No. 770,924. PATENTED SEPT. 27, 1904.

E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 1.

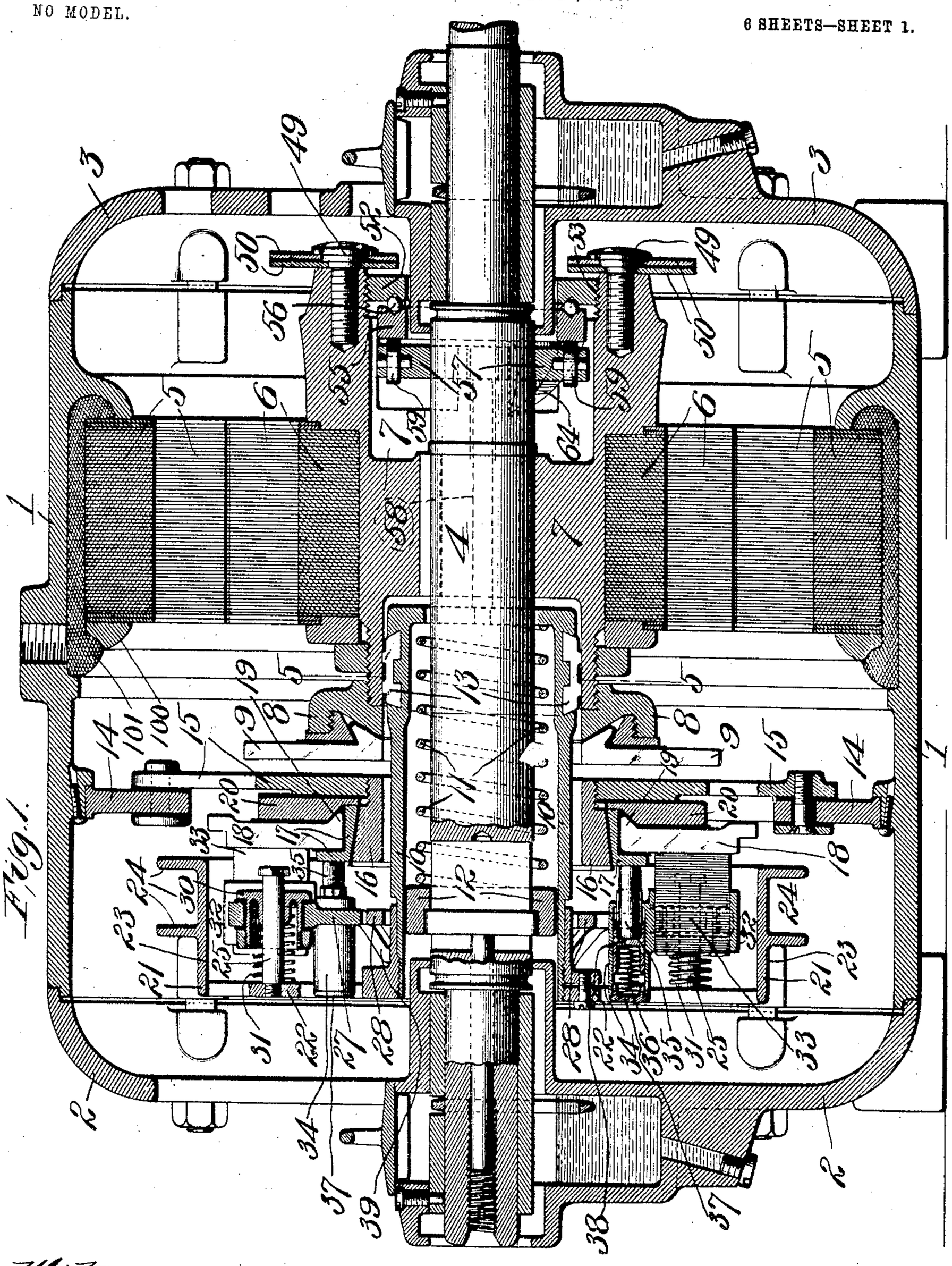


Fig. 1.

Witnesses:
Wm. H. Scott.
Jules F. Moore.

Inventor:
Edwin S. Pillsbury,
by Bakewell & Cornwall
Attys.

No. 770,924. PATENTED SEPT. 27, 1904.

E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 2.

Fig. 2.

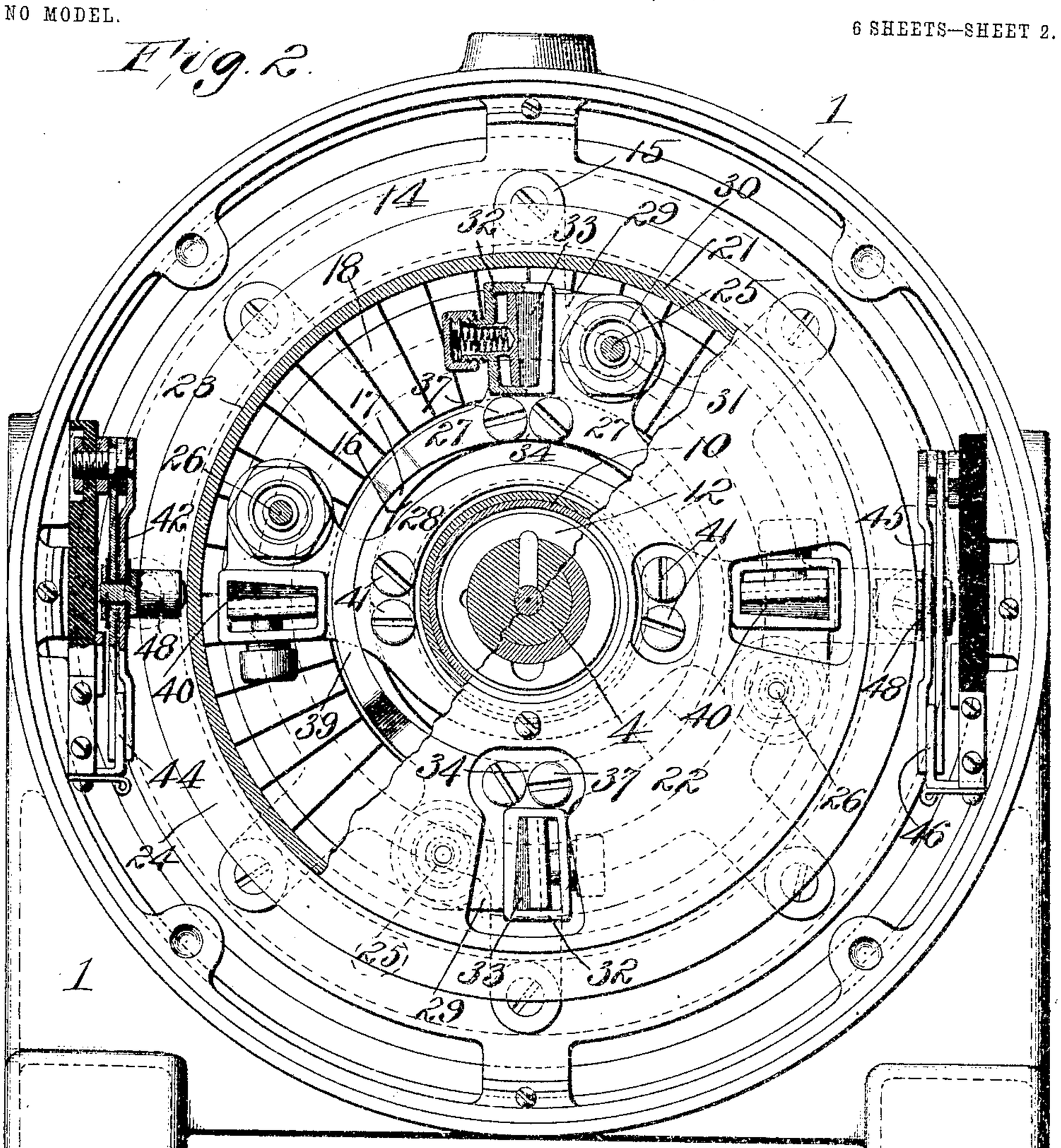
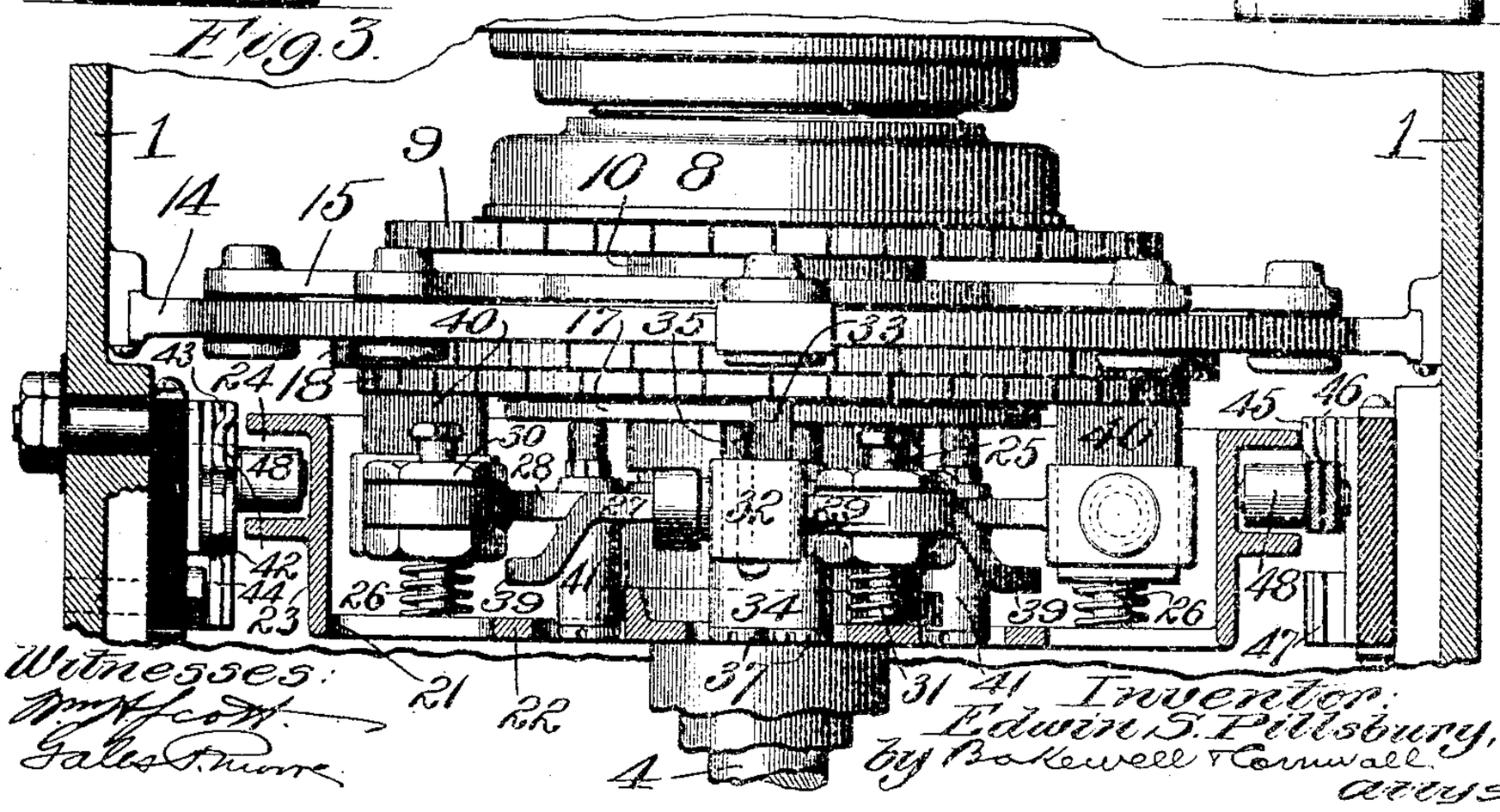


