(No Model.) 4 Sheets—Sheet 1.

E. J. HOUSTON.

ELECTRIC MOTOR.

No. 356,878. Patented Feb. 1, 1887.

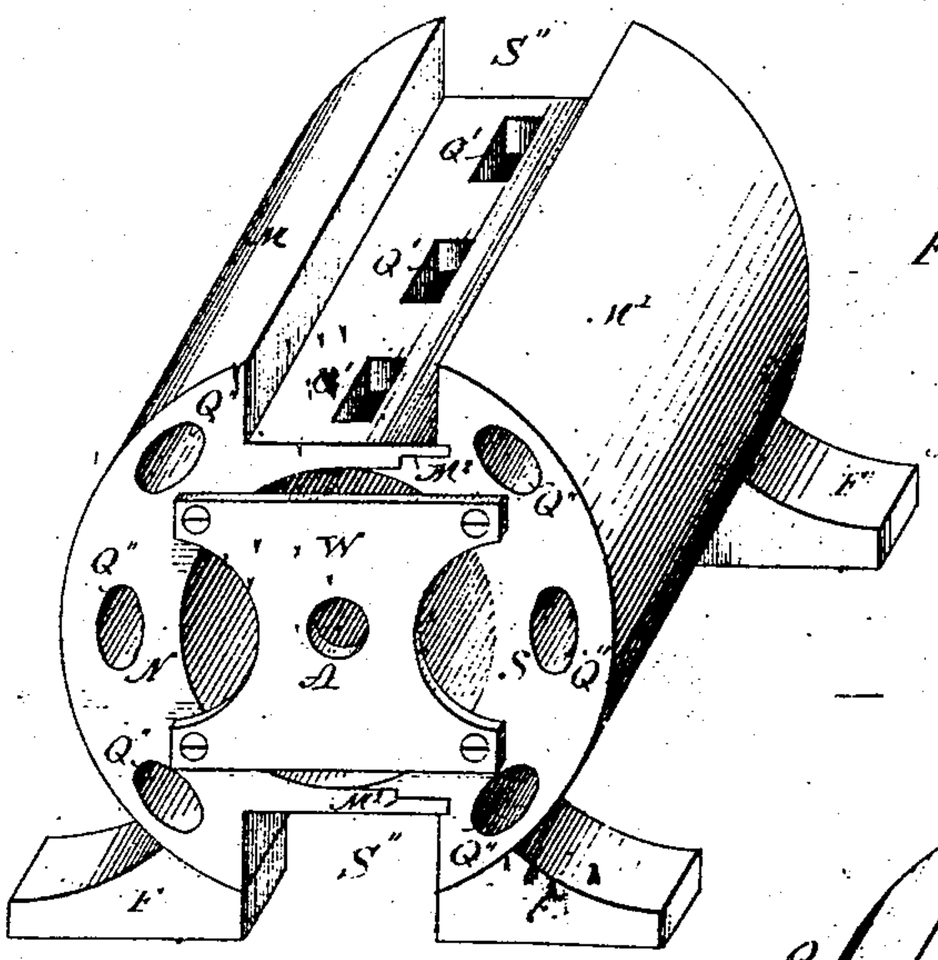


Fig. 1.

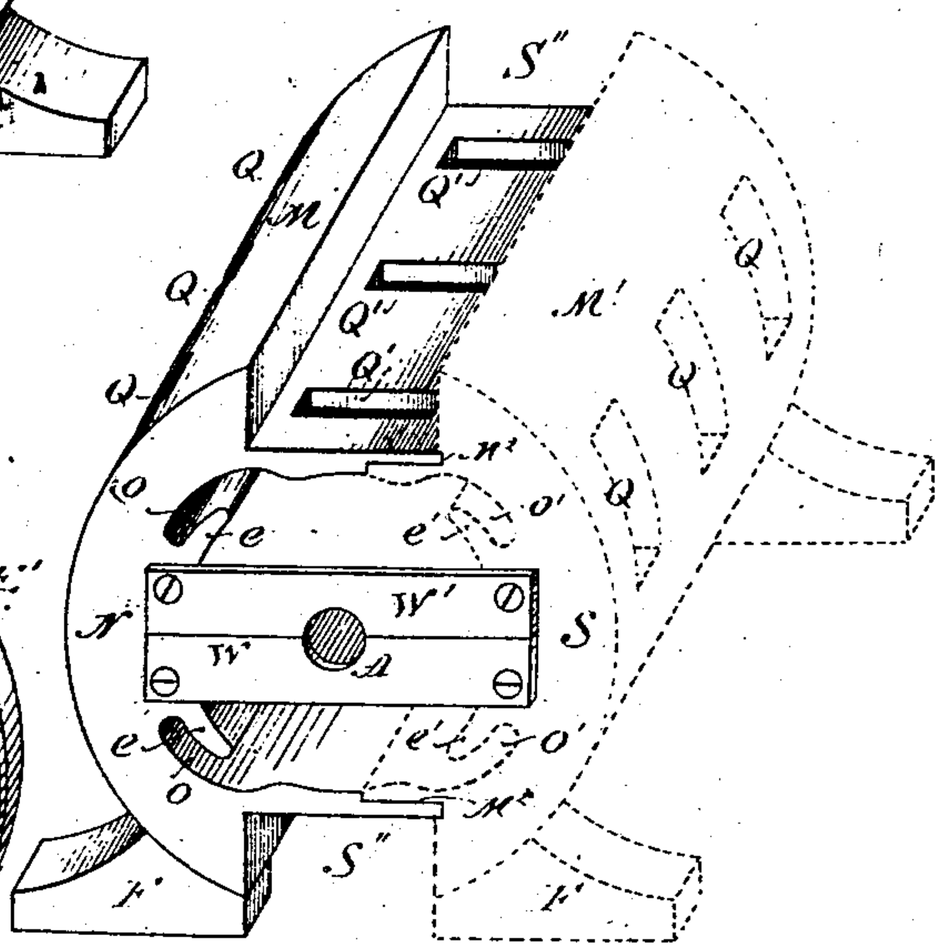


Fig. 2.

