(No Model.)

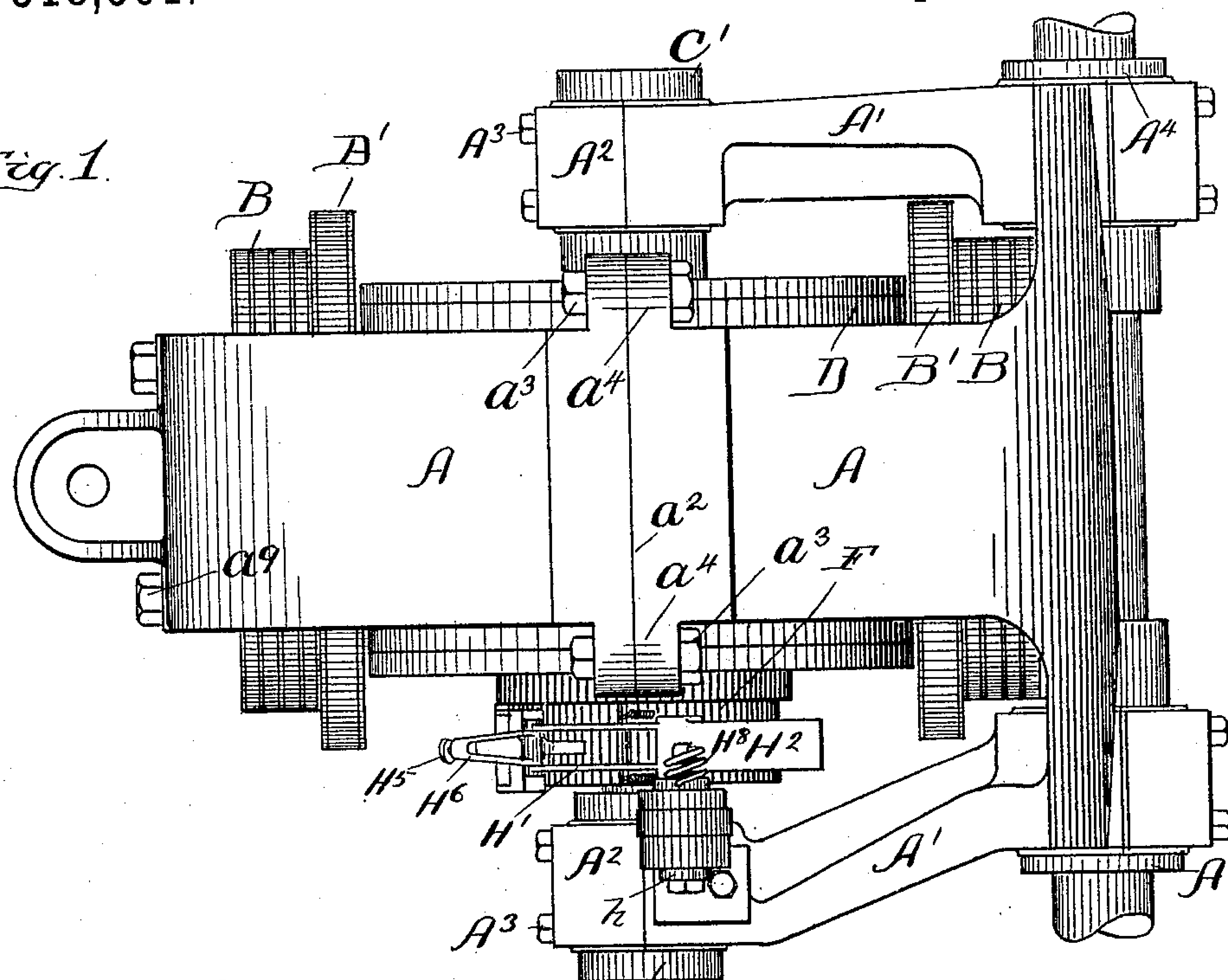
5 Sheets—Sheet 1.

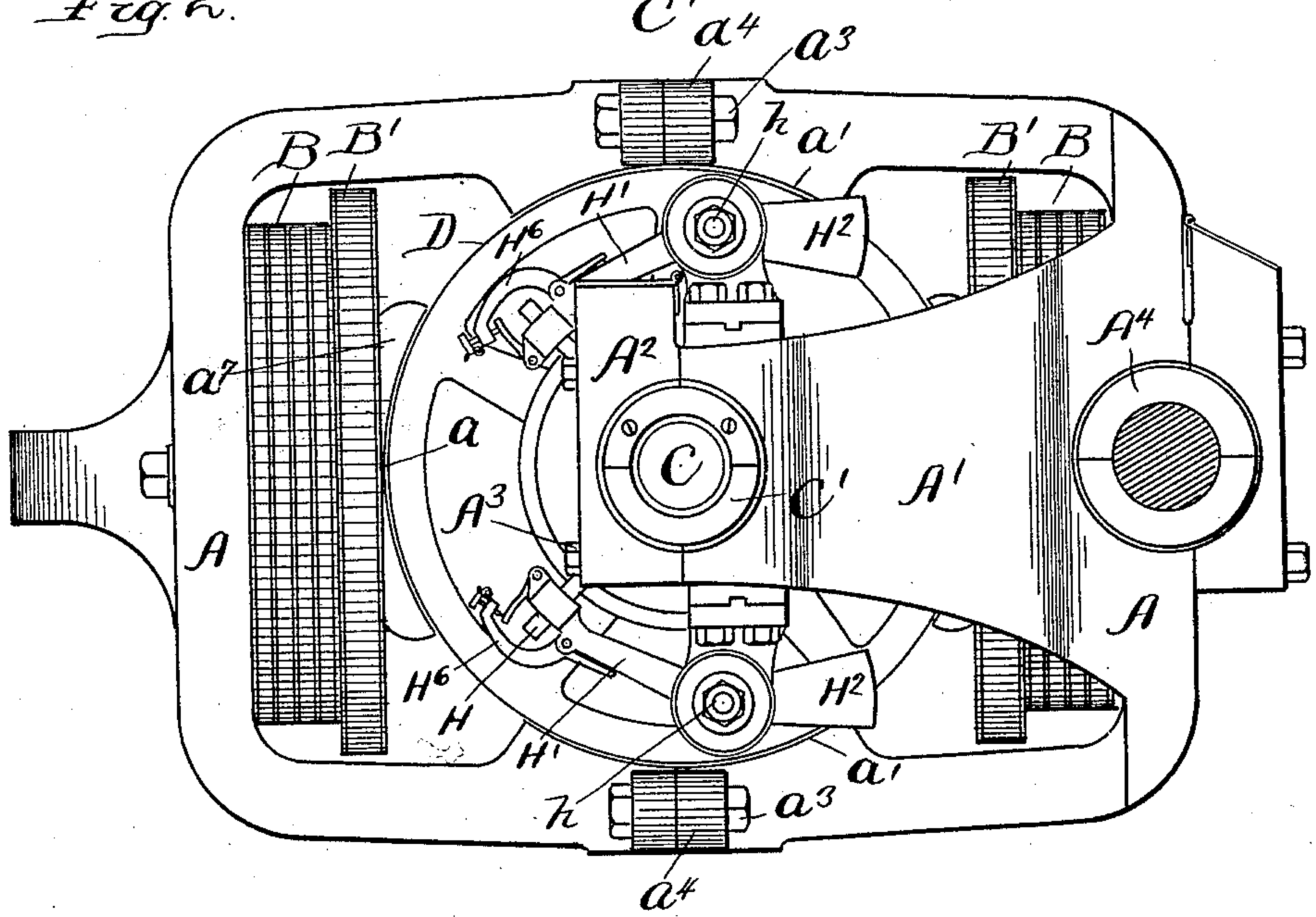
H. P. BROWN.

ELECTRIC MOTOR.

No. 518,561.

Patented Apr. 17, 1894.





Witnesses:
Sew. E. Curtis
A. M. Munday.

Inventor:
Harold P. Brown
By Munday, Evarts & Adcock.
His Attorneys.

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5 Sheets—Sheet 2.

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Fig. 3.

