the motor field with the interposition of the series transformer T^1 as shown in Fig. 10, in which case, when converting the motor into a shunt induction machine, I short-circuit either the secondary N or the primary N^1 or I short circuit both the primary and secondary of the transformer T^2.

In order to reverse the direction of rotation of this motor, I either reverse the direction of the transformer field relatively to that of the motor field by reversing the current through S_1 and also suitably altering the connections to S_3 as shown in Fig. 8, or I reverse the direction of the current through the rotor along the motor field axis and also the direction of the current through the field winding S_2 disposed on the stator.

What I claim and desire to secure by Letters Patent is:—

1. In a single phase commutator motor, the combination of a main stator winding, a field winding disposed partly on the rotor and partly on the stator and displaced with regard to the main stator winding, the two parts of the field winding and the main stator winding being connected in series relation to each other and across the mains, short-circuited armature brushes, and a switch for short-circuiting that part of the field winding which is disposed on the rotor.

2. In a single phase commutator motor, the combination of a main stator winding, a field winding disposed partly on the rotor and partly on the stator and displaced with regard to the main stator winding, the two parts of the field winding and the main stator winding being connected in series relation to each other across the mains, a source of compensating E. M. F., short-circuited armature brushes, and a switch for short-circuiting that part of the field winding which is disposed on the rotor so as to include the compensating E. M. F. within this closed circuit.

3. In a single phase commutator motor, the combination of a main stator winding, a field winding disposed partly on the rotor and partly on the stator and displaced with regard to the main stator winding, a source of compensating E. M. F., the two parts of the field winding, the main stator winding and the source of compensating E. M. F. being connected in series relation to each other and across the mains, short-circuited armature brushes, and a switch for short-circuiting that part of the field winding which is disposed on the rotor so as to include the compensating E. M. F. within this closed circuit.

4. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, the said main stator winding, stator field winding and rotor field winding being all connected in series relation and across the mains, and a switch for short-circuiting that part of the total field winding which is disposed on the rotor and between the field brushes.

5. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, the said main stator winding, stator field winding and rotor field winding being all connected in series relation and across the mains, a switch for short-circuiting that part of the field

winding which is disposed on the rotor and between the field brushes, and means for varying the number of turns of that part of the field winding which is disposed on the stator.

6. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, the said main stator winding, stator field winding and rotor field winding being all connected in series relation and across the mains, a source of compensating E. M. F. and a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include the said compensating E. M. F. in closed circuit.

7. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, the said main stator winding, stator field winding and rotor field winding being all connected in series relation and across the mains, a source of compensating E. M. F. a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include the said compensating E. M. F. in this closed circuit, and means for varying the number of turns of the stator field winding.

8. An alternate current motor comprising the combination of a stator, a rotor, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, a source of compensating E. M. F., the said main stator winding, stator field winding, rotor field winding and source of compensating E. M. F. being all connected in series relation and across the mains, a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include said compensating E. M. F. in this closed circuit.

9. An alternate current motor comprising the combination of a stator, a rotor, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, a source of compensating E. M. F., the said main stator winding, stator field winding, rotor field winding, and source of compensating E. M. F. being all connected in series relation and across the mains, a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include said compensating E. M. F. in this closed circuit. and means for varying the number of turns of that part of the field winding which is disposed on the stator.

10. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, an auxiliary winding disposed on the stator and adapted to provide a compensating E. M. F. the said main stator winding, stator field winding and rotor field winding being all connected in series relation and across the mains, a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include the said auxiliary stator winding in this closed circuit.

11. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature

brushes, a field winding on the stator approximately in the axis of the field brushes, an auxiliary winding disposed on the stator and adapted to provide a compensating E. M. F., the said main stator winding, stator field winding, rotor field winding and auxiliary stator winding being all connected in series relation and across the mains, a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include the said auxiliary stator winding in this closed circuit.

12. An alternate current motor comprising the combination of a rotor, a stator, a winding on the rotor connected to a commutator, said winding doing duty along one axis as armature winding and as field winding along another axis, short-circuited armature brushes on the said commutator, field brushes on the said commutator displaced with regard to the armature brushes, a main winding on the stator approximately in the axis of the short-circuited armature brushes, a field winding on the stator approximately in the axis of the field brushes, an auxiliary winding disposed on the stator and adapted to provide a compensating E. M. F., the said main stator winding, stator field winding, rotor field winding and auxiliary stator winding being all connected in series relation and across the mains, a switch for short-circuiting that part of the field winding which is disposed on the rotor and between the field brushes so as to include the said auxiliary stator winding in this closed circuit, and means for varying the number of turns of that part of the field winding which is disposed on the stator.

In witness whereof, I have hereunto signed my name in presence of two subscribing witnesses.

VALÈRE ALFRED FYNN.

Witnesses:

ROBERT MILTON SHEARPOINT,

ALFRED BEESLEY CAMPBELL.