(No Model.) 3 Sheets—Sheet 1.

T. M. FOOTE.

ELECTRIC MOTOR.

No. 434,180. Patented Aug. 12, 1890.

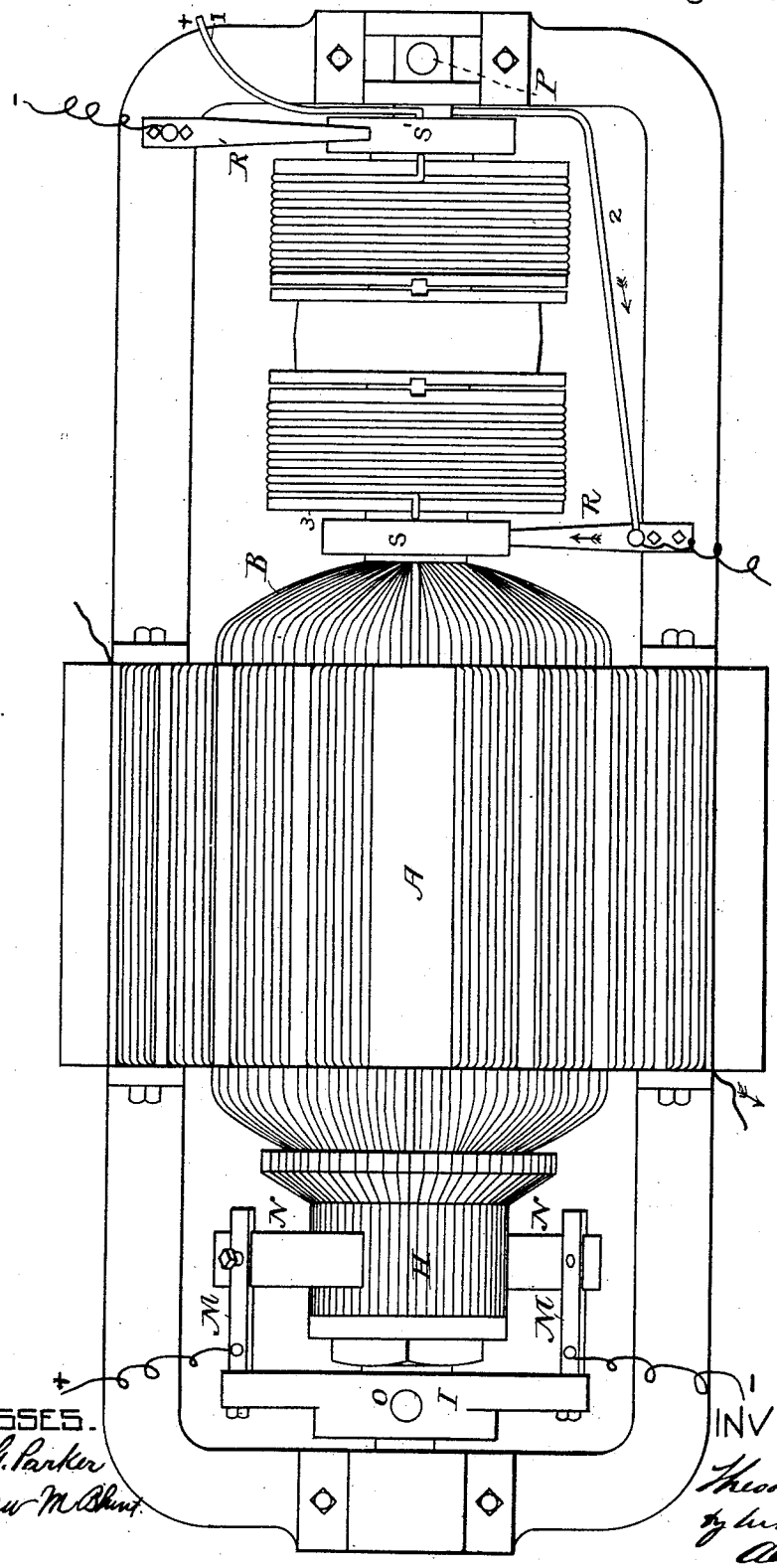

FIG. 1.

WITNESSES.
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(No Model.)