Fig. 3.



Witnesses:
Wm. H. Scott.
Gales Moore.

Inventor:
Edwin S. Pillsbury,
by Bakewell & Cornwall.
Attys

No. 770,924. PATENTED SEPT. 27, 19[illegible]

E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 3.

Fig. 4

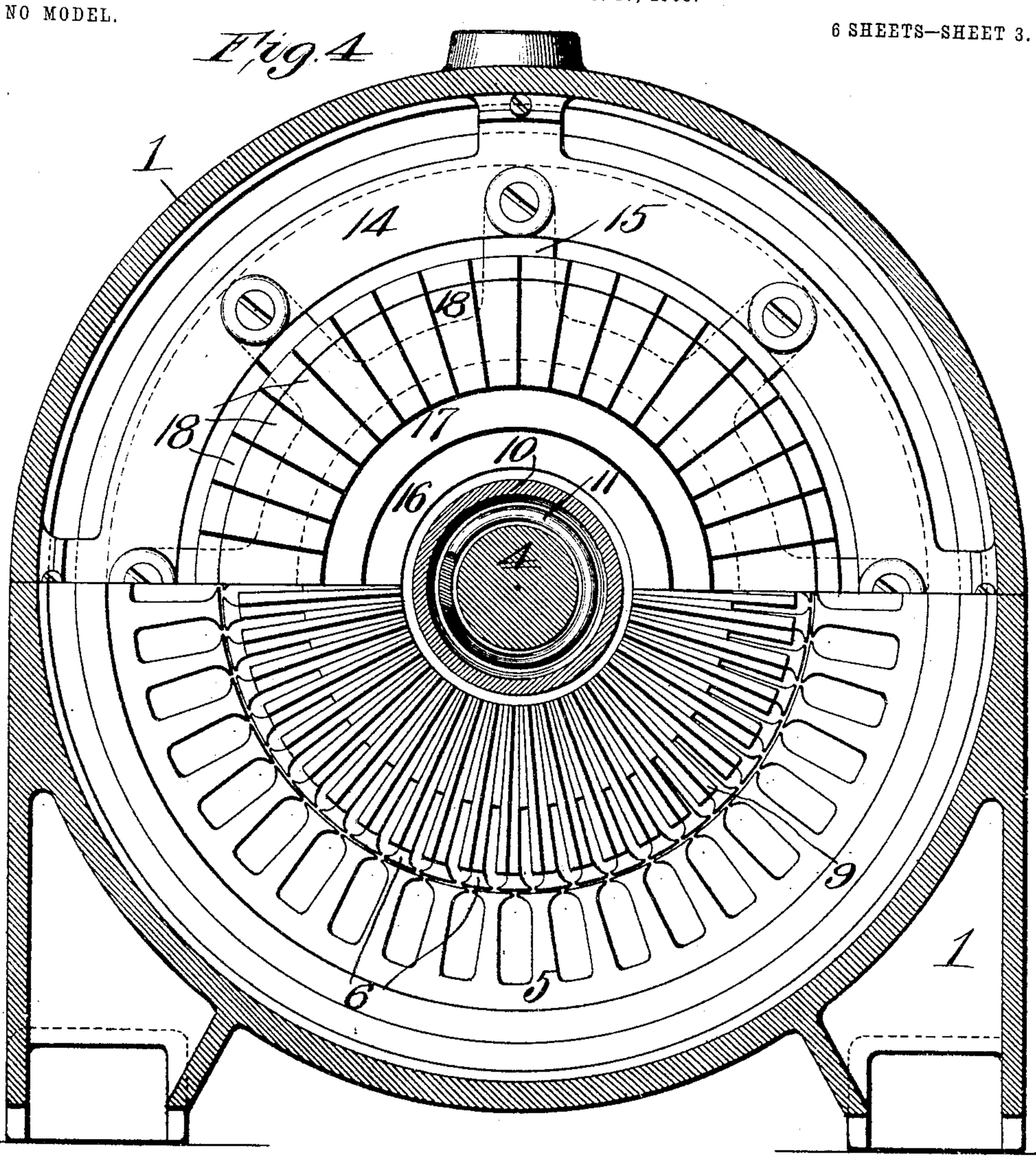


Fig. 5.