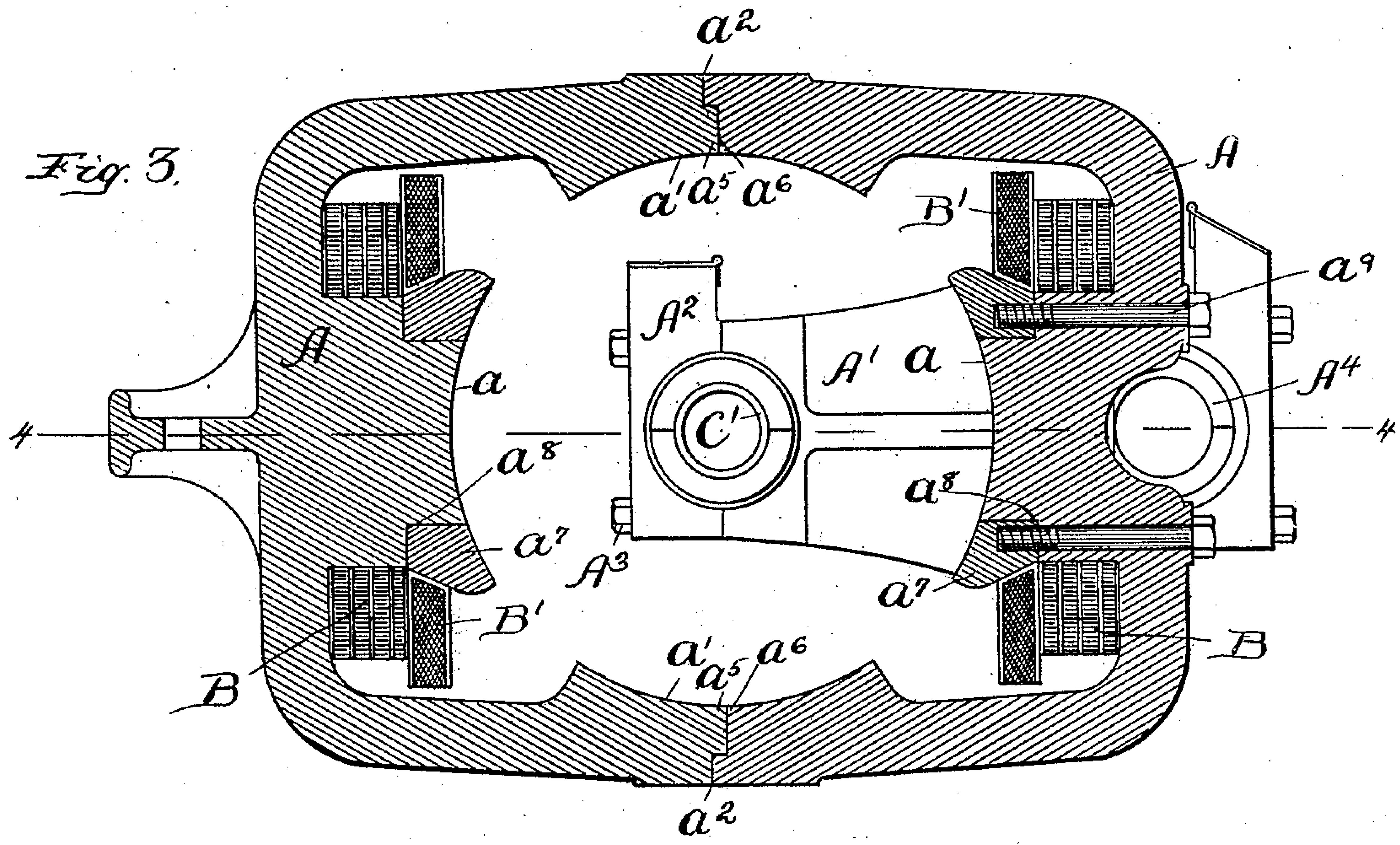
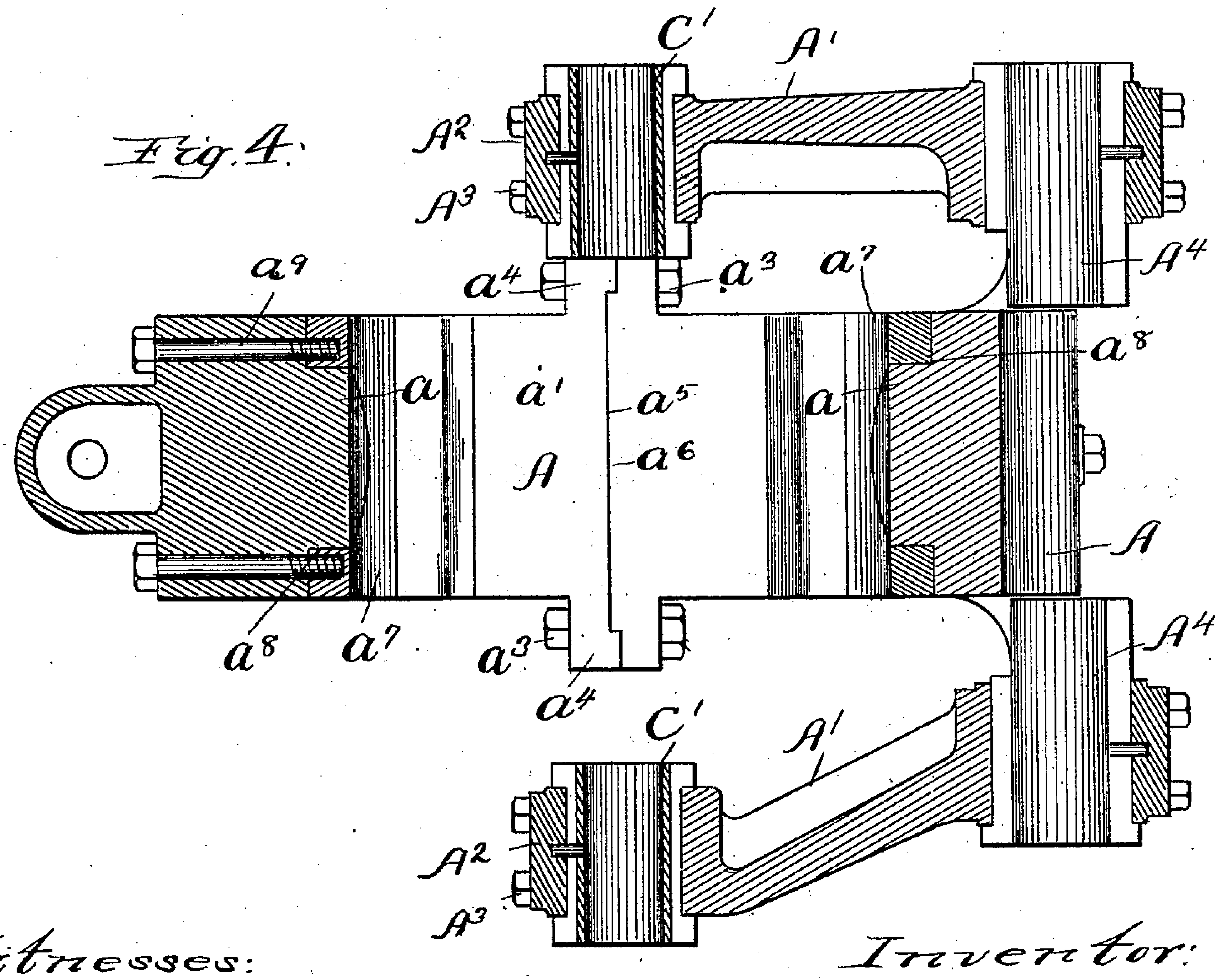


Fig. 4.



Witnesses:
Lew. E. Curtis
A. W. Munday,

Inventor:
Harold P. Brown
By Munday, Evarts & Adcock.
his Attorneys.

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H. P. BROWN.
ELECTRIC MOTOR.

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Fig. 5.