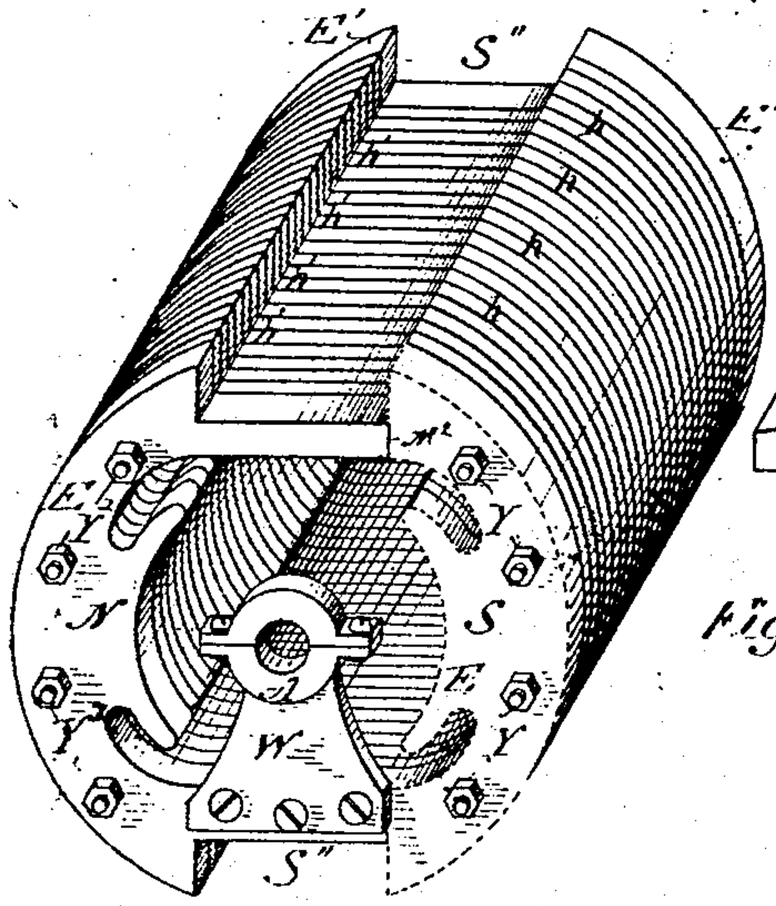


Fig. 3.

Witnesses:
Ernest Hoshagen
Thos. Dorney.

Inventor:
Edwin J. Houston
By his Attorney: R. L. Townsend

(No Model.)

4 Sheets—Sheet 2.

E. J. HOUSTON.

ELECTRIC MOTOR.

No. 356,878. Patented Feb. 1, 1887.

Fig. 4.

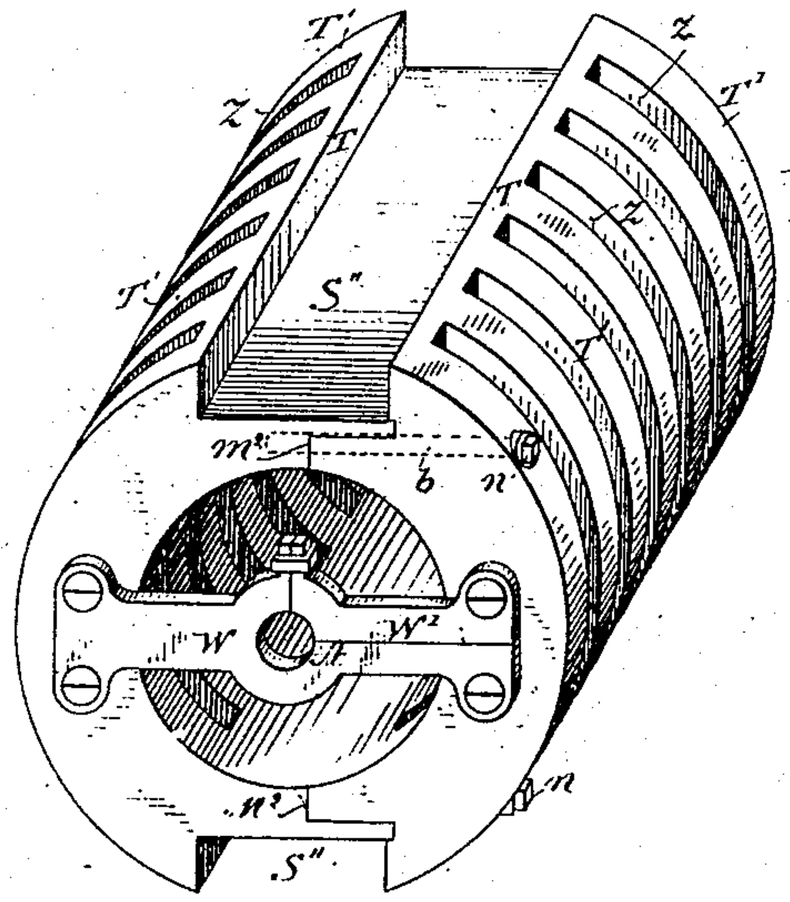


Fig. 10.