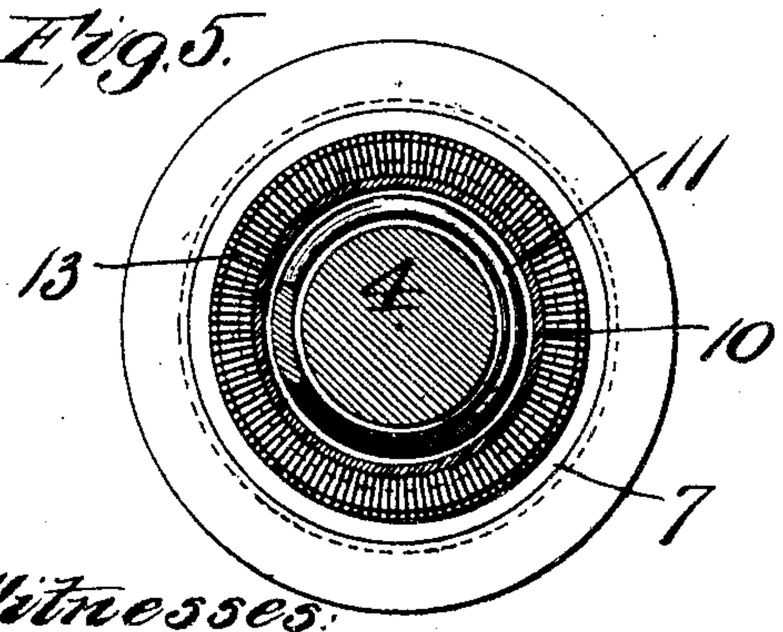
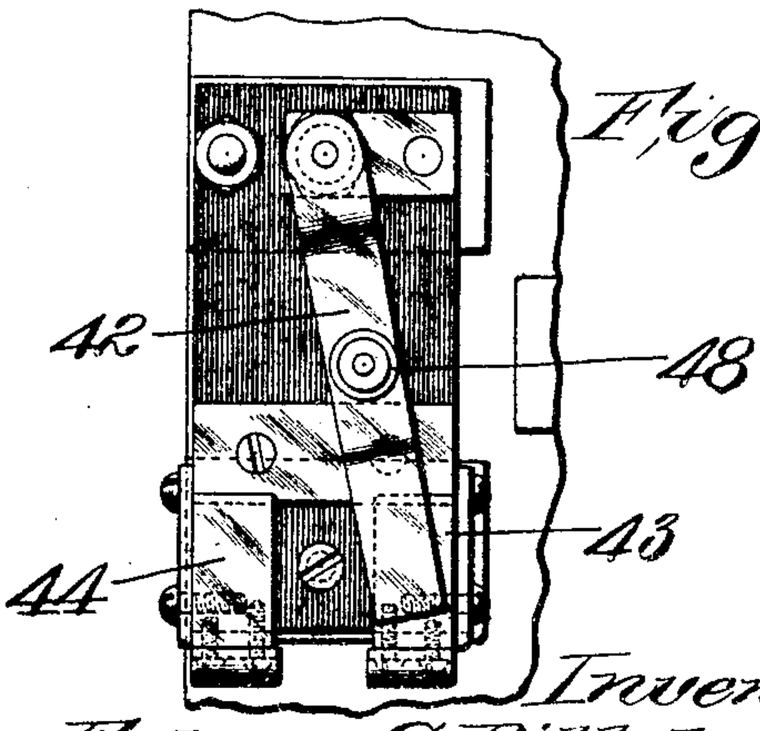


Fig. 6.



Witnesses:
Wm. H. Scott.
Jalas Thurs.

Inventor
Edwin S. Pillsbury,
by Bakewell & Cornwall
Attys.

No. 770,924. PATENTED SEPT. 27, 1904.

E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 4.

Fig. 7.

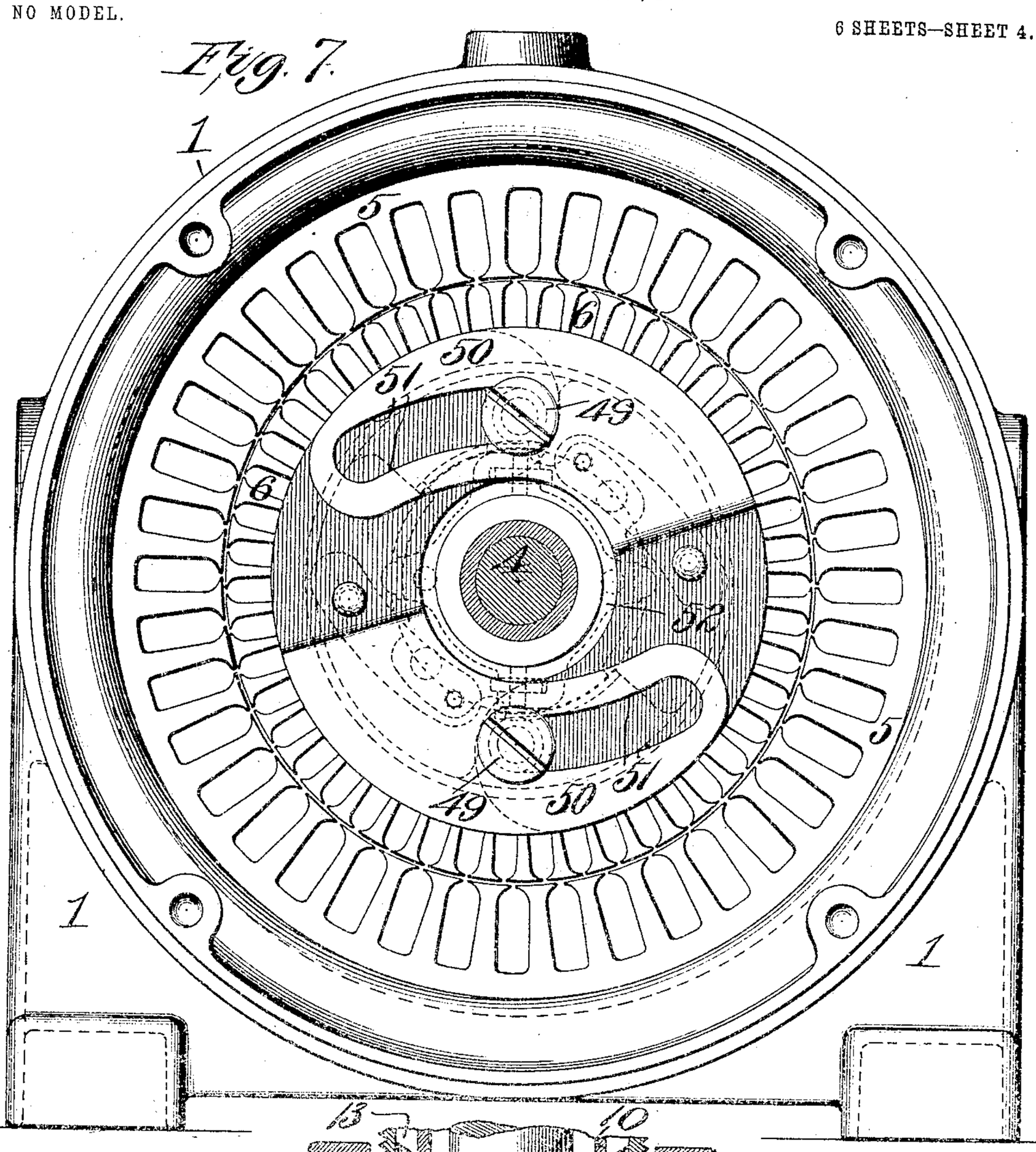
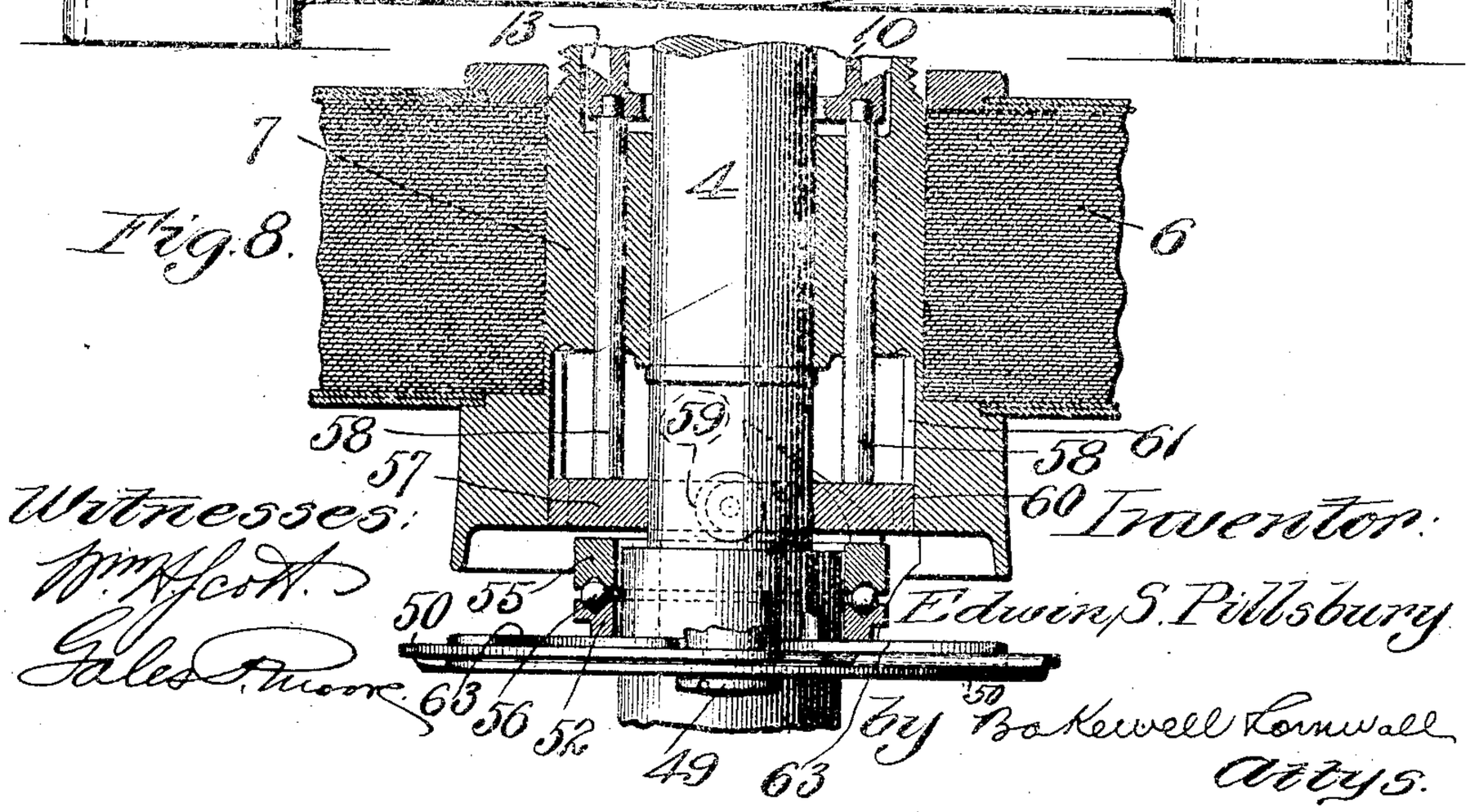