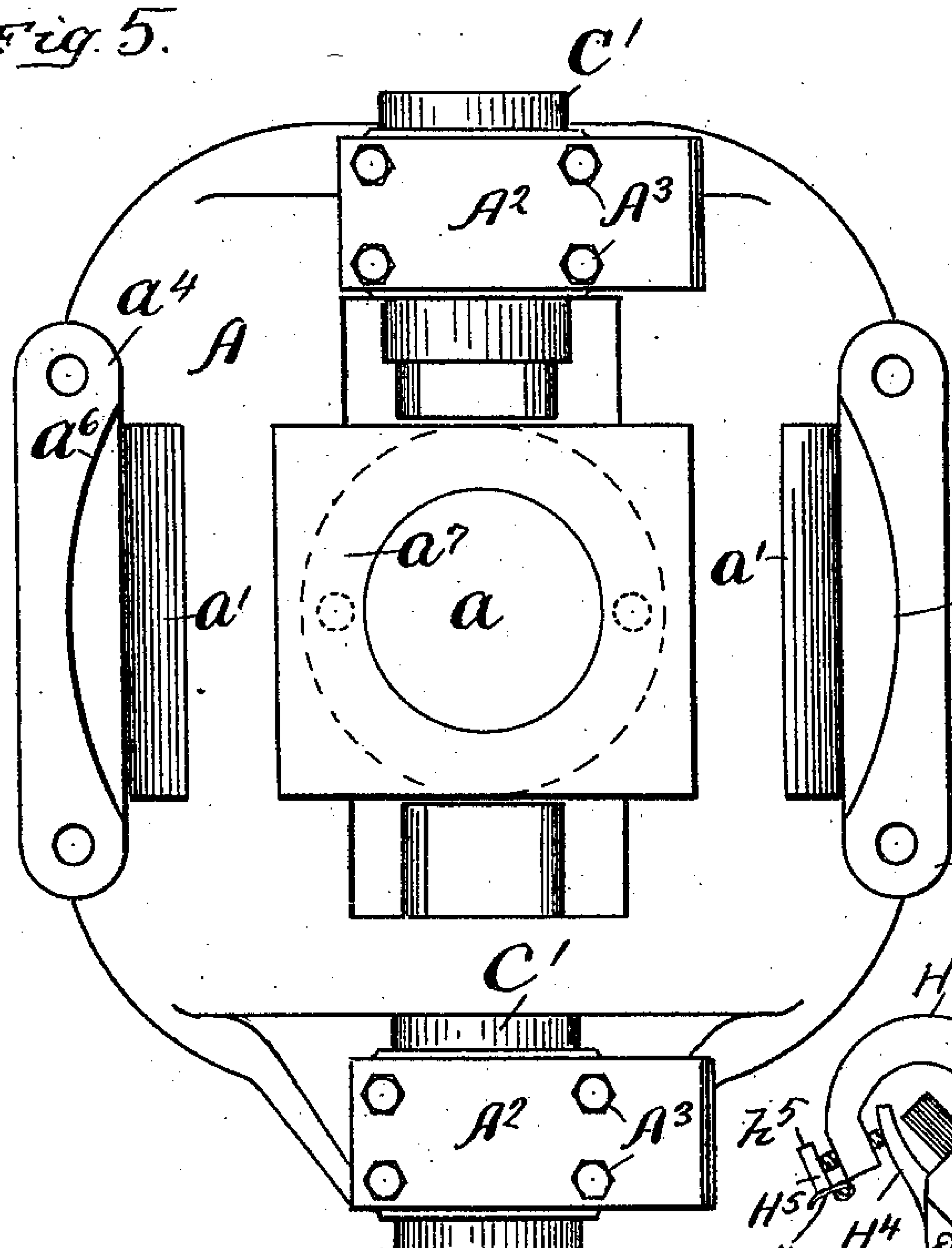


Fig. 8

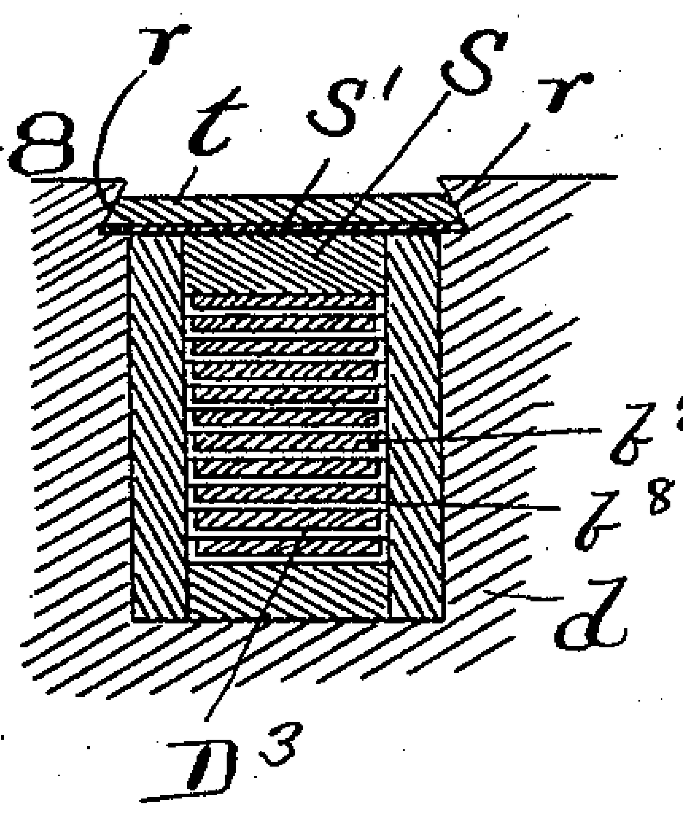


Fig. 9.

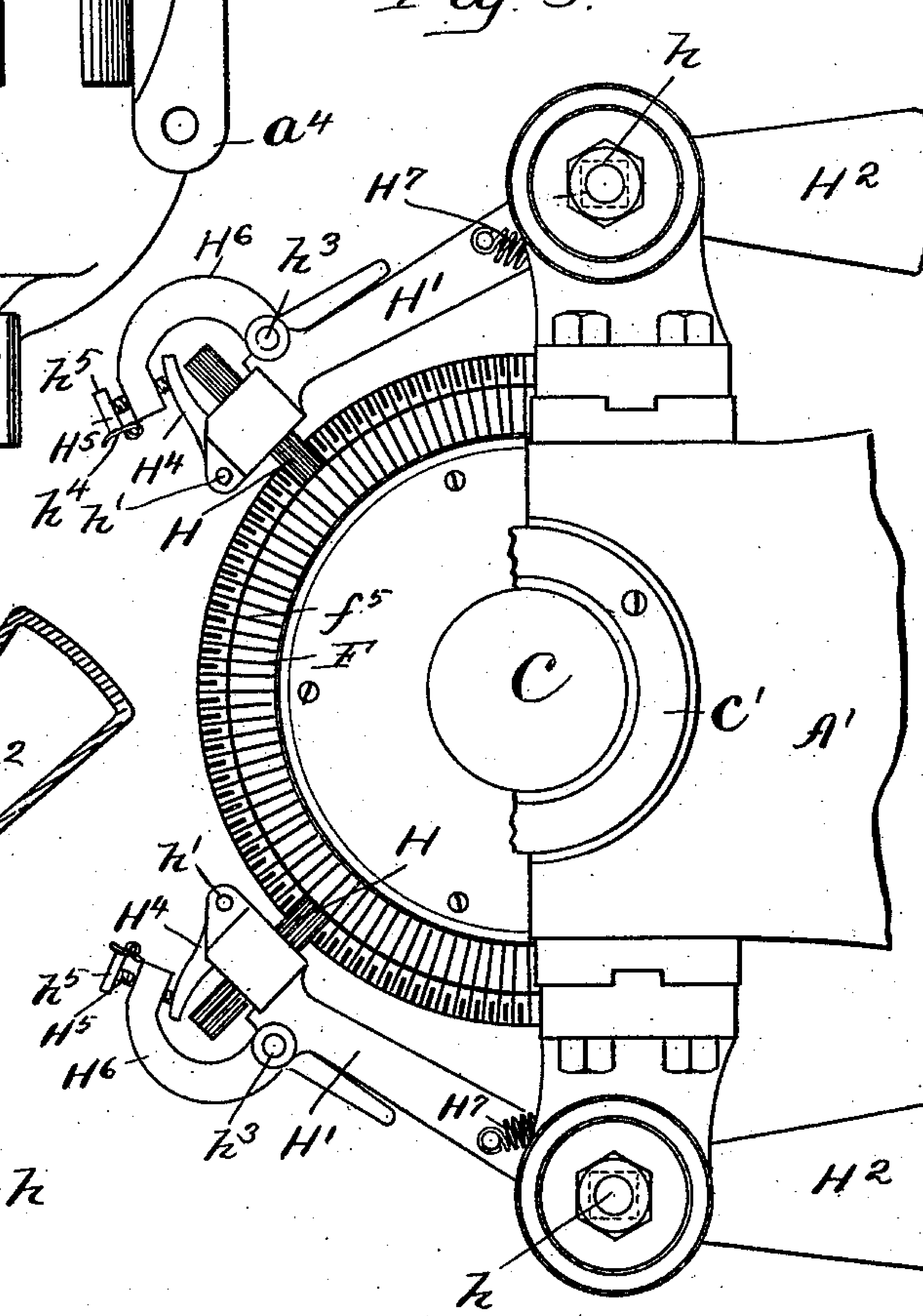


Fig. 10.