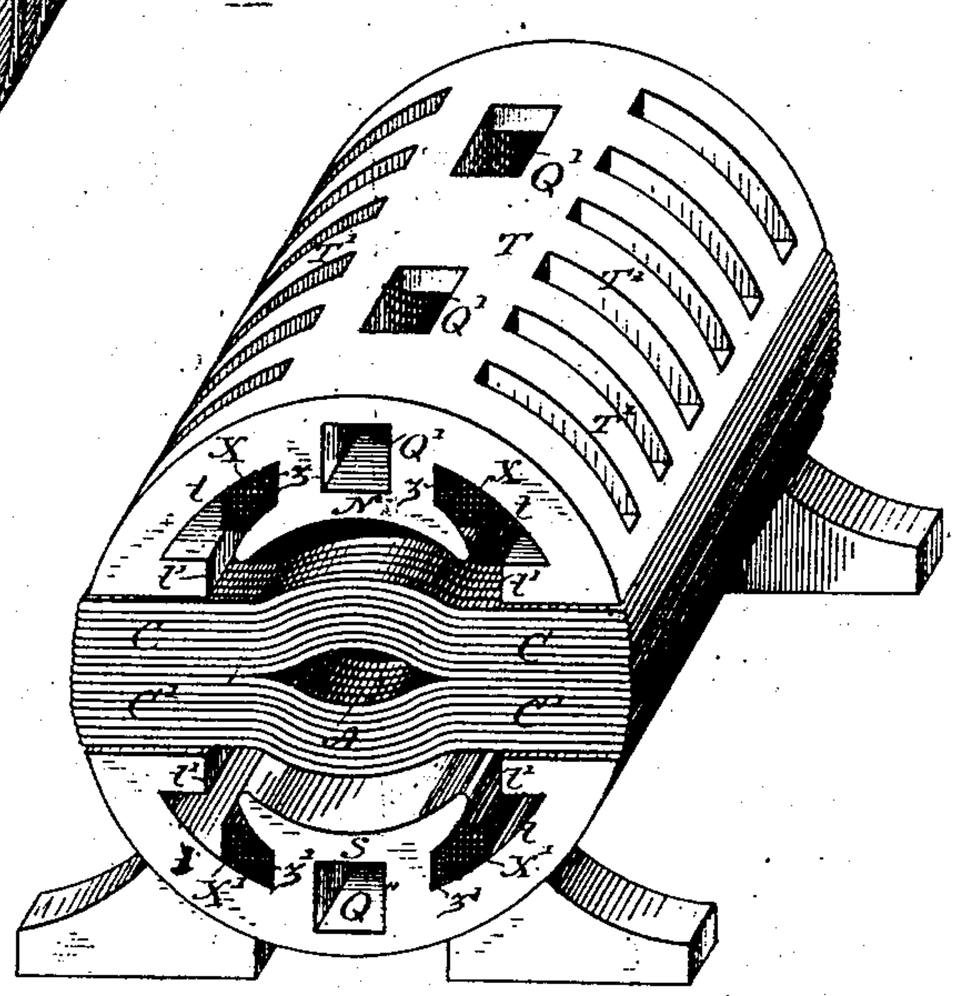
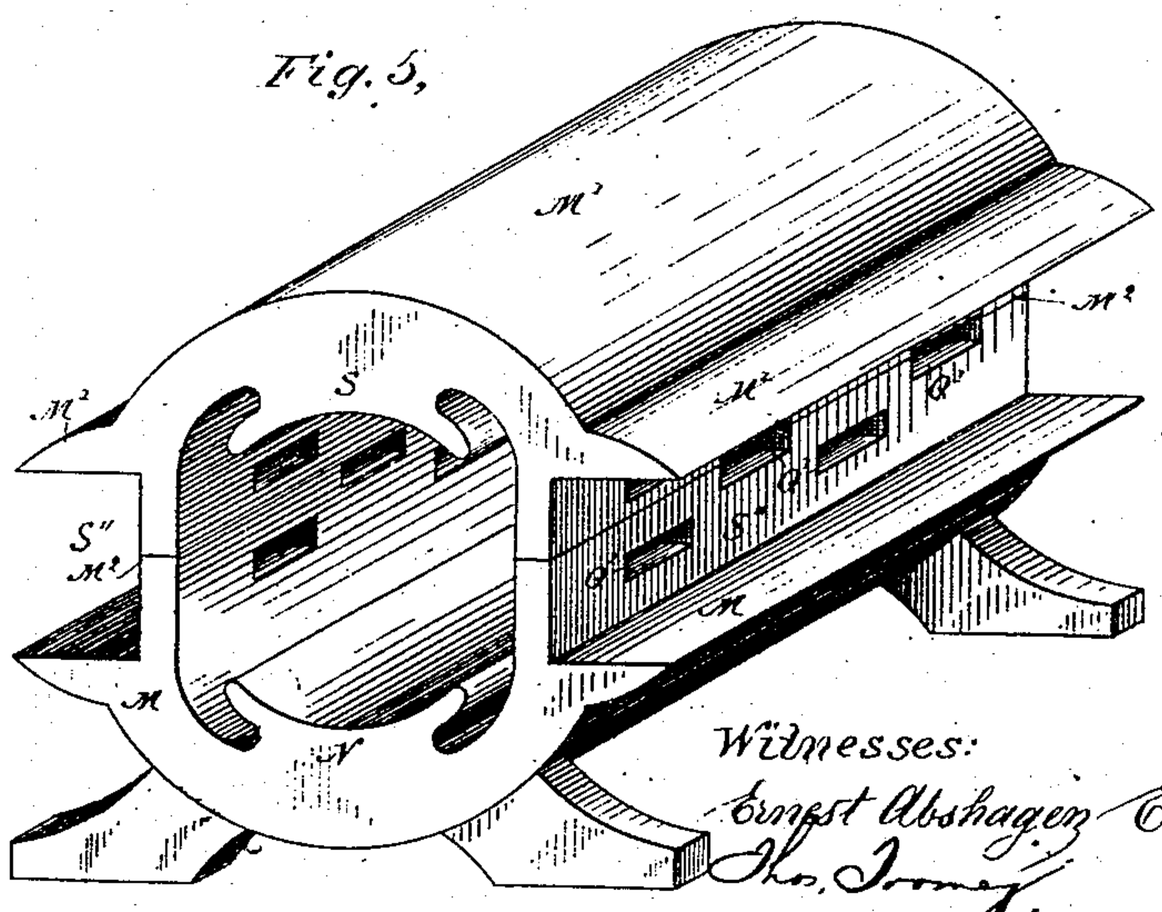


Fig. 5.



Witnesses:
Ernest Abshagen
Thos. Tormey

Inventor:
Edwin J. Houston

By his Attorney:
W. L. Townsend

(No Model.)

4 Sheets—Sheet 3.

E. J. HOUSTON.

ELECTRIC MOTOR.

No. 356,878. Patented Feb. 1, 1887.

Fig. 6.