Fig. 8.



Witnesses:
Wm. N. Scott.
Gales Moore.

Inventor:
Edwin S. Pillsbury
by Bakewell Cornwall
Attys.

No. 770,924. PATENTED SEPT. 27, 1904.

E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 6.

Fig. 10.

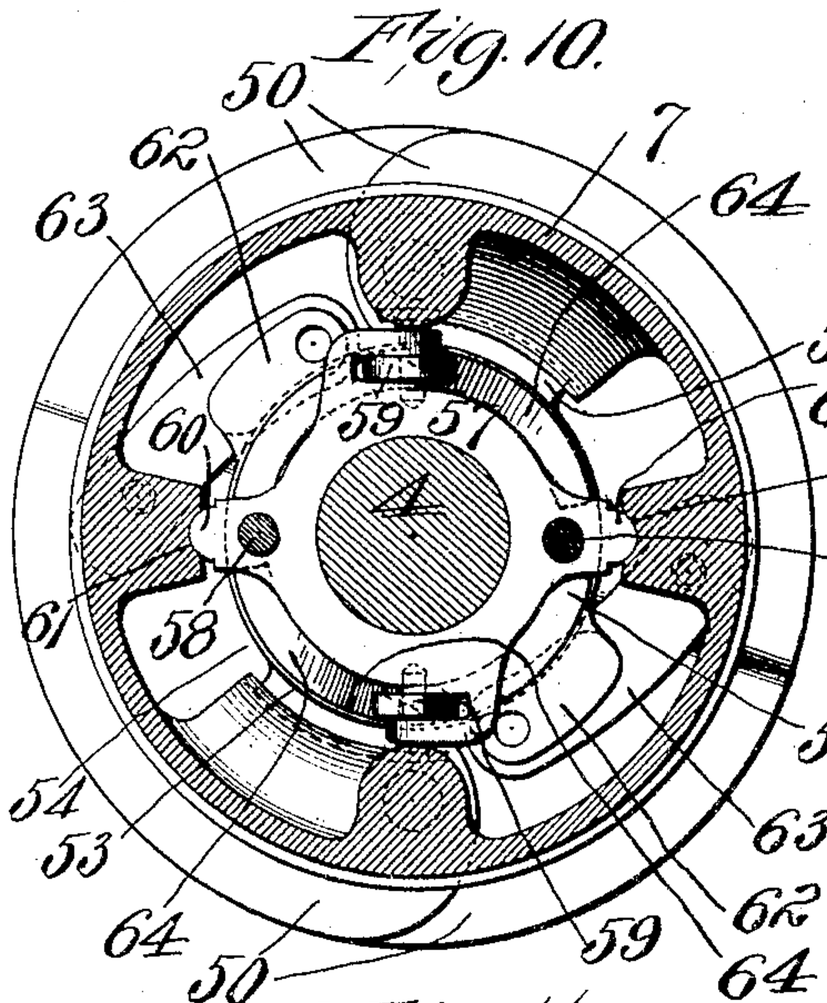


Fig. 11.

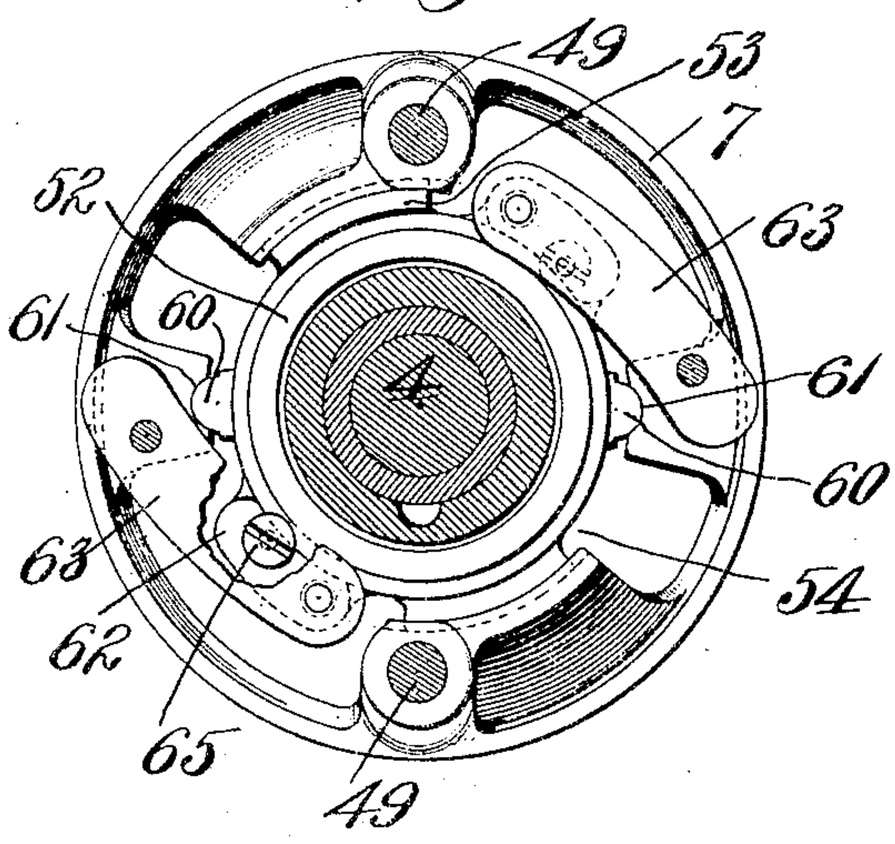


Fig. 9.