3 Sheets—Sheet 2.

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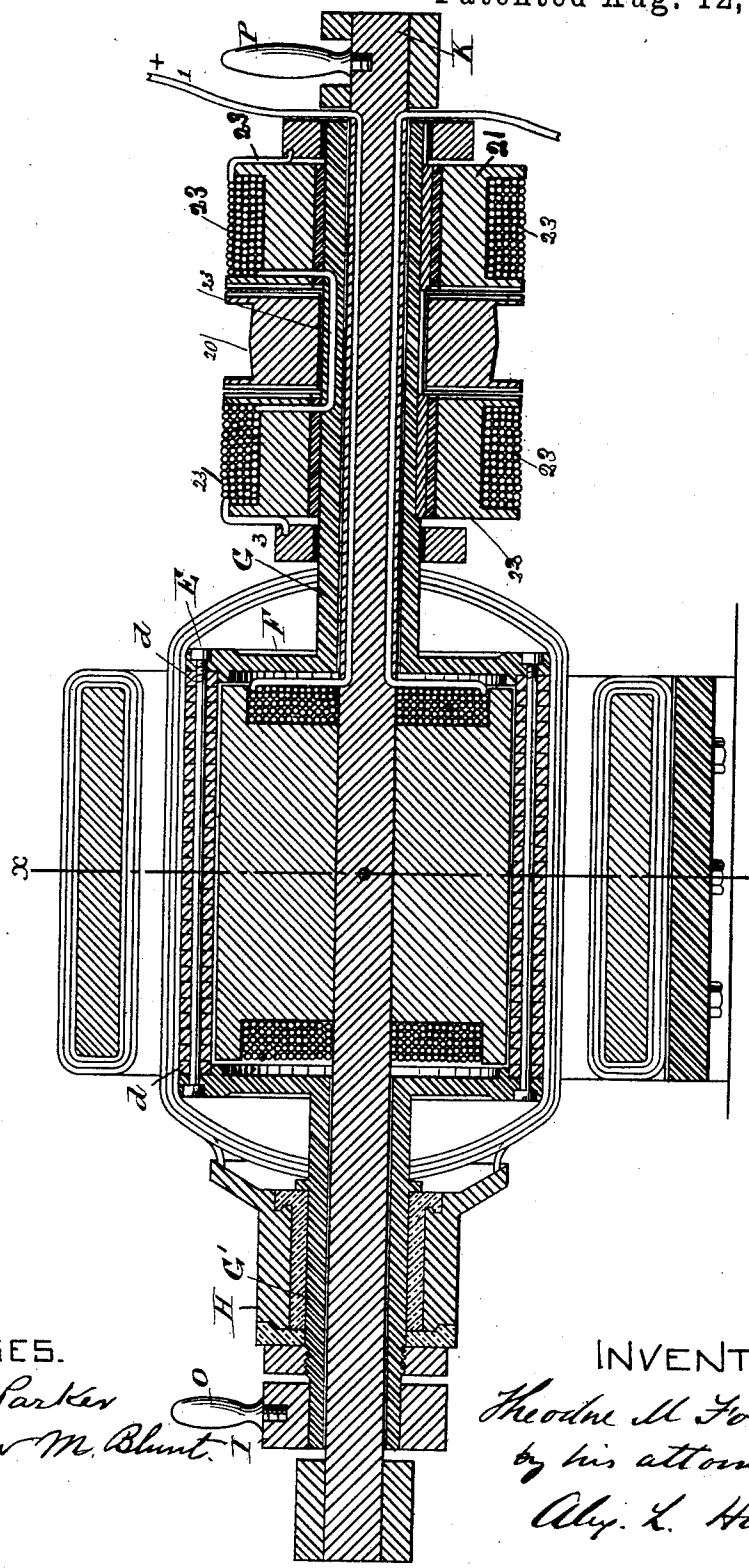

Fig. 2.

WITNESSES.

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(No Model.) 3 Sheets—Sheet 3.

T. M. FOOTE.

ELECTRIC MOTOR.