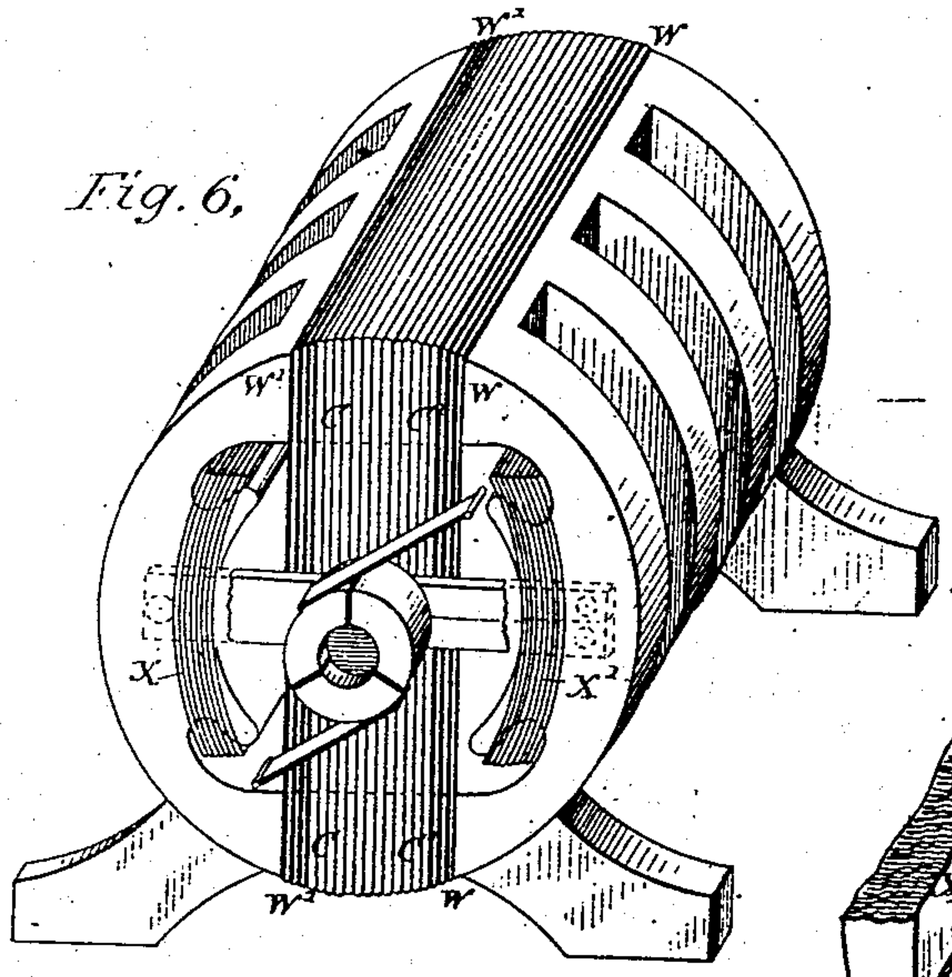


Fig. 7.

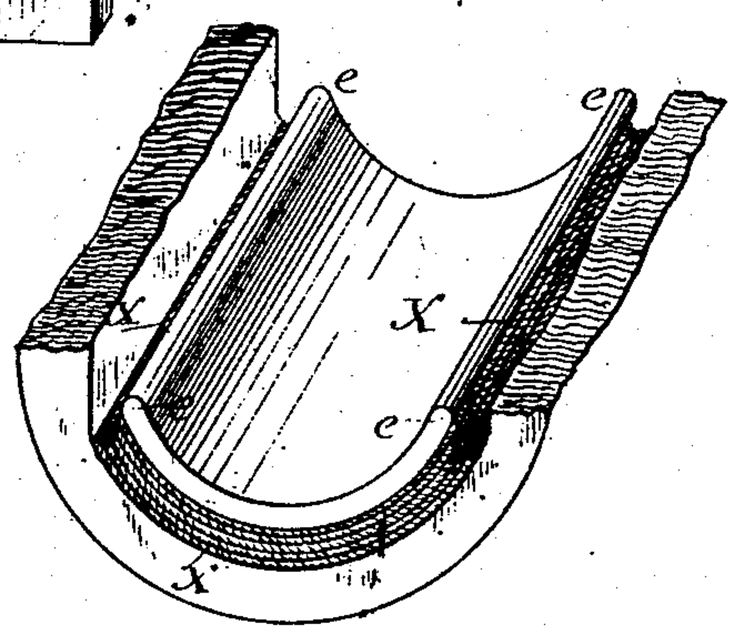


Fig. 12.

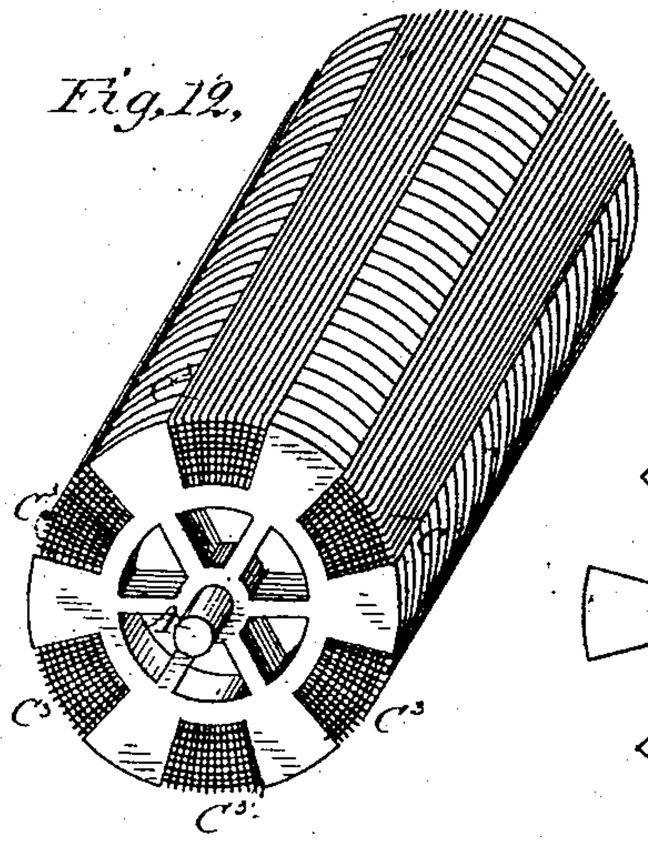


Fig. 13.