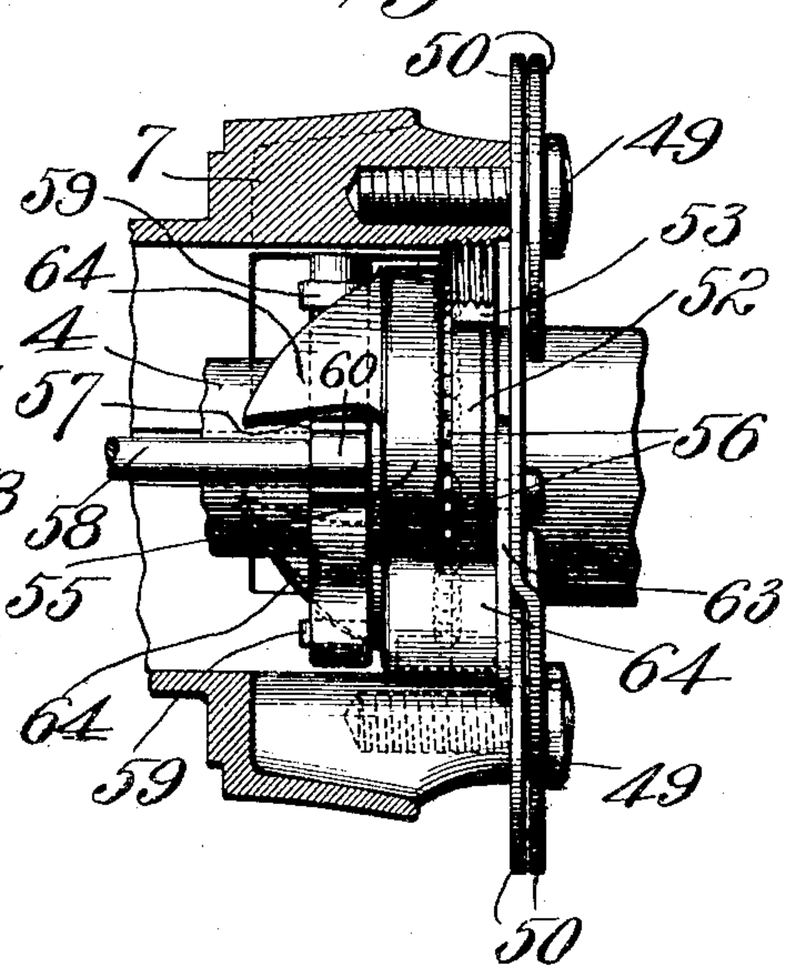
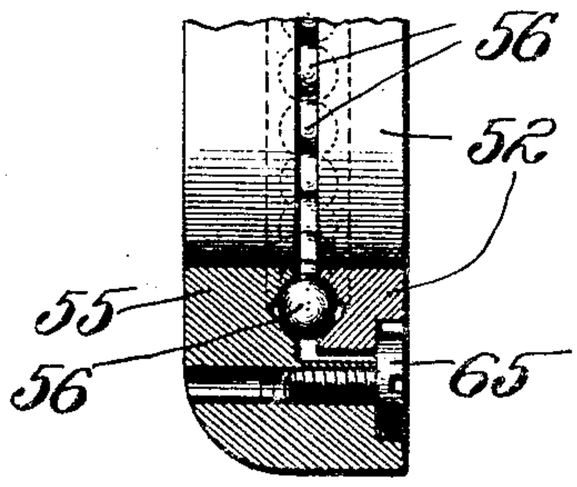


Fig. 12.



Witnesses:
Wm. H. Scott.
Gales Thurs.

Inventor:
Edwin S. Pillsbury,
by Bakewell & Cornwall
Attys.

No. 770,924. PATENTED SEPT. 27, 1904.

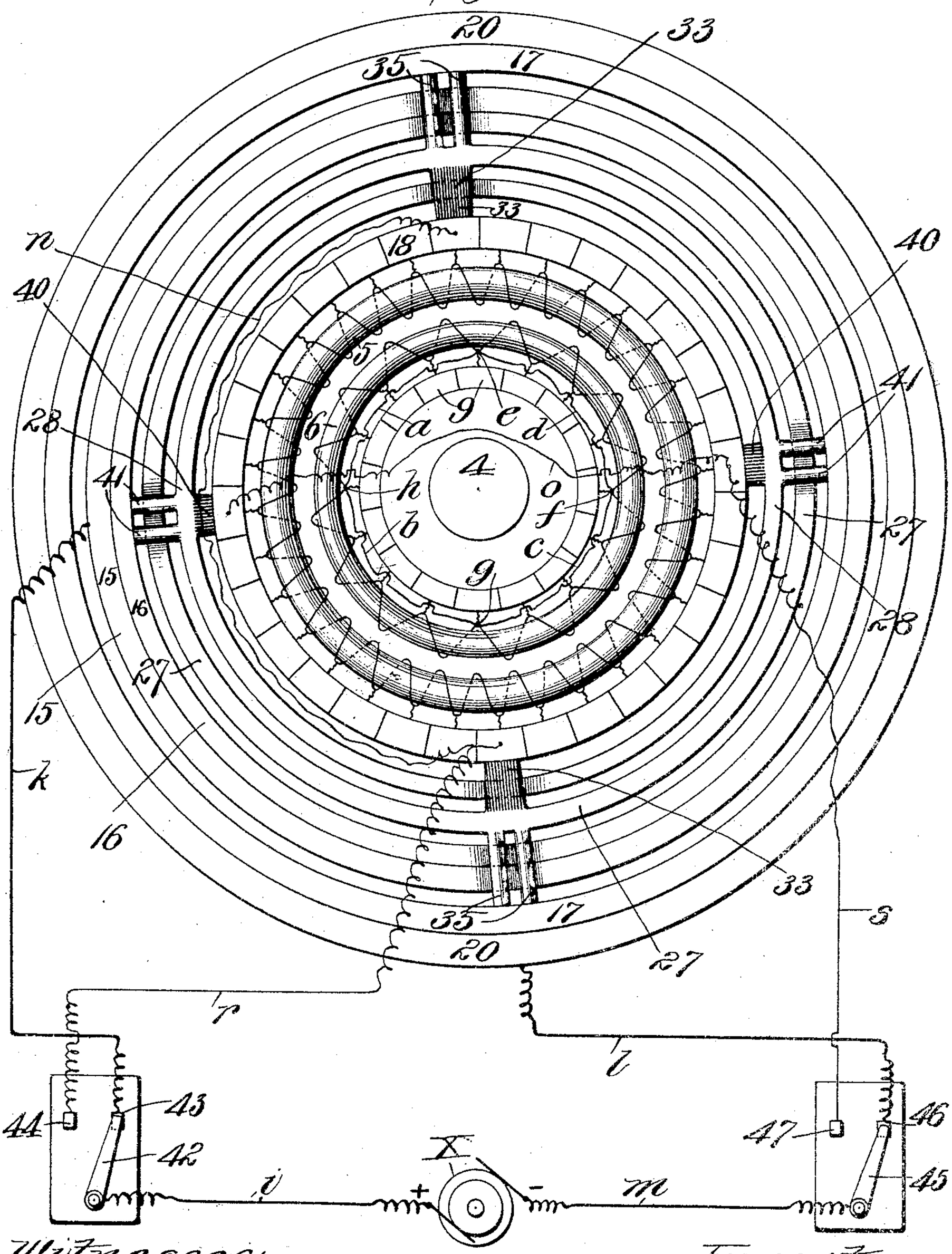
E. S. PILLSBURY.

ELECTRIC MOTOR.