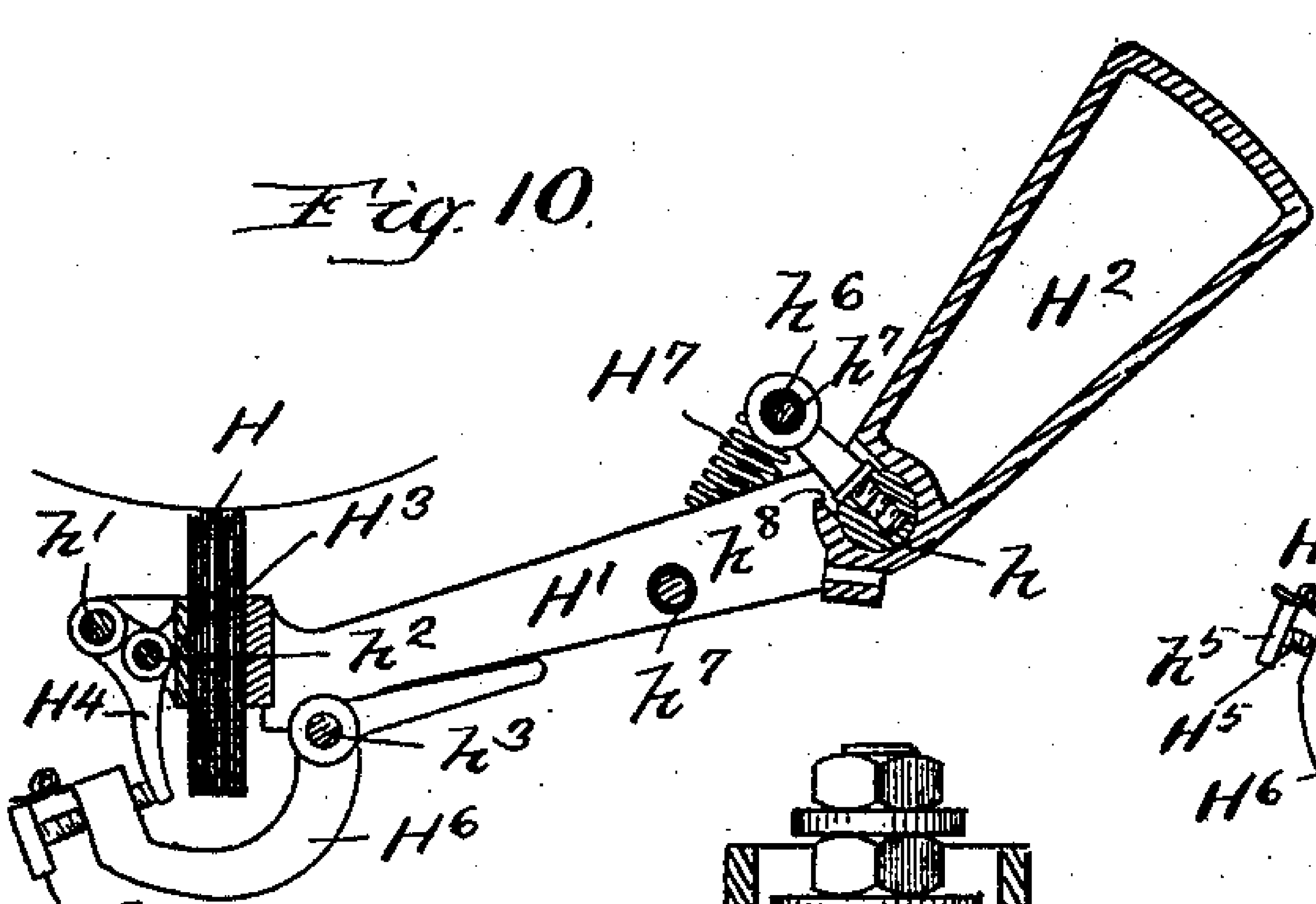
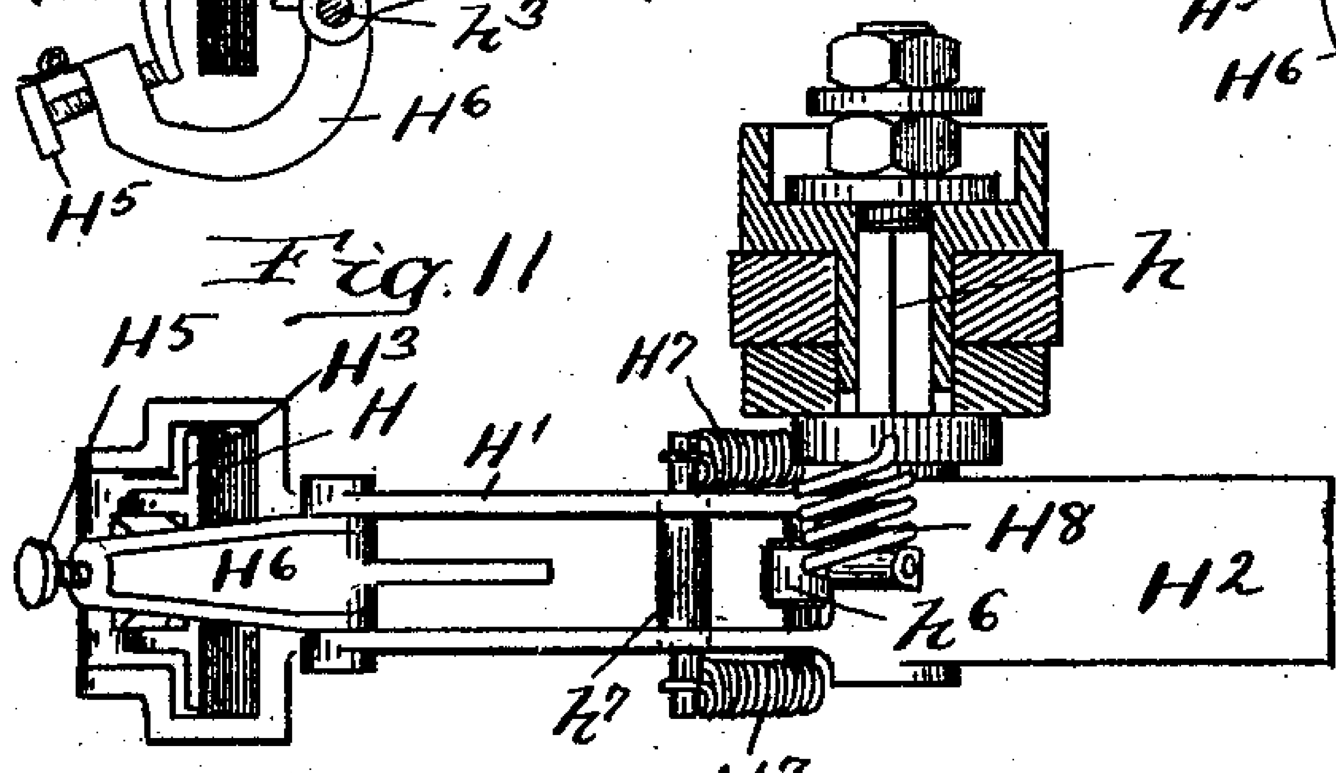


Fig. 11



Witnesses:
Lew. E. Curtis
H. M. Munday.

Inventor:
Harold P. Brown
By Munday, Evarts & Adcock.
his Attorneys.

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H. P. BROWN.

ELECTRIC MOTOR.

No. 518,561. Patented Apr. 17, 1894.

Fig. 6.