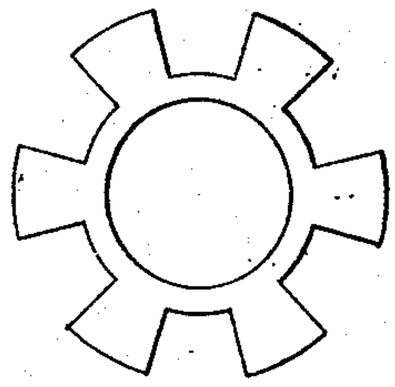
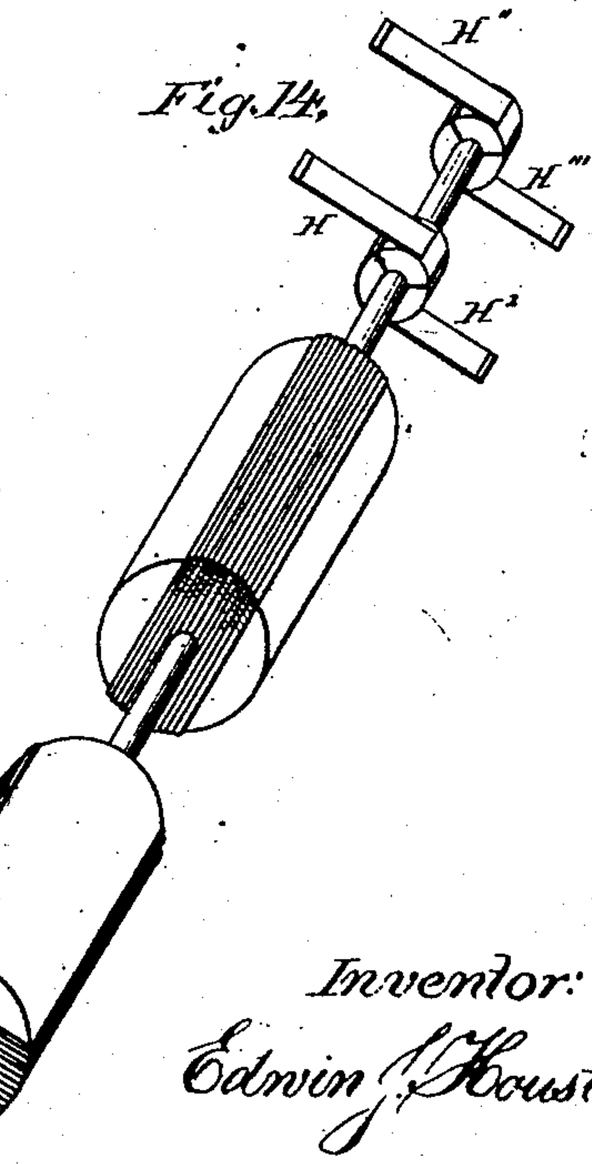


Fig. 14.



Witnesses:
Ernest Hopkagen
Thos Dorney

Inventor:
Edwin J. Houston

By his Attorney: W. L. Turnand

(No Model.)

4 Sheets—Sheet 4.

E. J. HOUSTON.

ELECTRIC MOTOR.

No. 356,878. Patented Feb. 1, 1887.