APPLICATION FILED DEC. 17, 1903.

NO MODEL. 6 SHEETS—SHEET 6.

Fig. 13.



Witnesses:
Wm. A. Scott.
Gales Moore.

Inventor:
Edwin S. Pillsbury
by Bakewell & Cornwall
Attys.

No. 770,924. Patented September 27, 1904.

UNITED STATES PATENT OFFICE.

EDWIN S. PILLSBURY, OF ST. LOUIS, MISSOURI.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 770,924, dated September 27, 1904.

Application filed December 17, 1903. Serial No. 185,542. (No model.)

To all whom it may concern:

Be it known that I, EDWIN S. PILLSBURY, a citizen of the United States, residing at the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Electric Motors, of which the following is a full, clear, and exact description, such as will enable others 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, in which—

Figure 1 is a longitudinal sectional elevation. Fig. 2 is an elevation, partly in section, at right angles to Fig. 1 and looking from the left of the motor as shown in Fig. 1, the casing-head being removed and a portion of the switch-actuating ring being broken away. Fig. 3 is a top plan view, partly in section, of the mechanism which is to the left of the field and armature as the motor is illustrated in Fig. 1. Fig. 4 is an elevation, partly in section, illustrating the laminations of the field, the laminations of the armature, the commutator for the field, and the contact members which are connected to the armature. Fig. 5 is a detail elevation, partly in section, on about the line 5 5 of Fig. 1. Fig. 6 is a front elevation of one of the switches. Fig. 7 is an elevation, partly in section, looking from the left of the motor as it is illustrated in Fig. 1, the windings not being shown. Fig. 8 is a view, chiefly in horizontal section, illustrating the centrifugally-operated mechanism. Fig. 9 is a detail elevation, partly in section, of the same. Fig. 10 is a detail elevation, partly in section, of the same looking from the left of Fig. 9. Fig. 11 is a detail elevation, partly in section, of the same looking from the right of Fig. 9. Fig. 12 is a detail showing the connection between the abutment-ring and the cam-ring, and Fig. 13 is a diagram.

This invention relates to improvements in electric motors, and more particularly to induction-motors.

My primary object is to so construct an induction-motor that at starting instead of the secondary current induced in the armature or secondary member being commutated the current supplied to the field or primary member is commutated. This makes it possible to employ larger and heavier conductors in the armature or secondary member in place of the fine-wire conductors heretofore employed, whereby the armature is rendered more substantial, is rendered of low resistance and small self-induction, and will carry a greater load than an armature provided with the fine-wire windings, the present armature thus being capable of withstanding a greater overload.

To this end and also to improve generally upon devices of the character indicated the invention consists in the various matters hereinafter described and claimed.

Referring now more particularly to the drawings, 1 indicates the main casing of the motor, and 2 and 3 are the heads thereof. Suitably journaled upon these heads is the armature-shaft 4. The field 5 (which is the stator and the primary member of the motor illustrated) is supported upon the casing 1 in a manner which will be readily apparent, 100 indicating the clamping-ring and 101 indicating the binding material for holding the field-laminations in position, and the armature 6 (which is the rotor and secondary member) is carried by the shaft 4, being directly supported upon the armature-hub 7, which is connected to the shaft to rotate therewith in a manner which is well understood. Supported upon what may be termed the "forward end" of said hub 7 is a supporting-ring 8, which carries a series of contact-segments 9, each of which is connected to one of the armature-windings, as indicated by Fig. 13. These segments are insulated from each other and from their support and are supported in a manner which will be readily apparent. In the central cylindrical cavity in the forward end of the armature-hub is an elongated sleeve 10, which extends beyond the forward side of the contact-segments 9 and also fits over the shaft 4, said sleeve being rotatable with said shaft and longitudinally slidable with respect to said shaft and to said contact-segments 9. A spring 11, coiled about said shaft, has one end in engagement with the rear or inner portion of said sleeve 10 and its other end in engagement with an abutment-ring 12, whereby said sleeve is held in innermost position. Carried by said sleeve at the periph-

ery thereof are short-circuiting plates or segments 13. When said sleeve is in innermost position, these short-circuiting plates or segments are upon the inner side of the contact-segments 9 and are out of contact therewith. When, however, said sleeve is moved into outer position against the action of the spring 11, these short-circuiting plates contact with said contact-segments 9, and thus serve to short-circuit said segments. The construction and operation of this sleeve and its short-circuiting segments are substantially similar to the construction and operation of the corresponding elements disclosed in my Patent No. 718,518, granted January 13, 1903.

Connected to the casing 1 is a supporting-ring 14, to which in turn is connected a second supporting-ring 15, insulated from said supporting-ring 14, and therefore from the motor-casing. This supporting-ring 15 encircles the slidable sleeve 10 and has supported thereon (as by being screwed thereinto) an outwardly-extending base-ring 16, which also encircles said slidable sleeve 10 and has its outer periphery inclined toward the rear and the longitudinal axis of said base-ring. This base-ring 16 is in electrical connection with the before-mentioned supporting-ring 15. An angular clamping-ring 17, which is insulated from said base-ring 16 and has its inner circumference inclined to correspond to the inclination of the periphery of said base-ring, fits about said base-ring and has the inner ends of the commutator-segments 18 received in its angles. These commutator-segments have rearwardly-extending toes 19 at their inner ends, and an intermediate ring 20, which lies between said supporting-ring 15 and said commutator-segments, extends over these toes, so that the commutator-segments are firmly clamped in position when the base-ring 16 is screwed home. The intermediate ring 20 is in electrical connection with the clamping-ring 17, but is insulated from the commutator-segments, the supporting-ring 15, and the base-ring, while the clamping-ring 17 is insulated from said base-ring 16, and the commutator-segments are of course insulated from their supporting-rings and from each other, as is usual. The commutator-segments are electrically connected to the field-windings, as illustrated in Fig. 13, in the same manner in which the comutator-segments are usually connected to the armature-windings. Supported upon the outer or forward end of said rotatable and longitudinally-slidable sleeve 10 is an annular carrying and shifting member 21, which has a head 22 and an inwardly-extending peripheral flange 23, which is provided with an annular peripheral groove 24. Supported upon said head 22 and projecting inwardly therefrom are headed guide-studs 25 and 26, there being in the present embodiment of my invention two of such studs 25 and two of such studs 26, the corresponding-numbered studs being diametrically opposite each other.

Two rings 27 and 28 are provided for supporting the brushes and collectors. The ring 27 has a central annular portion provided with substantially radial extensions 29, which are diametrically opposite each other. Through each of these radial extensions is a hollow bushing 30, which is suitably clamped upon its extension, and each of said bushings is slidable upon one of the before-mentioned guide-studs 25, being normally forced into inner or operative position by means of a spring 31, coiled about the guide-studs and bearing at its opposite end against said bushing and the head 22. Each of said projections 29 has a brush-holder 32 formed thereupon and receiving a brush 33. Also formed upon each ring 27 are a suitable number of holders 34 for collectors or auxiliary brushes 35, these holders 34 being tubular with their inner ends open in order to permit play of said collectors 35, said collectors being normally pressed into inner or operative position by means of springs 36, received in said tubular holders 34 and bearing at one end against the removable cap 37, which closes the outer end of the holder, and bearing at its other end against a follower 38, which engages the collector. Two such collectors are shown at the point at which each brush 33 is located; but the number of such collectors can be varied as circumstances may suggest. The ring 28 is substantially similar to the ring 27, except that its annular body portion is of less diameter than that of the ring 27, so that said ring 28 can fit within said ring 27, and also the ring 27 is deflected, as shown at 39, in order to permit the same to avoid and lie out of engagement with the ring 28. Said ring 28 is slidable upon the guide-studs 26 in the same manner in which the ring 27 is slidable upon the guide-studs 25 and carries brushes 40 and collectors 41, which are similar in their construction and mounting to the before-mentioned brushes 33 and collectors 35, the brushes 40 being diametrically opposite each other and being at right angles to the brushes 33. The bushings 30 are insulated from their rings, and these rings are out of electrical connection with each other.