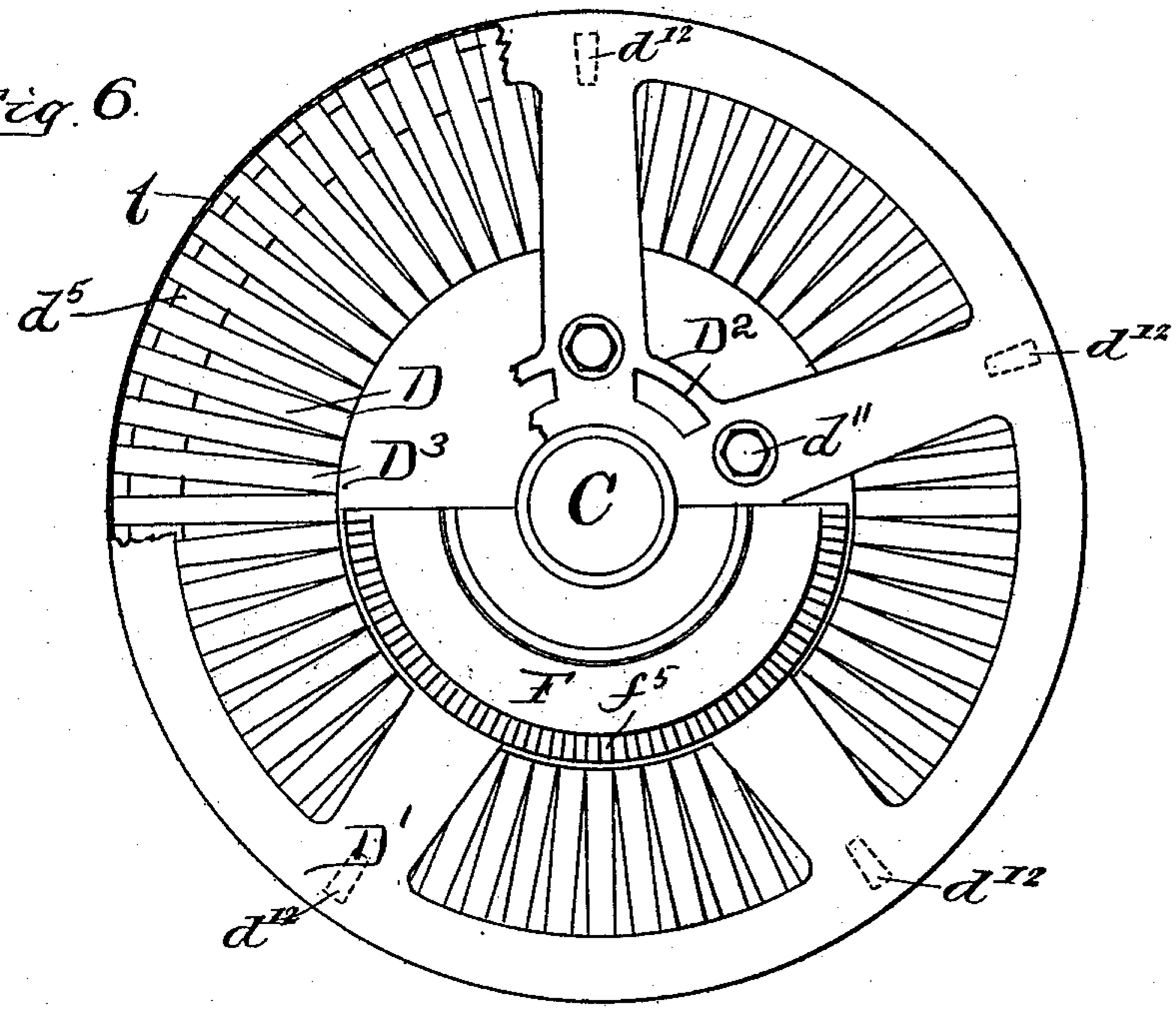


Fig. 7

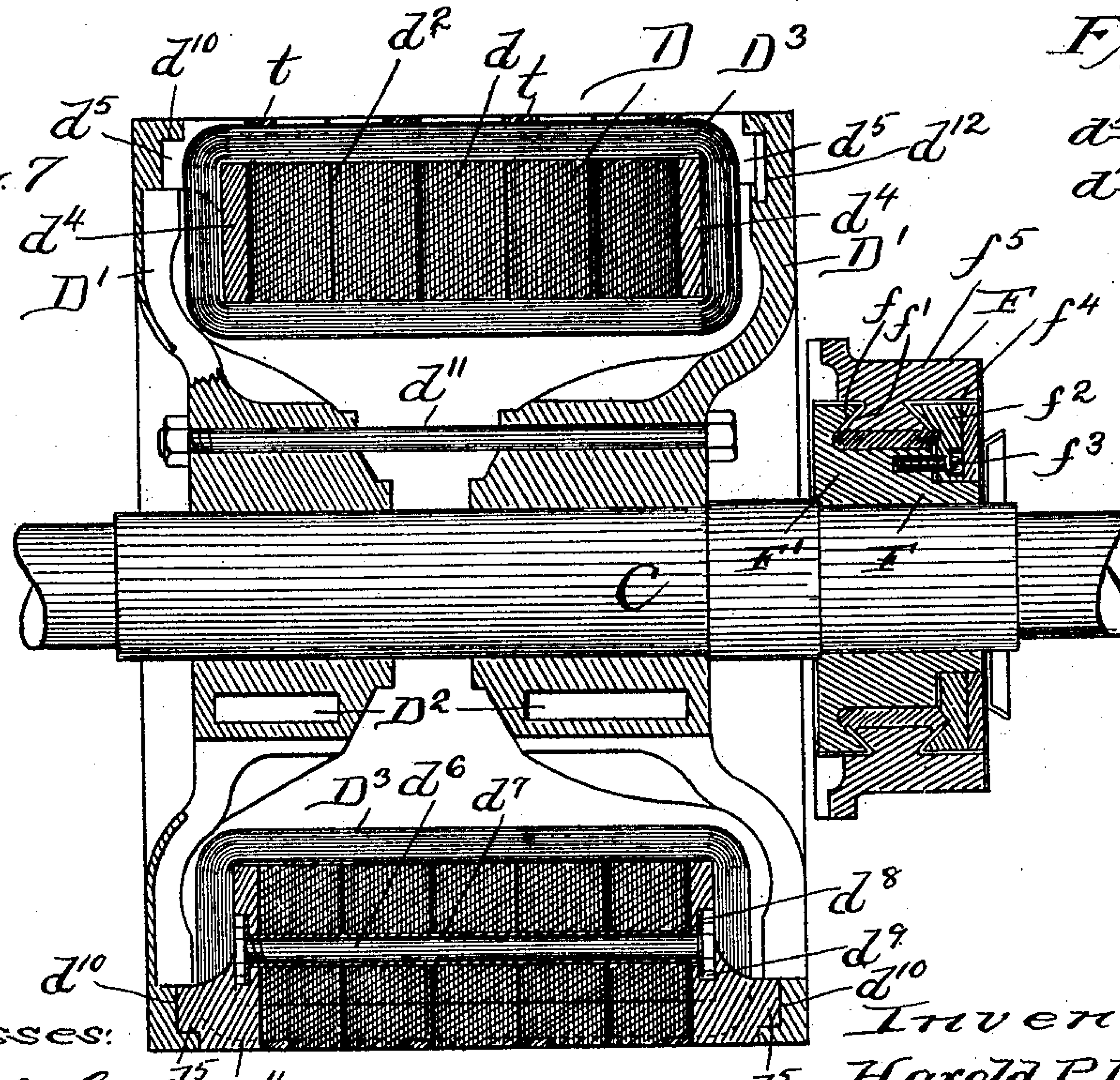
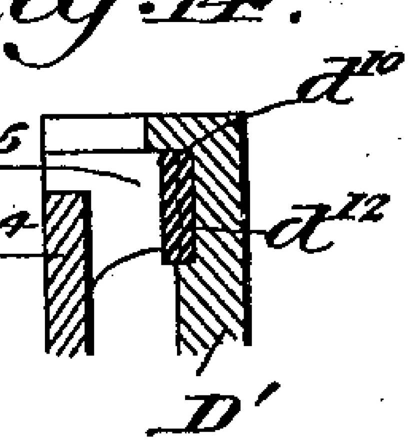


Fig. 14.



Witnesses:
Lew. E. Curtis
H. M. Munday.

Inventor:
Harold P. Brown
By Munday, Evarts & Adcock,
his Attorneys.

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H. P. BROWN.

ELECTRIC MOTOR.

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Fig. 12.

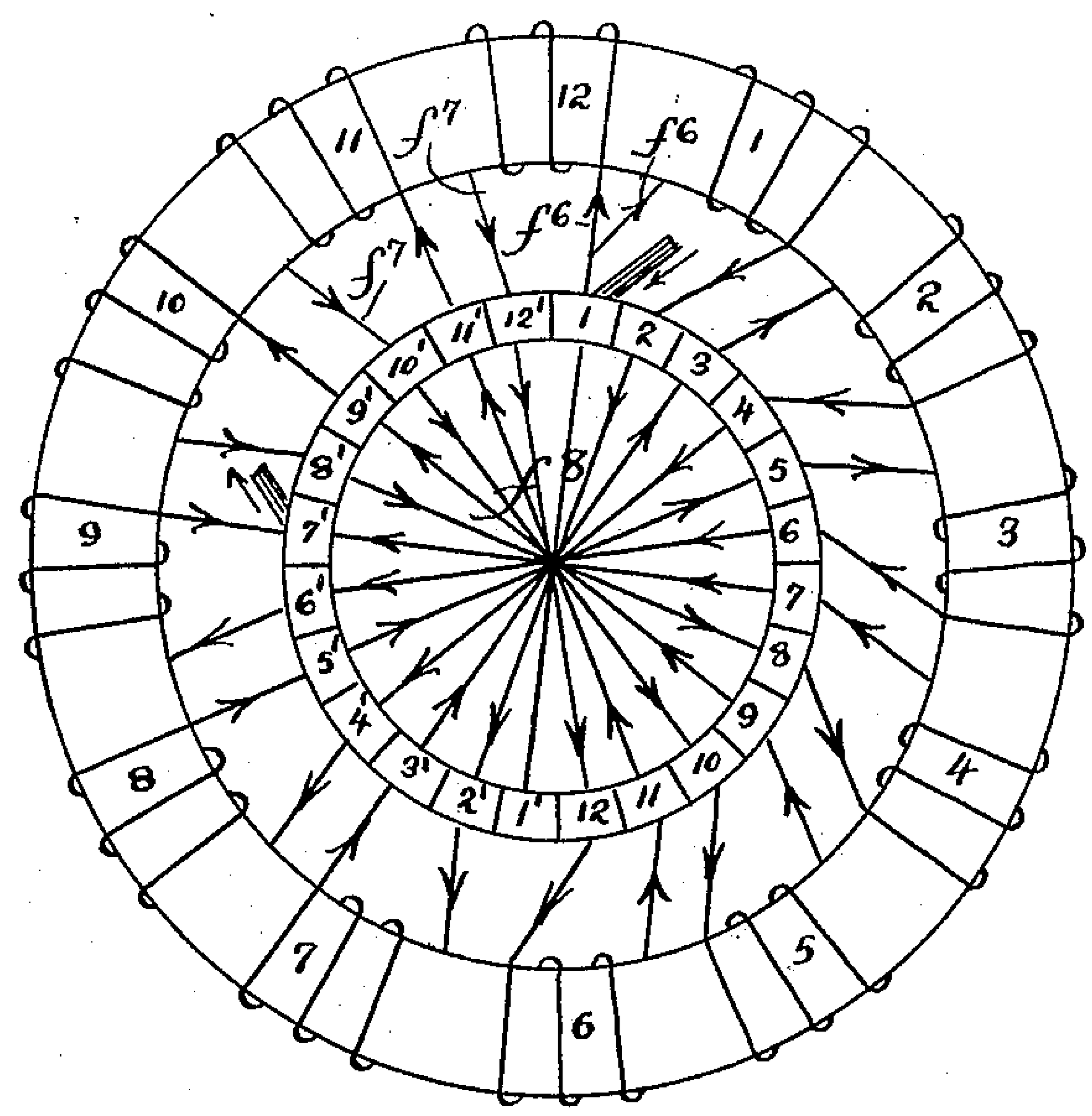
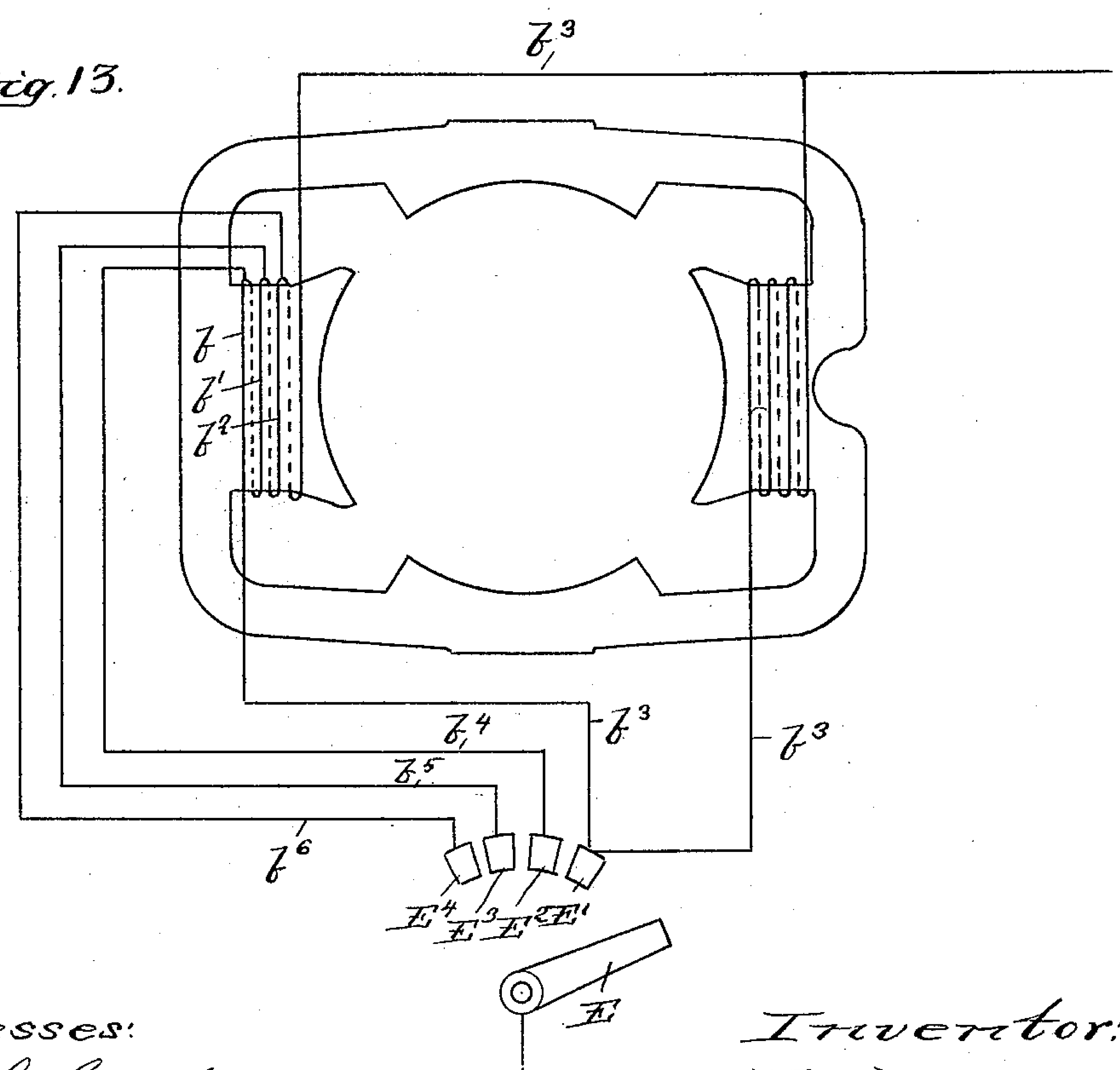