Fig. 8,

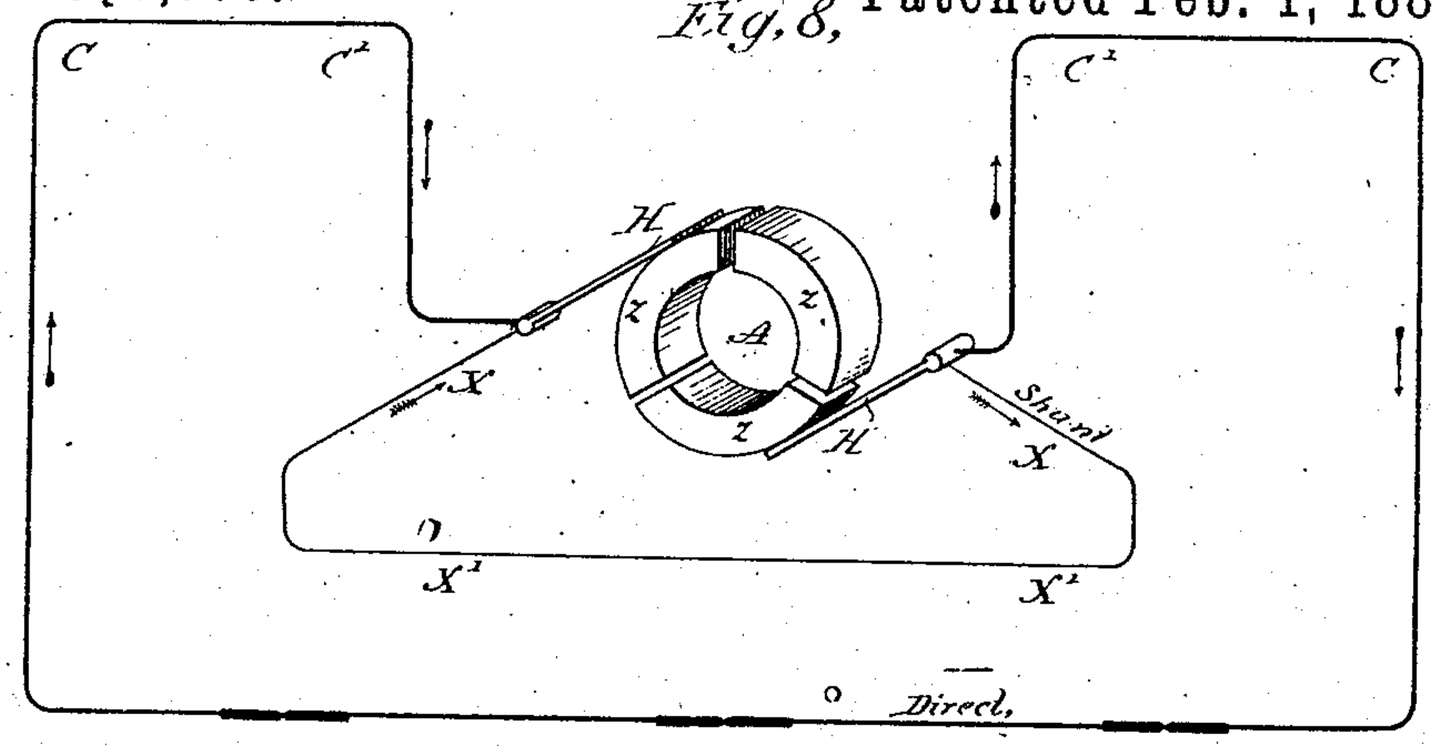


Fig. 9,

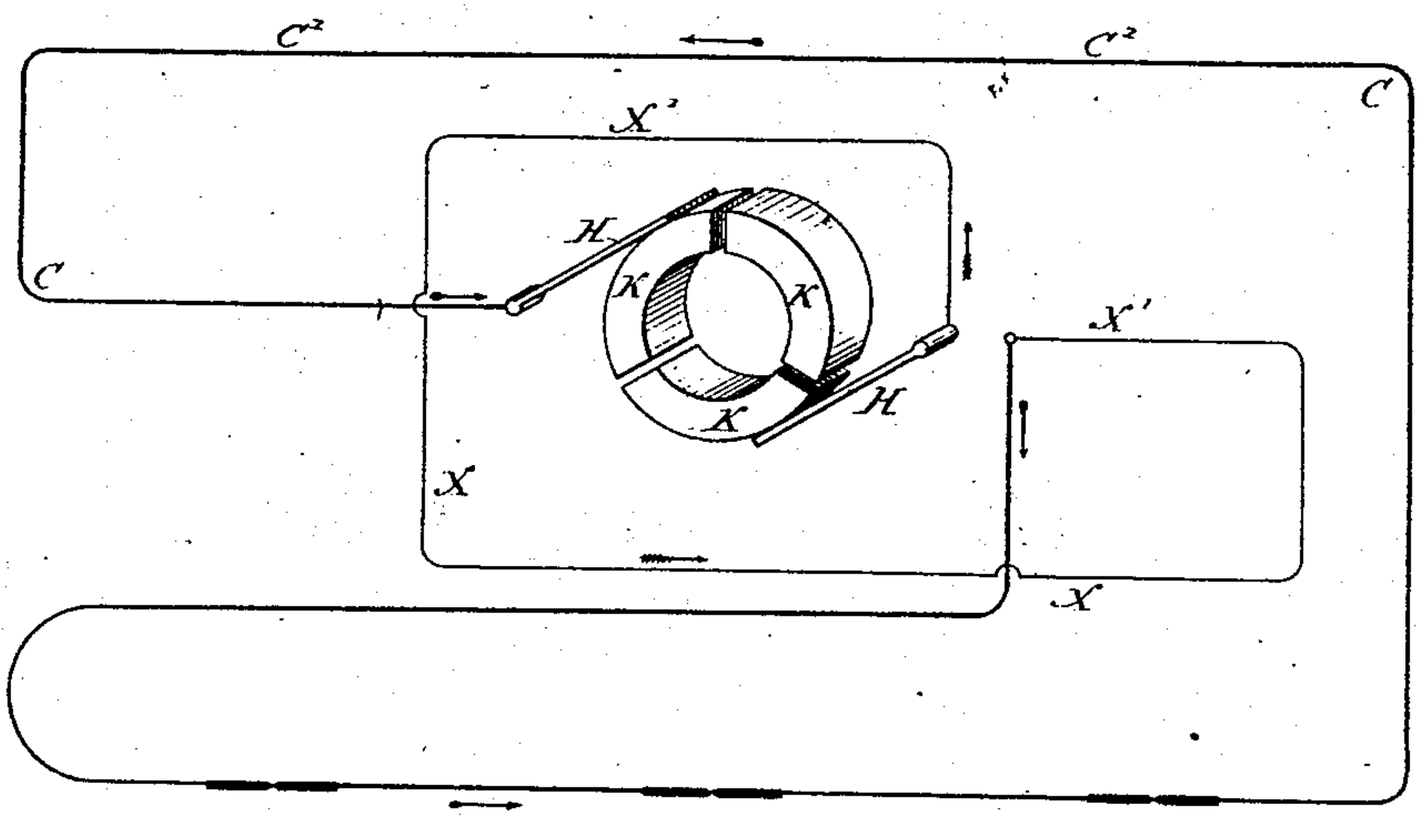
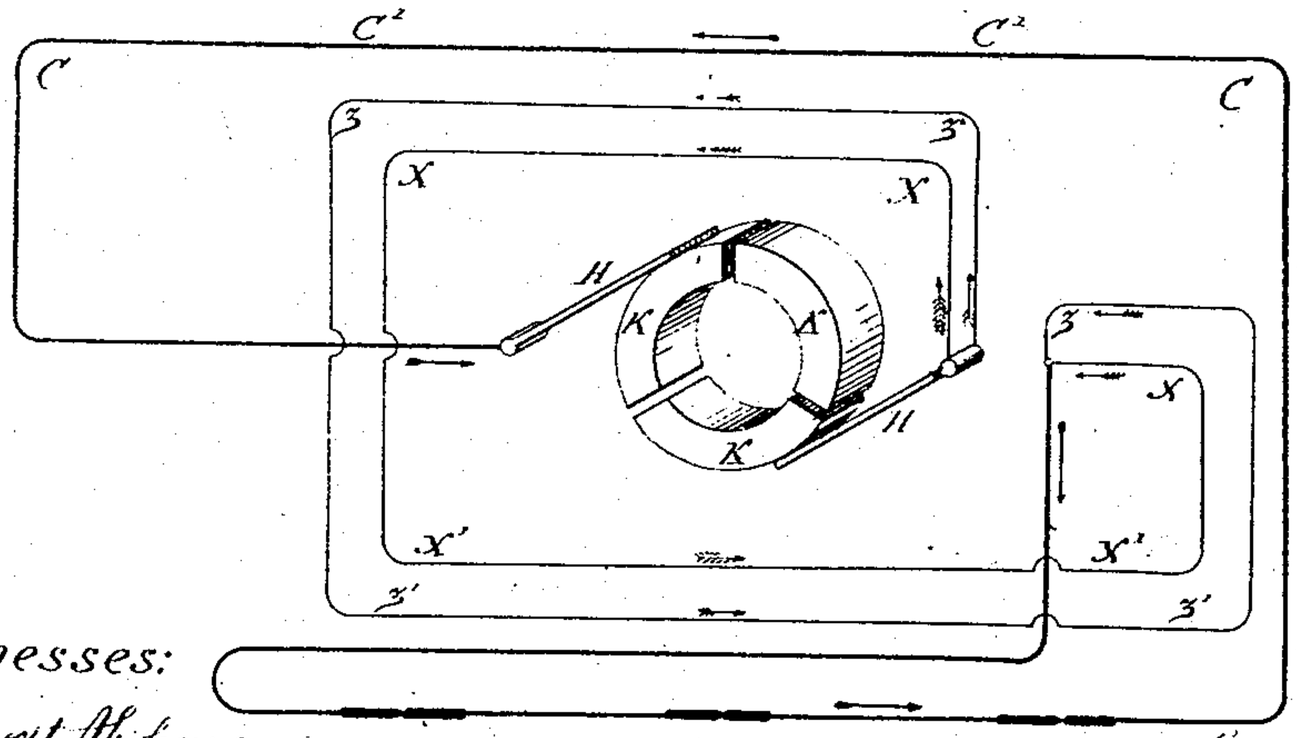


Fig. 11,



Witnesses:
Ernest Hopkinson
Thos. Dewey.

Inventor:
Edwin J. Houston
By his Attorney: W. C. Townsend

UNITED STATES PATENT OFFICE.

EDWIN JAMES HOUSTON, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 356,878, dated February 1, 1887.

Application filed January 2, 1884. Serial No. 116,295. (No model.)