The motor herein illustrated happens to be provided with four poles, and for this reason four brushes and four sets of collectors are shown. The number of poles of the motor, however, has nothing whatever to do with the present invention, and of course the number of brushes and collectors will be varied to suit the particular form of motor in connection with which they are employed.

It will now be manifest that under what may be termed "normal conditions" the spring 11 serves to hold the sleeve 10 in inner or inoperative position, so that the short-circuiting segments 13 are out of connection with the

contact-segments 9. Furthermore, when this sleeve 10 is in innermost position the brushes 33 and 40 bear against the commutator-segments 18, while the collectors 35 engage the angular clamping-ring 17 and the collectors 41 engage the base-ring 16. Should the sleeve 10 be thrown outwardly, the short-circuiting plates 13 engage the contact-segments 9 and the carrying member 21 moves outwardly with said sleeve and carries the brushes and collectors out of contact with their respective cooperating contact members.

Suitably mounted upon the interior of the motor-casing and diametrically opposite each other are switches. These switches are similar to each other in construction, and one of them includes a pivoted switch-arm 42 and insulated switch-points 43 and 44. The other switch includes pivoted switch-arm 45 and insulated switch-points 46 and 47. Each of said switch-arms is provided with some suitable projection, such as the roll 48, which is received in the before-mentioned groove 24 upon the annular carrying and shifting member 21. When said sleeve 10 is in inner position, as illustrated in Fig. 1, the switch-arms 42 and 45 contact with the switch-points 43 and 46, while as said sleeve 10 moves outwardly, and thus carries said shifting member 21 outwardly, the said switch-arms are through their rolls 48 thrown out of contact with said switch-points 43 and 46 into contact with said switch-points 44 and 47, respectively.

In order to avoid confusion, the wiring is not shown in any of the figures of the drawings except Fig. 13. Furthermore, in Fig. 13 of the drawings the armature and field are for the sake of simplicity and clearness shown as provided with well-known Gramme windings, although in other views of the drawings the armature and field laminations are illustrated as adapted to receive the well-known drum-windings for parallel or progressive connection. The particular type of winding employed has, however, no bearing whatever upon the present invention and can be disregarded.

Referring now more particularly to Fig. 13, which is a diagrammatic illustration, it will be seen that the windings of the armature 6 are connected to the contact-segments 9 in the same general manner in which armature-windings are usually connected to commutator-segments, and the windings of the field 5 are connected to the commutator-segments 18 in a well-understood manner. As the type of motor herein illustrated is provided with four poles, the armature-windings at four points ninety degrees from each other are connected, as by the wires *a*, *b*, *c*, and *d*, so that the rotatable armature has the four poles *e*, *f*, *g*, and *h*. The brushes 33 and 40 are rotatable with the armature through the connections heretofore described and are so set that they are slightly displaced with relation to the armature-poles in a manner which is thoroughly well understood in motor construction. From the dynamo or other source of power X the current flows through a suitable conductor *i* to the switch-arm 42. The switch-point 43 is in electrical connection, as through the conductor *k*, with the before-mentioned supporting-ring 15. This ring, as has been previously indicated, is in electrical connection with the base-ring 16. The collectors 41 when the sleeve 10 is in inner position engage said base-ring 16. These collectors are in electrical connection with their supporting-ring 28, and the brushes 40, which engage the commutator-segments 18 when said sleeve 10 is in inner position, are also in electrical connection with said ring 28. The intermediate ring 20 is in electrical connection, as through the conductor *l*, with the switch-point 46, and the switch-arm 45 is in electrical connection, as through the conductor *m*, with the side of the generator X opposite that to which the switch-arm 42 is connected. As has been previously indicated, the angular clamping-ring 17 is in electrical connection with said intermediate ring 20. The collectors 35 engage said ring 17 when the sleeve 10 is in inner position. These collecters are in electrical connection with their supporting-ring 27, and the brushes 33, which engage the commutator-segments 18 when said sleeve 10 is in inner position, are also in electrical connection with said ring 27. Diametrically opposite commutator-segments 18 are connected to each other in a well-understood manner, as by the wires *n* and *o*. The wire *n* is in electrical connection, as by the conductor *r*, with the switch-point 42, and the wire *o* is in electrical connection, as by the conductor *s*, with the switch-point 47.

When the motor is at rest, with the sleeve 10 in inner position and the switch-arms 42 and 45, respectively, engaging the switch-points 43 and 46, the windings of the armature are not short-circuited (except for the purpose of producing the before-mentioned armature-poles) and current from the generator X flows through the wire *i*, the switch-arm 42, the switch-point 43, the wire *k*, the supporting-ring 15, the base-ring 16, the collectors 41, the ring 28, and the brushes 40 to the appropriate commutator-segments 18, from which the current passes to the field-winding in a well-known manner, and in an equally well-known manner this current thus led into the field passes therefrom to other appropriate commutator-segments, from which it is conducted through the brushes 33, the ring 27, the collectors 35, the angular clamping-ring 17, the intermediate ring 20, the conductor *l*, the switch-point 46, the switch-arm 45, and the conductor *m* back to the generator. The action of the motor when current is supplied in this manner will be readily apparent. When, however, the motor at-

tains speed, the sleeve 10 is moved outwardly in a manner to be hereinafter described, whereupon the short-circuiting plates 13 serve to short-circuit the contact-segments 9, and therefore the armature-windings upon each other, and the brushes 33 and 40, together with the collectors 35 and 41, are lifted from the field-commutator and from the rings 17 and 16, the switch-arms 42 and 45 being, respectively, thrown into engagement with the switch-points 44 and 47 simultaneously with the actions just described. Under these conditions current from the generator X passes through the wire *i*, the switch-arm 42, the switch-point 44, the wires *r* and *n*, and the appropriate commutator-segments 18 into the field-winding, and this current, through those commutator-segments which are connected by the wire *o*, passes out of the field-winding and through the conductor *s*, the switch-point 47, the switch-arm 45, and the conductor *m* back to the generator. Therefore after the motor has attained speed the armature-windings are short-circuited, and the current is fed without commutation into and out of the field, whereupon the motor operates as an induction-motor until its speed decreases sufficiently to permit the sleeve 10 to be moved into inner position, when the parts assume the positions and the connections are those first described in connection with the diagram 13.

Manifestly the sleeve 10 can be rotated and moved longitudinally in many ways. In the present embodiment of my invention, however, I have illustrated the rear of the armature-hub 7 as provided with a recess about the shaft 4, and upon studs 49, arranged at diametrically opposite points and secured in the rear face of said hub, are pivoted centrifugally-operable plates or weights 50. Each of these plates extends through an arc somewhat greater than a semicircle and is provided in what may be termed its "free end" with an elongated slot 51, so that each of said plates is pivoted upon one of said studs 49 and has the other stud 49 received in its said slot 51, so that one of the studs 49 serves to guide each of said plates in its swinging movement. It will of course be apparent that as said studs 49, with their connected plates or weights 50, are carried by the rotatable armature-hub 7 rotation of said hub will serve to swing said plates by centrifugal action in a manner which is well understood.

An abutment-ring 52 is received in the end of the before-mentioned recess formed in the rear of said hub 7 and has radial extensions 53, by means of which said abutment-ring is fastened to said hub, these radial extensions affording slots or clearances 54 between the inner circumference of said armature-hub and the periphery of said abutment-ring. Upon the inner side of said abutment-ring is a cam-ring 55, between which and said abutment-ring 52 suitable antifriction devices, such as the balls 56, are preferably interposed. Upon the inner side of said cam-ring and fitting about the armature-shaft 4 to permit movement longitudinally thereof is a slidable ring 57, which is connected by rods 58 with the before-mentioned sleeve 10, these rods of course passing through suitable openings in the armature-hub, as is well understood and shown, for example, in my previous patent, No. 718,518, granted January 13, 1903. Mounted upon said slidable ring 57 are rollers 59, which contact with the inner face of said cam-ring 55, and, preferably, ribs or projections 60 at suitable points upon the periphery of said slidable ring 57 enter guide-grooves 61, formed in the armature-hub, as illustrated in Figs. 10 and 11, whereby said slidable ring 57 is guided in its longitudinal movements and is firmly held to rotate with the armature-hub. Outwardly-extending bosses or projections 62 upon said cam-ring and projecting through said before-mentioned slots or clearances 54 are connected, as by means of the links 63, with the respective centrifugally-operable weights or plates 50. It will now be apparent that when said weights or plates are in retracted position and the cam-ring is consequently in what may be termed its "normal" position, with its cam projections 64 out of operative engagement with the said rollers 59, the before-mentioned spring 11 is free to force its sleeve 10 and the slidable ring 57 into the positions illustrated in Fig. 1. When, however, the said weights or plates are by the rotation of the armature-shaft thrown into extended position by centrifugal action, the cam-ring 55 is rocked and the cam projections 64 engage said rollers 59 to force said slidable ring 57 and its connected sleeve 10 longitudinally along the armature-shaft.