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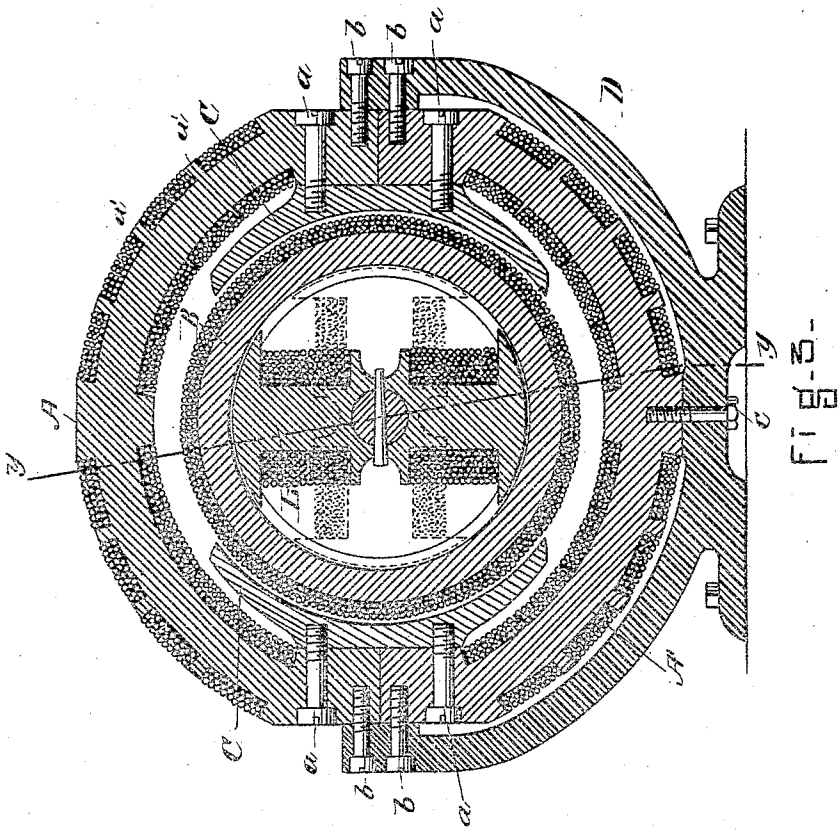

Fig. 5.

WITNESSES.

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UNITED STATES PATENT OFFICE.

THEODORE M. FOOTE, OF BOSTON, MASSACHUSETTS.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 434,180, dated August 12, 1890.

Application filed July 18, 1889. Serial No. 317,880. (No model.)

To all whom it may concern:

Be it known that I, THEODORE M. FOOTE, of Boston, in the county of Suffolk and State of Massachusetts, have invented a new and useful Improvement in Electric Motors, of which the following, taken in connection with the accompanying drawings, is a specification.

The object of this invention is to obtain simplicity and economy of construction, increase of electrical efficiency, reduction of the weight of metal required to obtain a certain output, maintenance of the axis of commutation at the point of least sparking under varying conditions of load, and separate and independent circuits in the machine for the exciting-current.

To these ends this invention consists, first, in the construction, substantially as hereinafter more fully set forth, of the field-magnets and their pole-pieces; second, in the combination, substantially as hereinafter more fully set forth, with a cylindrical armature rotating between the poles of a cylindrical field-magnet, of another field-magnet within the armature and having pole-pieces opposite pole-pieces of the external field-magnet, and, third, in means, substantially as hereinafter more fully set forth, for altering the position of the pole-pieces of the internal field-magnet relatively to the pole-pieces of the external field-magnet, whereby the effect due to the distortion of the field caused by the increase of current in the armature is corrected.

In the accompanying drawings, Figure 1 is a plan view of the motor. Fig. 2 is a longitudinal sectional view through the line *y y*, Fig. 3; and Fig. 3 is a transverse vertical section through the line *x x*, Fig. 2.

In the several figures the same letters and numerals refer to the same parts.

In order that the sectional views may show all the parts of the machine, the internal field-magnet is represented as turned into a position in which its axis is at right angles to the axis of the external field-magnet; but the normal position of the internal field-magnet is with its axis coincident with the axis of the external field-magnet, except when it is partially rotated in order to correct the effect due to the distortion of the field.

The external field-magnet is composed of two semi-cylinders A A′, united together to form a cylinder inclosing the armature B, and having pole-pieces C C on the inside of the cylinder on opposite sides of the armature. These pole-pieces are provided with extensions on each side between the armature and the core of the field-magnet, and are secured to the cores A A′ by bolts *a a* passing through the cores from the outside. Each pole-piece is united to the opposing ends of the cores, and thus serves to hold them, the two semi-cylinders forming the cylindrical field-magnet. The cores of this field-magnet have a series of projections *a′ a′* on the outside and corresponding narrowing projections on the inside, which have the effect of increasing the magnetic power of the core. The wire is wound between these projections.

The cylindrical field-magnet is supported in a semi-cylinder D, of non-magnetic metal, and is secured to the same by bolts *b b* on each side and by a central bolt C in the bottom of the semi-cylinder A′. The support is suitably secured to the bed-plate of the machine. I have shown this manner of supporting the field-magnet; but it is obvious that it may be supported in any other manner that may be found convenient and suitable.

It will be seen that the several parts of the machine are firmly and compactly held together, and that they can be readily separated from one another by removing the bolts.