To all whom it may concern:

Be it known that I, EDWIN JAMES HOUSTON, a citizen of the United States, and a resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Electric Motors, of which the following is a specification.

The objects of my invention are to secure ease, economy, and compactness in the construction of electro-dynamic motors, to increase the economy of their operation, and to permit their working at relatively high rates of speed without the proportion of energy they develop being considerably reduced.

The first part of my invention relates to the construction and arrangement of the field-magnet frame and its pole-pieces.

Figure 1 is a perspective view of a field-magnet frame embodying my invention. Fig. 2 illustrates a modification in the form thereof. Fig. 3 shows a way of building up the field-magnet frame from a number of separate pieces. Fig. 4 shows another way of making the frame. Fig. 5 illustrates a modification in the shape of the frame. Fig. 6 shows the manner of applying the exciting coil or coils. Fig. 7. illustrates a detail of the field-magnet. Figs. 8 and 9 are diagrams of connections. Fig. 10 illustrates a further modification in the form of the field-magnet. Fig. 11 illustrates diagrammatically a modified winding of the field-magnets. Fig. 12 shows in perspective a form of the armature. Fig. 13 shows one of the plates from which the armature, Fig. 12, is made. Fig. 14 shows another form of armature that may be used with the field-magnet.

In Fig. 1 of the accompanying drawings is shown the general form I give to the field-magnet frames. This consists, as shown, of a hollow cylindrical frame, M M', of malleable cast-iron or other suitable material, furnished with exterior longitudinal slots or recesses S'' S'', extending through the entire length of the cylinder and situated at opposite extremities of one of its diameters. This slot is provided for the field-magnet coil or coils, wound preferably in two sections, and placed as shown at C C C' C', Fig. 6.

N and S are the magnetic pole-pieces, which in this case are formed of a portion of the cylindrical mass of the field-magnet frame, their position being dependent on the position of the coil C C C' C' on the outside of the cylindrical field M M'. When it is desired to give greater definiteness of position to the pole-pieces, the shape of the cylindrical magnet-frame is modified, as shown in Fig. 2, where edges or lips *e e* and *e' e'* are formed on the pole-pieces N and S, in the manner shown. In this case, the longitudinal slots or openings *o o* and *o' o'*, that extend the entire length of the cylindrical frame, are utilized for the location of a coil or coils of wire, X X', Fig. 6, the arrangement and function of which form another feature of my invention, which will be more fully explained hereinafter. In order to provide for the ventilation of the armature and frame, openings are provided at Q Q Q and Q' Q' Q', as shown in Fig. 2; or these openings may be provided as at Q'' Q'' Q'' Q'', &c., Fig. 1, extending longitudinally throughout the entire length from end to end, as shown.

Where the shaft of the motor is not directly coupled to the shaft to be driven, feet F F F, of any suitable form and position, are provided.

In order to prevent the circulation of induced or local currents in the conducting masses of the magnet-frames and pole-pieces, they may be formed of separate pieces, separately and singly insulated from one another in a manner well known in the art. These pieces are shaped in such a manner as would be produced by cutting the field-magnet frame, as shown in Figs. 1 and 2, transversely by planes perpendicularly to the axis of the cylindrical frame. This division of the magnet-frame is shown in Fig. 3, where the separate sections *h h h h* and *h' h' h' h'*, formed of sheet-iron, thin plates of cast-iron, or other suitable material are separately insulated from one another and secured between the iron end plates, E E and E' E', by the bolts Y Y' Y Y', &c., as shown.

In order to secure greater ease of construction, I sometimes form the cylindrical magnet-frame by the malleable-iron casting, shaped as shown in Fig. 4, where the ribs T' T' T' T', &c., supported by the flanges T T, have the spaces Z Z Z, &c.

I do not confine myself to the true cylindri-

cal form of outline of the field-magnet frame, since one of the objects of this form of frame is to obtain a field-magnet frame in which the north and south polarity of the pole-pieces N and S can be obtained with but practically or actually a single field-magnet coil. It will be evident that this feature can be obtained by a great variety of forms of magnet-frames without departing from the essential features of the invention. I have shown, for example, in Fig. 5, another form of field-magnet frame in which space is provided for a much larger magnet-coil. In this case the pieces M M′ M′, &c., are modified in shape in the manner shown. Nor do I confine myself to the use of the field-magnet frame in which a single coil or bobbin wound in two or more or less sections is employed to obtain its north and south polarity for the field-magnet frame of an electro-dynamic motor, since it is also applicable to the use of any dynamo-electro machine, whether for lighting, for plating, or for other purposes. The magnet-frame so provided is wound with a single coil, C C C′ C′, wound in two or more sections, which surrounds the frame longitudinally in the manner as shown in Fig. 6.

Since the armature rotates inside the field-magnet coil, it is evident that suitable means must be provided for the ready introduction or removal of the armature. This I effect as follows, viz: I form the cylindrical magnet-frame in such a manner that a part thereof may be readily removed, so as to permit the armature to be moved in or out through the longitudinal opening so provided. The shape and arrangement of these movable pieces are shown in Figs. 2, 3 by the dotted lines.

In Figs. 4 and 5 the joint between the two portions is indicated at m^2. The field-magnet-coil sections C C and C′ C′ are wound separately. The first half, C C, may, if so desired, be placed permanently in position in the space S″ S″. The armature is then inserted and the remaining half of the field-magnet coils C′ C′ is then slipped on and the removable part of the cylindrical magnet-frame is placed in position and securely attached by any suitable means—such as bolts or bands. I have shown one of these in Fig. 4, where openings are left in the removable piece for the passage of the bolts *b b*, screwed into the fixed piece. The nuts *n n* afterward hold the two pieces together; or they may be held together by the end pieces, W W, that support the axis at A.

In order to permit the ready removal of the coil-sections C C and C′ C′, I prefer to wind each on a suitable insulated form. When the armature and coils are placed in position, a metallic end plate, W W, of any suitable shape, is securely attached to the cylindrical magnet-frame and provided with an opening, A. This plate forms the journals or bearings for the axis or shaft of the revolving armature.

In order to secure the ready introduction or removal of the armature, I sometimes prefer to construct the journals or bearings so that the part marked W, and shown in Figs. 2, 3, and 4, may be detached.

I do not limit myself to the exact arrangement of parts herein described and shown, since it is evident that the same general effect may be obtained in a variety of ways.