Fig. 13.



Witnesses:
Lew. E. Curtis
A. W. Munday,

Inventor:
Harold P. Brown
By Munday, Evarts & Adcock
his Attorneys.

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

HAROLD P. BROWN, OF NEW YORK, N. Y., ASSIGNOR TO THE EDISON GENERAL ELECTRIC COMPANY, OF SAME PLACE.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 518,561, dated April 17, 1894.

Application filed January 26, 1893. Serial No. 459,822. (No model.)

To all whom it may concern:

Be it known that I, HAROLD P. BROWN, a citizen of the United States, residing in New York, in the county of New York and State of New York, have invented a new and useful Improvement in Electric Motors or Machines, of which the following is a specification.

My invention relates to improvements in electric motors or other electric machines.

My invention consists, first, in the means I employ for varying the strength of the field magnets, and at the same time maintaining the diametrically opposite poles of equal force.

It further consists in the novel construction herein shown and described, of the frame of a four-pole motor, the same being made in two parts and split at the neutral points so as to maintain an unbroken magnetic circuit in the two adjoining quadrants.

It further consists in a pole-piece composed in part of a central integral core, and in part of a supplemental removable collar surrounding the central core, thus permitting the coil, ready wound, to be slipped on the central core, and a supplemental coil to be wound on the removable collar before it is applied to the core, and at the same time securing an unbroken magnetic circuit.

It further consists in the tongue and groove construction of the field magnet frame of the motor which serves to relieve the bolts from shearing strains.

It further consists in armature end plates made of magnetic metal, and having projecting teeth connecting with the spider.

It further consists in the means for securing the end-plates of the armature together by bolts insulated with tubes of asbestus paper or mica, and with end washers of similar material.

It further consists of an armature, the core of which is composed of thin, soft iron rings with asbestus or mica insulation plates placed at intervals, or between some of the rings but not between others.

It further consists in an armature, the core of which is composed of thin rings made of black iron sheets, the oxide or black coating on the surface of the sheets serving to partially insulate the individual rings from each other owing to the electric resistance offered by such coating.

It further consists in connection with a four-pole field magnet of a two-parallel connected armature having an even number of coils, and the system or method of connecting the coils of the armature.

It further consists in the means for securing the armature on the spiders by peripheral keys between the teeth of the armature end-plates, and in the center of or opposite to the arms of the spider.

It further consists in the novel construction of parts and devices and in the novel combinations of parts and devices herein shown and described, and more particularly pointed out in the claims.

In the accompanying drawings, which form a part of this specification, and in which similar letters and numerals of reference indicate like parts throughout all the views, Figure 1 is a plan view of a motor or electric machine embodying my invention. Fig. 2 is an end view. Fig. 3 is a detail sectional view of the field magnet frame and pole pieces. Fig. 4 is a vertical section taken on line 4 4 of Fig. 3. Fig. 5 is a detail view of one half the frame. Fig. 6 is a detail sectional view of the armature. Fig. 7 is a cross sectional view of the armature showing the same partly in elevation. Fig. 8 is an enlarged detail sectional view of the armature coil winding and the means of clamping same in position. Fig. 9 is an enlarged view showing the commutator and brushes. Figs. 10 and 11 are detail views of the brush holder. Fig. 12 is a diagram view showing the system of armature connection. Fig. 13 is a diagram view showing the switch connection for varying the strength of the series field and maintaining the opposite poles of equal force. Fig. 14 is a detail radial sectional view showing the manner of keying the armature to the end plates.

In the drawings A represents the frame of the motor, which has four poles a a and a' a', and is made in two parts, the same being split at the neutral points a^2 a^2 so as to maintain an unbroken magnetic circuit in the two adjoining quadrants. The two parts A A of the frame are secured together by bolts a^3 passing through ears or lugs a^4 on each of the adjoining halves, and the meeting faces of the two parts A A at a^2 are furnished with countering grooves and shoulders or rabbets a^5 a^6

so as to leave the bolts a^3 free from any shearing strain. The two similar poles a a consist of a central integral core upon which the field magnet coil B may be slipped after it has been wound into a coil or onto a spool or shell. The two poles a a are also provided with a removable pole piece or collar a^7 adapted to fit on the central core and be secured thereon after the field magnet coil B′ has been placed thereon. The core of the pole a has a shoulder a^8 to receive the collar a^7, and the collar is secured in place by bolts a^9. By thus making the pole in part of a central integral core and in part of a removable collar fitting thereon, the coil B may be applied ready wound to the pole piece, and the coil B′ may likewise of course be conveniently wound upon the removable collar portion a^7 of the pole before it is attached to the core of the pole. The following advantages are secured by this construction: The magnetic circuits in the frame are maintained unbroken between a a and a' a', the pole piece or collar a^7 serves merely to properly distribute the magnetic lines of force through the armature; no magnetic circuit is made to depend on the tightness of a bolt; the bolts a^3 and the collar bolts a^9 are relieved of all shearing strain; the mechanical work in making the front portion of the frame A is reduced to merely centering it in a vertical position on a vertical boring mill and in one operation cutting the faces of the meeting surfaces a^5 a^6 and the surfaces of a and a^8; the same is done with the other portion, and a fit is thus insured between the two parts of the frame and their coils B and B′ and their pole pieces a^7; the frame is then bolted together and placed on a horizontal boring mill and with one setting on same, the bearings A^4 A^4, C′ C′ and the salient faces of the poles a a a' a' are bored. The only planing necessary is the small amount on the bearings, caps and brush holder brackets. The construction is, therefore, much stronger, better and cheaper than the ordinary form in which the frame is planed to receive the separable core a and its pole piece a^7, (which are cast in one piece, planed, turned and bolted on, thereby introducing a break in the magnetic circuit,) and in which the meeting faces a^5 are planed without grooves or rabbets, so that any slackening or partial shearing of the bolts a^3 will ruin the armature. The pole piece or frame A A is furnished with integral brackets A′ A′ to receive and support the bearing C′ of the armature shaft C, the bearings or boxes C′ being secured in place by a cap A^2 attached by a bolt A^3 to the bracket A′. As the electric machine or motor, which is illustrated in the drawings, is one specially designed for use upon a railway car, the frame A is further provided with bearings A^4 for the car axle.

The field magnet coils B B′ of the motor are, in part, connected as a series, and in part as a shunt field.