The armature B is preferably made of a series of iron rings *d d*, placed side by side and secured together by bolts E between two caps F of non-magnetic metal, one on each end. On each of these caps and cast with the same is a sleeve G G′. On one of these sleeves G′ is keyed the commutator H and brush-holder I, and on the other sleeve G may be keyed, as shown, the magnetic coupling, which is described and claimed in another application, Serial No. 317,879, for Letters Patent of the United States filed by me with this application. This magnetic coupling or electro-magnetic friction-clutch comprises a loose collar 20 on the sleeve G, and a collar 21 fixed to rotate with said sleeve. The loose collar 20 may be in the form of a pulley and may be disposed between two collars 21 and 22, all of said collars being composed of magnetic metal. A wire 23, forming a part of an electric cir-

cuit, is wound upon the fixed collars, whereby they may be magnetized. Either the loose collar or the fixed collars are capable of a slight longitudinal movement on the sleeve G, whereby when one of the fixed collars is magnetized the adjacent faces of the loose collar and the magnetized fixed collar will unite, forming a friction-clutch, transmitting the power from the sleeve G to the collar or pulley 20, and thence by a belt to the work. The current may be conducted to the wire 23 in any suitable manner, as by brushes bearing upon collars 3, of non-magnetic metal, fixed on the sleeve G, adjacent to the magnetizable collars constituting a part of the clutch. This coupling is shown in order to exhibit the arrangement of the circuit when the coupling is used with the motor, as will preferably be the case when the motor is used for street-cars; but it forms no part of the present invention, as the motor can be used equally well with or without the coupling. Within the sleeves and suitably supported at each end is a non-rotating shaft K, and on this shaft within the armature is keyed the internal field-magnet L, which magnet consists of a core suitably wound and having pole-pieces curved concentrically with the armature and as near as possible to its internal walls. The form of these pole-pieces is, however, not essential to the operation of the machine, but it is preferable that they should have this form.

The armature shown is a drum-armature, and may be wound in any manner that is adapted for winding drum-armatures, and the different sections of the wire are connected in the usual manner to the sections of the commutator H, which commutator may be of any desired form.

If desired, the armature may be wound in the same way that a ring-armature is wound.

The brush-holder is mounted upon the sleeve G′, and is provided with the arms—one on each side—to which are secured parallel supports M M for the brushes N N. These brushes can be adjusted on the face of the commutator by moving the brush-holder on the sleeve by means of the lever O. Any other form of brush-holder may be adopted, if desired.

The winding of the machine may be series, shunt, or compound, or there may be separate and independent circuits for the field-magnets and the armature, and these circuits may be connected together, as may be desired.

In the drawings the armature and external field-magnets are included in the circuit which is connected with the commutator; but the independent circuit through the internal field-magnet includes the magnets of the clutch. This circuit is as follows: By the wire 1, which is laid in a channel in the shaft K, to the internal field-magnet, around this magnet and by another wire, also laid in a channel in the shaft K, to the wire 2, thence by brush R to an insulated collar of metal S upon the shaft L, and through the coils of the clutch-magnet to another collar S′ and brush R′. The lines of force produced by the external field-magnet are concentrated by passing through the iron of the internal field-magnet, and the field in which the armature rotates is strengthened by the lines produced by the internal field-magnet, so that the armature rotates in an intense field and the lines of force constituting the magnetic circuit are concentrated within this field of force with the result that there is no waste of force, and the machine is therefore one of high efficiency.

The shaft to which the internal field-magnet is attached is capable of being turned on its bearings by means of a lever P, so that the position of the pole-pieces of the internal field-magnet relative to the pole-pieces of the external field-magnet can be changed as may be desired to correct the distortion of the field, due to any increase of the armature-current caused by variations in the work or otherwise, and the necessity of any adjustment of the brushes to insure commutation at the point of least sparking will be avoided, thus enabling them to be permanently fixed in the most suitable position. The same means may be adopted to prevent sparking in case the brushes become so worn away that the current is not delivered at the proper point on the commutator.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. A cylindrical field-magnet composed of two semi-cylindrical sections, arc-shaped pole-pieces within said cylinder at opposite sides thereof and covering the joints between the semi-cylindrical sections, and bolts passing through the adjacent ends of said sections into said pole-pieces, substantially as described.

2. The combination of a cylindrical field-magnet, a cylindrical armature therein, and a field-magnet within said armature, having its pole-pieces adjustable relatively to the outer field-magnet, a semi-cylindrical support on said field-magnet, and bolts passing through said support near its upper edges and entering said cylindrical field-magnet adjacent to the joints between the sections, substantially as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 12th day of July, A. D. 1889.

THEODORE M. FOOTE.

Witnesses:
FRANK G. PARKER,
MATTHEW M. BLUNT.