My invention consists, broadly, in the combination, in an electro-dynamic or dynamo-electric machine, of a revolving armature in combination with a single field-magnet coil in two or more or less sections, said field-magnet coil completely surrounding the armature-coils throughout their entire length. By this method of construction I obtain the following advantage—viz., compactness and simplicity of construction, and in case of repairing any damage that may occur to either the armature or to the field-magnet coil, the ready formation of a powerful magnetic field that will respond promptly to any variations in the strength of the electric current traversing its coils, the powerful effects produced by the induction of the coils of the field-magnets on the coils of the revolving armature which they completely surround, and complete protection of the revolving armature by the surrounding field-magnet frame—a feature that not only secures the armature itself from injury, but also prevents it from readily injuring anything outside it during its rapid revolution.

When the field-magnet pole-pieces are shaped in the manner shown in Figs. 2, 3, 5, and 6, I wind coils of wire X X, Fig. 6, in the hollow spaces *o o′*. These coils are wound longitudinally in the manner shown in connection with Fig. 7. Any size of wire may be employed on these projections; but as I generally place these coils in a shunt-circuit to the field-magnet circuit, I prefer to wind them with fine wire in the manner generally practiced in the art. The direction of winding of the accessory coils X X′ is such that the current passing through them produces poles of the same name as that produced by the main coil or coils C C C′ C′.

I have shown diagrammatically in Fig. 8 the manner in which the coils are connected in a shunt-circuit. C C C′ C′ represent the magnet coil or coils, and X X X′ X′ the coils on the projections of the pole-piece. The coils are connected as shown, a terminal of each end of the direct and shunt wire being connected to each of the brushes H H of the commutator Z Z Z. This method of winding, well known in the art, is especially applicable to electro-dynamic motors constructed in accordance with the principles of my invention, owing to the current generated in the coil or coils C C C′ C′ and X X X X by the revolution of the armature. There are, however, conditions under which I deem it advisable to connect the wire of the coils C C C′ C′ and X X X′ X′ in series—that is, in one continued line, as indicated in Fig. 9. In such a case it is of course necessary to make the wire in each coil of the same diameter, so as to avoid undue resistance.

In this event some modification is necessary, in order to secure sufficient space for the coils X X and X′ X′. I have shown this modification in Fig. 10, where I have prolonged the cores of the pole-pieces N and S, and provided a longitudinal groove or space for the coil C C C′ C′, extending to *t′ t′* beyond the edge *t t* of the end plate, T. This form is especially suitable for dynamo-electric machines in general. In cases when it is desirable to employ it in the construction of motors, I place additional coils of fine wire, *z z* and *z′ z′*, and place them in a shunt-circuit around the armature in the manner shown in connection with Fig. 11. I sometimes place coils of fine wire in the space provided for the coils C C C′ C′ and in the position shown in Fig. 6 at W W W′ W′. In this case I place these either in a shunt-circuit around the coils C C C′ C′ or around the brushes H H of the commutator K K K. I may employ either one or both of these shunt-circuits on one and the same motor—viz., the shunt-coils on the projections of the pole-pieces and the shunt-coils on the main or direct magnets C C C′ C′. In the magnetic field so provided I place any suitable armature-core provided with coils of insulated wire and a commutator. An armature suitable for this purpose is shown in Fig. 12, and consists of a core constructed, in a manner well known in the art, of separate pieces of iron shaped as shown in Fig. 13, and placed as shown in Fig. 12. These pieces or sections are of course separated from one another. In the spaces, as provided, coils of insulated wire are wound and suitably connected to a commutator.

An armature of very simple construction is shown in Fig. 14, which consists of two Siemens armatures placed on the same shaft in position at right angles to one another. I sometimes employ this plan when a high efficiency is not required.

When but a single coil of wire is wound on the armature and used in connection with a single coil of wire in the field-magnet frame, I obtain an electro-dynamic motor of great simplicity and fair economy.

What I claim as my invention is—

1. In a dynamo-electric machine or motor, the hollow cylindrical field-magnet frame M M′, provided with longitudinal grooves or depression S″ S″, on opposite sides thereof, for the reception of a field-magnet coil wound over and over upon said frame in a plane passing directly through the armature.

2. A cylindrical field-magnet frame having openings Q″ Q″ Q″ Q″, &c., Q′ Q′ Q′, &c., and Q Q Q, extending as shown.

3. In an electro-dynamic motor, a cylindrical field-magnet frame constructed with a removable longitudinal section for the insertion or removal of the armature, substantially as shown and described.

4. In an electro-dynamic motor, a cylindrical field-magnet frame provided with a longitudinal space or groove, S″ S″, in combination with the pole-pieces *e e* and *e′ e′*, and the spaces *o o* and *o′ o′*, for the purpose of giving greater definiteness to the position of the poles N and S, produced by the field-magnet coil wound in the space or groove S″ S″.

5. In an electro-dynamic motor, a cylindrical field-magnet frame consisting, essentially, of the end plates, E E and E′ E′, shaped as shown, and provided with bolts and nuts, to clamp in position the separately-insulated plates *h h h h*, &c., of soft iron or other suitable material, so as to form or produce the hollow cylindrical frame provided with the longitudinal slots S″ S″ S″, and the curved pole-pieces N and S.

6. In an electro-dynamic motor, the cylindrical field-magnet frame, substantially as described and specified, in combination with a single coil capable of division into two parts, C C and C′ C′, for the purpose specified.

7. In an electro-dynamic motor, a hollow cylindrical field-magnet frame provided with extended internal pole-pieces and wrapped with coils X X′, for the purpose of increasing the polarity produced by the coils wound on the outside of the cylindrical frame in the space provided therefor.

8. In an electro-dynamic motor, the hollow cylindrical field-magnet frame, in combination with the coils C C C′ C′, connected in series with the coils X X′, as shown and specified.

9. In a dynamo-electric machine or motor, the cylindrical field-magnet frame provided with inwardly-extending grooves or slots for the reception of the coils C C C′ C′ and the projecting pole-pieces N and S, with spaces for the coils X X X′ X′, connected in series with the coils C C and C′ C′.

10. In a dynamo-electric machine or motor, the cylindrical field-magnet frame in which the pole-pieces N and S are wound with the accessory coils *z z* and *z′ z′*, connected in a derived circuit around C C C′ C′ and X X X′ X′.

Signed at Philadelphia, in the county of Philadelphia and State of Pennsylvania, this 28th day of December, A. D. 1883.

EDWIN JAMES HOUSTON.

Witnesses:
J. R. MASSEY,
W. V. MASSEY.