To vary the strength of the series field and at the same time maintain the four magnetic circuits of equal strength, I employ a system of switch connection which is clearly illustrated in the diagram view Fig. 13, by which the total current divides between a fraction of the coil on one pole piece, and the remainder of the coil on that pole piece (flowing in the opposite direction) plus all the coil on the opposite pole piece, inversely in proportion to the resistance, thus maintaining equal the magnetic strength of the two poles a a. By this means the larger portion of the current is given a path of less and less resistance the more the force of the magnet is weakened, thus materially preventing unnecessary waste of current or power. This ordinarily requires a complicated cylinder switch with ten or more spring connections. To accomplish this result a single movable switch arm or contact piece E is moved into connection with a series of contact pieces E′ E^2 E^3 E^4, which are connected to different parts or sections b, b', b^2, &c., of the coil B on one of the two opposite poles, and the two opposite coils B B are connected together by a wire b^3 b^3 which leads to the first contact piece E.′ The several contact pieces E′ E^2, &c., are connected to the different portions of the coil B by wires or connections b^4, b^5, b^6. By this system it will be observed that when the switch E makes connection with the first contact piece E′, the whole current will divide equally between the coils B B on the two opposite poles: and that when the switch E is in contact with one of the switch points E^2 E^3 E^4 the greater portion of the current will flow through the fraction of the left hand coil and the lesser fraction of the current will flow backward through the other portion of the coil of such magnet and thence through the wires b b forward through all the coil B of the right hand pole. For example, suppose the points of connection, b, b', b^2, divide the left hand coil B into fourths, and the switch E is on the contact piece E^2. The total amount of coil B B on the two opposite poles will thus be eight-eights and the current will of course divide in the proportion of five to three, five-eighths of the current flowing forward through three-eighths of the coil on the left hand pole and three-eighths of the current flowing backward the remaining one-eighth coil on this left hand pole, and thence forward through the four-eighths coil on the right hand pole. The magnetic force of the right hand pole will thus be represented by three-eighths times four-eighths, or twelve sixty-fourths, while that on the left hand pole will be represented by five-eighths times three-eighths, minus three-eighths times one-eighth, which equals twelve sixty-fourths, the same as that of the right hand pole. The same equality will be preserved at any other point of division. This makes a very simple system of switch connection for varying the strength of the field magnets and maintaining the two opposite poles of equal strength and also results in a material saving of current or power, especially when the normal force of the magnet is greatly weakened, because the chief portion of the current has a path of very low resistance, while the path of the smaller fraction of the current is always less than that of the sum of the two coils B B′. The coils B B′ are formed of flat metal tape, the individual turns b^7 being insulated from each other by interposed insulating tape b^8 made preferably of asbestus paper coated or impregnated with burned or partly carbonized shellac, or other water proof substance.

The armature D has a core consisting of a series of separate annular disks d preferably made of soft black sheet iron, so that the oxide or black coating on the surface of the iron disks or sheets will serve, to a greater or less extent, to insulate or segregate electrically the separate disks from each other, while at the same time the disks are clamped closely and rigidly together. The oxide or black coating of the surface of the sheets possesses an appreciable electric resistance. At intervals between the series of thin flat core plates d I place insulating disks or rings d^2, preferably made of mica or asbestus. I find that ordinarily about six of these insulating disks d^2 in connection with the black iron disks d will be sufficient to employ for an ordinary sized motor. This materially economizes space and increases the power of the motor for a given size as very little space in the aggregate is taken up by the few insulating plates d employed. Where, as frequently has been done heretofore, paper insulating disks have been inserted alternately with the core disks, a material portion of the space is thus occupied by the insulating disks, thus materially increasing the size of the armature. The series of core disks d and insulating disks d^2 are clamped between a pair of end-plates d^4 d^4 made of magnetic metal, preferably of iron or steel, and having on their outer faces projecting teeth d^5 which connect with the spiders D′ D′ which are secured to the armature shaft C. The armature end-plates d^4 are secured together by clamp bolts d^6 which are insulated from the core ring d and from the end plates d^4 by a tube of asbestus paper or mica d^7, and washers d^8 of similar material. The armature end-plates d^4 have countersinks d^9 to receive the head and nut of the clamp bolt d^6. The spiders D′ have grooves or notches d^{10} to receive the teeth or projections d^5 on the end plates d^4. The spiders D′ D′ are secured or clamped together by bolts d^{11}. The armature end plates are also secured in place on the spiders D′ D′ by peripheral keys d^{12} which extend between the teeth of the armature end plates, and in or near the center of the arms of the spiders. The peripheral keys d^{12} extend radially into the armature between the spiders and the armature end plates, the same fitting partially in suitable grooves cut in the spiders, and partially in the spaces between the teeth on the armature end plates, so that the keys will thus effectually prevent any radial movement of the armature end plates in respect to the spiders. After the armature spiders D′ have been completed and fitted to the armature body and the shaft, they are taken apart and a groove say a quarter of an inch deep is cut in the inside of the center of each spider arm starting at the inner edge of d^{10} and running down say two inches, or a little more than the length of the projecting armature teeth d^5. These grooves are cut with an end milling tool preferably. Into these grooves are fitted the keys d^{12} which are of the same length and width as the grooves but are of double the thickness, so that say one quarter of an inch of their thickness fits into the groove and another quarter projects beyond the groove. This projection, when the armature is again assembled, fits between two of the projecting teeth d^5 of the armature and thus causes the armature and spiders to turn together when the shaft rotates. This construction and assembling renders it impossible for the key d^{12} to get loose, and as there are ten of them and they are near the periphery their section may be small.

In order to prevent the generation of wasteful currents in the teeth d^5 of the end plates d^4, the base plane of said teeth is placed in or outside of the outer plane of the pole pieces a^7. It is true that some wasteful currents are generated in the solid portion of the end plates d^4 inside of said planes, but as the teeth afford means of dissipating the heat thus generated and as the spiders in contact with the teeth materially aid in such dissipation, this disadvantage is not serious. It is more than offset by the advantages of this construction of armature which are as follows: Only magnetic metal is inclosed by the armature conductors, instead of wasting a portion by inclosing a bronze spider ring; the armature is wound before the spiders are attached, thus leaving ample room for doing the work and inspecting the insulation instead of crowding the same between spider arms; ample room is left for insulation between the coils on the inside of the armature, and the coils are radial instead of being crowded and distorted out of radial lines in order to make room for the spider arms; ample space is left between the spider and the coils, which aids in insulation of the coils and allows space for ventilation, as a current of air is by the motion of the armature, drawn in between the arms of the back spider and forced out at the periphery through the interstices between the coils and the spider rings.

The spiders D′ are provided with pockets D^2 cored out therein at the time they are cast. These pockets are for use in balancing the armature when it is completed, by filling one or more of the pockets to a greater or less extent with lead or other metal, as may be necessary.

D^3 D^3 are the armature coils, the same being made preferably of flat metal tape with interposed insulating tape of asbestus paper. The coils D^3 are wound around the ends of the clamp bolts d^6 and cover the heads of the same, thus enabling the coils to be placed close together without any intervening space between the clamp bolts. The armature preferably has about sixty coils, though the number may be of course varied. In the diagram view, Fig. 12, showing the armature connection, for convenience however only twelve coils are shown.

F is the commutator secured to the shaft C by a hub or sleeve F′, having undercut or dovetail projections f which engage dovetail projections f' on the segmental commutator ring; it is secured in place by a clamp ring f^2 attached by screws f^3 to the sleeve F′. The commutator ring F and the hub F′ are insulated from each other by interposed insulation f^4.

In the ordinary type of four pole motor the inner and outer terminals of contiguous coils are connected together and to one commutator segment, so there are as many segments as there are coils. Four brushes are used at quadrants of the commutator; or the opposite commutator segments are connected together and two brushes used on adjoining quadrants. In either case there are four paths in parallel through which the current may flow through the armatures. If, as occasionally occurs, the armature through wear or jarring drops below the absolute center of the bore of the pole pieces, the conductors on the two lower quarters of the armature will cut more magnetic lines of force than those on the upper quarters. Therefore the electro-motive force or counter-electro-motive force will not be equal in the upper and lower halves of the armature and a serious loss of efficiency will result. To avoid this, armatures of this type have been connected so that but two paths are presented and so that the diametrically opposite coils are in series. But the ordinary method of accomplishing this is to have an odd number of coils and double the number of commutator segments. It is obvious that this method makes the two paths always unequal and is not as good as the other method when the armature is in the center. In my method I avoid both difficulties by making the paths always equal in resistance and in electro-motive force or counter-electro-motive force. The commutator is cross connected and has twice as many segments f^5 as there are coils D^3 on the armature; and there are an even number of coils and an even number of segments. The armature is connected so as to form but two parallel paths for a four pole motor, each path having an even number of coils, the diametrically opposite coils being connected together in series as is clearly shown in the diagram view, Fig. 12. In this view the twelve coils shown are numbered in two series from 1 to 12 consecutively, and the twenty four commutator segments are numbered in two series from 1 to 12 consecutively and from 1′ to 12′ consecutively, so that the two corresponding numbers, as for example 3, 3′, come diametrically opposite each other. To each of the commutator segments f^5 is connected one of the two terminals of one of the coils D^3. The coils and commutator segments which are connected together, are marked with corresponding numbers with the exception of the two segments 1 and 1′. One of these, marked 1, is connected to the terminals f^6 f^6 of the first and last coils, the same being contiguous and marked 1 and 12 respectively; the other segment marked 1′ is not connected to the terminals of any coil, excepting of course through its diametrically opposite segment marked 1. By this system of connection it will thus be seen that each segment of the commutator has connection with two coils. The segments 1 and 1′ being connected with the coils 1 and 12, and for example the segments 11, 11′ being connected with the coils marked 11 and 6, and so on. The ingoing terminals leading from the commutator segments are marked f^7, while the wires connecting the diametrically opposite segments are marked f^8. Examination will show that this form of connection is symmetrical for it makes no magnetic or electrical difference whether the current, after passing through the upper coil 12 and the lower coil 6, is next led to the adjoining coil 5 on the bottom and then to the diametrically opposite coil 11, on the top, or whether it is first led to the coil 11 on the top and then to the coil 5 on the bottom. Through two quarters of the revolution the adjoining coil is first put in; through the other two quarters the coil opposite the adjoining one is first put in.