For convenience and in order to prevent separation of the abutment-ring 52 and the cam-ring 55 when the parts are not assembled I prefer to insert headed screws 65 in the outer face of said cam-ring and permit the heads of the screws to overlap and engage the abutment-ring, as shown in Fig. 12. Thus the necessary circumferential movement between said rings 52 and 55 is permitted, but accidental separation of the rings is prevented.

I am aware that minor changes in the construction, arrangement, and combination of the several parts of my device can be made and substituted for those herein shown and described without in the least departing from the nature and principle of my invention.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. In a motor, the combination with a primary member, and a secondary member, of means for supplying commuted current to said primary member, means for supplying uncommuted current to said primary member and

means for short-circuiting said secondary member; substantially as described.

2. In a motor, the combination with a primary member, and a secondary member, of contact-segments connected to said secondary member, means for supplying commuted current to said primary member, means for supplying uncommuted current to said primary member, and a short-circuiting device coöperating with said contact-segments; substantially as described.

3. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, contact-segments connected to said secondary member, brushes coöperating with said commutator, means for establishing and disestablishing commutating relationship between said brushes and said commutator, means for supplying current to said primary member when said commutating relationship is disestablished, and a short-circuiting device coöperating with said contact-segments; substantially as described.

4. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, contact-segments connected to said secondary member, a movable element, brushes carried by said movable element and coöperating with said contact-segments, said movable element having movement to carry said brushes into contact with said commutator and said short-circuiting device out of contact with said contact-segments, and also having movement to carry said short-circuiting device into contact with said contact-segments and to carry said brushes out of contact with said commutator, and means for supplying current to said primary member when said brushes are out of contact with said commutator; substantially as described.

5. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, brushes coöperating with said commutator, means for establishing and disestablishing commutating relationship between said brushes and said commutator, means for supplying energy to said primary member when said commutating relationship is disestablished, and means whereby when said motor attains speed said commutating relationship is disestablished; substantially as described.

6. In a motor, the combination with a primary member, and a secondary member, of a commutator in connection with said primary member, brushes coöperating with said commutator and adapted to be in and out of commutating relationship with said commutator, means for supplying energy to said primary member when said commutating relationship is disestablished, means whereby in starting said motor such commutating relationship exists, and means whereby when said motor has attained speed such commutating relationship is disestablished and said secondary member is short-circuited upon itself; substantially as described.

7. In a motor, the combination with a primary member, and a secondary member, of a commutator in connection with said primary member, brushes coöperating with said commutator and adapted to be connected to a source of energy, means for supplying energy to said primary member independently of said brushes, and means for short-circuiting said secondary member; substantially as described.

8. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, brushes coöperating with said commutator, means for supplying current to said brushes, means for cutting off the supply of current to said brushes, and for otherwise supplying current to said primary member, and means for short-circuiting said secondary member; substantially as described.

9. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, brushes coöperating with said commutator, two sets of switch-points, connection between one of each of said sets of switch-points and said brushes, connection between another of each of said sets of switch-points and said primary member independently of said brushes, a switch-arm for each of said sets of switch-points and adapted to be connected to a source of energy, and means for short-circuiting said secondary member; substantially as described.

10. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, brushes coöperating with said commutator, a circuit including said brushes, a second circuit including said primary member, a switch controlling said circuits, and means for shifting said switch; substantially as described.

11. In a motor, the combination with a primary member, and a secondary member, of a commutator connected to said primary member, contact-segments connected to said secondary member, a movable element having movement with respect to said commutator and said contact-segments, brushes carried by said movable element and coöperating with said commutator, a circuit including said brushes, a circuit including said primary member, a switch controlling said circuits, a short-circuiting device carried by said movable element and coöperating with said contact-segments, and operative connection between said movable element and said switch; substantially as described.

12. In a motor, the combination with a stator, and a rotor, of a relatively stationary commutator in connection with said stator, con-

tact-segments in connection with said rotor, an element rotatable with said rotor and having movement with respect to said commutator and to said contact-segments, a short-circuiting device carried by said element and cooperating with said contact-segments, and brushes also carried by said element and cooperating with said commutator; substantially as described.

13. In a motor, the combination with a stator, and a rotor, of a commutator, rotatable brushes coöperating with said commutator, two contact members adapted to be connected to opposite poles of a source of energy, a collector in connection with one of said brushes coöperating with one of said contact members, and a second collector in connection with another of said brushes and coöperating with the other of said contact members; substantially as described.

14. In a motor, a supporting-ring, a base-ring secured thereto, a clamping-ring interlocking with said base-ring, and contact-segments held between said clamping-ring and said supporting-ring; substantially as described.

15. In a motor, a supporting-ring, a base-ring connected thereto, a clamping-ring interlocking with said base-ring, an intermediate ring between said supporting-ring and said clamping-ring, and contact-segments engaged by said clamping-ring and said intermediate ring; substantially as described.

16. In a motor, a base-ring, a clamping-ring coöperating therewith but insulated therefrom, commutator-segments supported by said clamping-ring, means whereby said rings serve to hold said commutator-segments in position, brushes coöperating with said commutator-segments, a collector in electrical connection with one of said brushes and engaging one of said rings, and a second collector in electrical connection with another of said brushes and engaging the other of said rings; substantially as described.

17. In a motor, the combination with a commutator, of a rotatable element, a head connected thereto, guide-studs extending from said head, brush-holders carried by said studs and movable longitudinally thereof, and brushes carried by said brush-holders and cooperating with said commutator; substantially as described.

18. In a motor, the combination with a commutator, and a contact member, of a rotatable element, a head connected thereto, guide-studs projecting from said head, a support carried by said studs and movable longitudinally thereof, brushes upon said support and coöperating with said commutator, and collectors upon said support and coöperating with said contact members; substantially as described.

19. In a motor, the combination with a stator, and a rotor, of a switch, a commutator, a movable element, a head thereon, a flange extending from said head toward said commutator, operative connection between said flange and said switch, and brushes coöperating with said commutator and supported upon said head, said flange extending about said brushes; substantially as described.

20. In a motor, the combination with a stator, and a rotor, of a commutator connected to said stator, a movable element, brushes carried by said movable element and coöperating with said commutator, centrifugally-operable weights carried by said rotor, and rods slidable longitudinally of said rotor and connected with the same to rotate therewith, said rods being connected to said movable element and to said centrifugally-operable weights, whereby, through the instrumentality of said rods, said brushes are rotated and are also moved toward and away from said commutator; substantially as described.

21. In a motor, a shifting mechanism comprising a shiftable element, a cam-ring, centrifugally-operable means for displacing said ring circumferentially, and a member connected to said shiftable element and engaging the cam-surface of said ring; substantially as described.

22. In a motor, a shifting mechanism comprising a shiftable element, centrifugally-operable weights, a cam-ring, operative connection between said ring and said weights, and a member connected to said shiftable element and engaging the cam-face of said ring; substantially as described.

23. In a motor, the combination with an armature-shaft, of an armature-hub about the same and having a recess therein, and a shifting mechanism comprising a shiftable element, centrifugally-operable weights pivotally supported upon said hub, an abutment-ring in said recess, a cam-ring in said recess and connected to said weights, and a member in said recess connected to said shiftable element and engaging the cam-face of said ring; substantially as described.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 12th day of December, 1903.

EDWIN S. PILLSBURY.

Witnesses:
GEORGE BAKEWELL,
GALES P. MOORE.