H. H are the commutator brushes. The brushes H are held radially to the commutator by the pivoted brush holder H′. This brush holder is pivoted to the frame at h and has a gravity counterbalance arm H^2 so as to prevent the brush from jarring from the commutator when the car to which the motor is applied is passing over crossings or switches; or when, from other causes, the motor may be subjected to jarring motion. The counterbalance arm H^2 is made hollow so that it may be filled to a greater or less extent with lead or other metal as required to counterbalance the brush and brush holder arm and thus cause the brush and holder to be supported at or near their center of gravity. The brush H is mechanically clamped to the brush holder H′ by a clamp H^3, operated by a toggle arm or lever H^4 which is pivoted at h' to the holder H′, and at h^2 to the clamp H^3. As the bearing face of the clamp H^3 against the brush H and the pivots h' h^2 are arranged so as to make a very obtuse angle or approximate straight line, the lever H^4 acts in the nature of a toggle and gives a more powerful, firm and secure clamping action on the brush. The toggle lever H^4 itself is also operated and held firm set by a screw

H^5 threaded in an arm H^6 which is secured to the brush holder arm H′ by a pin h^3. The set screw H^5 is locked against turning by a spring h^4 attached to the arm H^6 and which fits against the head h^5 of the screw H^5. H^7 is the tension spring attached at one end to the brush holder arm H′ and at its other end to an eye bolt h^6 secured to and projecting from the pivot pin or shaft h of the brush holder H′. The tension spring H^7 is furnished with an insulated bushing h^7 at its point of attachment with the eye bolt h^6, or at its point of attachment with the brush holder H′, one or both, in order to prevent the current from passing through the spring and thus destroying or varying the tension or elasticity thereof. This frequently occurs with ordinary motors and causes serious trouble and injury. This insulated spring may, of course, be used on any brush holder. The eye bolt h^6 projects through a slot or opening h^8 in the brush holder H′ and it thus serves not only as a point of attachment to tension spring H^7, but also to hold the brush holder longitudinally in place on its pivot or shaft h, and also as a stop or limit to the radial motion of the brush holder H′ on its shaft h. H^8 is a flexible wire or cable electrical connection between the brush holder H′ and its pivot or shaft h. By this means the resistance between the pivoted brush holder and its shaft h is materially lessened the electrical connection being much more perfect, especially where the fit between the brush holder and its pivot becomes a little loose or imperfect from wear or other cause. By compressing the carbon brush with the toggle lever, not only is the contact resistance reduced between the holder and the brush but the resistance of the brush is also reduced. In order to hold the coils of the armature firmly in place without the ordinary band wires I cut, as shown in Fig. 8, a slight groove r near the top of each armature tooth. After the coil has been completed and its top insulation strips S S′ have been put in place, I insert a short piece or clamp of sheet metal t, bent into the arc of a circle and with beveled edges, into the slot. By then hammering or pressing the rounded portion of the piece t, it is straightened out until it wedges itself into the grooves r r on each side of the slot, thereby firmly securing the coil into place. It will be noticed the entire face of the slot has been left open so that the armature coil can be wound in place without twisting it. If desired the plate t can be slid in from the edge of the armature.

The supplemental field magnet coils B′ may represent the shunt field coils; in which case they are connected in the ordinary manner of shunt field coils to the armature terminals. As the manner of connecting shunt field coils is familiar to those skilled in the art and as my invention does not relate thereto I have not shown this connection in the drawings. If the motor has series field coils alone the supplemental coils B′ may represent part of the series field.

I claim—

1. In a four pole electric machine or motor, the system or means of varying or changing the strength of the field magnets consisting in connecting two field coils in parallel to the first of a series of switch contact pieces, the other of said series being connected to different portions of one of said coils, so that when the strength of the magnets is to be reduced, the current may divide differentially in one coil, a portion of the current flowing backward in said coil in order to reach the other coil, thus keeping the magnetic strength of the two coils equal, substantially as specified.

2. In an electric machine or motor, the system or means for varying or changing the strength of the field magnets, consisting in a switch having a series of contact pieces connected at or to different portions of the coil on one of the two opposite poles, and one contact piece connected to both of the two opposite coils, so that the current may divide, when the strength of the magnet is to be weakened, between a fraction of the coil on one pole and the remainder of the coil on that pole (flowing in the opposite direction) plus the coil on the opposite pole, thus maintaining the opposite poles of equal intensity, substantially as specified.

3. In an electric machine or motor, the field magnet frame made in two parts A A, the meeting faces of which are provided with interfitting tongues and grooves to relieve the clamp bolts from shearing strains, in combination with the clamp bolt for securing the two parts together, and extending longitudinally from one part to the other substantially as specified.

4. In an electric machine or motor, a pole piece composed in part of a central core a integral with the frame A and in part of a supplemental removable collar surrounding the central core, thus properly distributing the lines of force and permitting the coil ready wound to be slipped on the central core portion of the pole, and a supplemental coil to be ready wound on the removable collar portion of the pole before it is applied to the core portion, substantially as specified.

5. In an electric machine or motor, a pole piece composed in part of a central integral core and in part of a supplemental removable collar surrounding the central core, thus permitting the coil ready wound to be slipped on the central core portion of the pole, and a supplemental coil to be ready wound on the removable collar portion of the pole before it is applied to the core portion, in combination with a removable coil B and a removable supplemental coil B′, substantially as specified.

6. In an electric machine or motor, the armature having a core composed of a series of thin soft iron rings, in combination with in-

sulating plates or rings placed at intervals or between some of the iron rings, but not between others, substantially as specified.

7. In an electric machine or motor, the armature having a core composed of a series of thin soft iron rings, in combination with asbestus or mica insulation plates or rings placed at intervals or between some of the rings but not between others, substantially as specified.

8. In an electric machine or motor, the armature having a core composed of a series of thin soft iron rings, in combination with insulating plates or rings placed at intervals or between some of the iron rings but not between others, said soft iron rings having an oxide or black coating on the surface thereof to partially insulate the individual rings from each other by the electric resistance offered by such coating substantially as specified.

9. In an electric machine or motor an armature having a core composed of a series of thin rings made of black iron sheets, the oxide or black coating on the surface of the sheets serving to partially insulate the individual rings from each other, substantially as specified.

10. In an electric machine or motor having a four pole field magnet, a two parallel connected armature having an even number of coils, in combination with a commutator having double the number of segments that there are coils on the armature, the opposite segments of the commutator being electrically connected together, and one terminal of each coil being connected to one of the segments, with the exception of two opposite segments marked 1 1′, with one of which two coil terminals are connected, and with the other of which, 1′, no terminals are connected excepting through its opposite fellow segment, 1, substantially as specified.

11. In an electric machine or motor, the combination of the armature core and its coils with the armature end-plates provided with projecting teeth, and the spiders having a projecting rim, shoulders or notches engaging said teeth, and peripheral keys for securing the armature on the spiders, said keys being inserted between the teeth of the armature end plates, substantially as specified.

12. In an electric machine or motor the armature in combination with the spider to which it is secured, said spider having a projecting rim to engage said armature and provided with pockets cored therein, and adapted to receive metal or other weight for balancing the armature, substantially as specified.

13. In an electric machine or motor, the combination with the commutator, of a pivoted brush holder furnished with a clamp for holding the brush, said clamp being arranged to hold the brush radially to the commutator, and positive mechanical devices for operating or holding the clamp to grip the brush, substantially as specified.

14. In an electric machine or motor, the combination with the commutator of a pivoted brush holder furnished with a counterbalance arm, so that said brush and its holder may be supported at or near the center of gravity, substantially as specified.

15. In an electric machine or motor, the combination of a commutator with a brush holder furnished with a clamp for gripping the brush and a toggle arm or lever for operating and holding said clamp, substantially as specified.

16. In an electric machine or motor, the combination of a commutator with a brush holder furnished with a clamp for gripping the brush, and a toggle arm or lever for operating and holding said clamp, and a screw for operating and holding said toggle arm or lever in position, substantially as specified.

17. In an electric machine or motor, the combination of the commutator with a brush holder furnished with a clamp for gripping the brush, and a toggle arm or lever for operating and holding said clamp, a screw for operating and holding said toggle arm or lever in position, and a device for locking said screw from turning, substantially as specified.

18. In an electric machine or motor the combination of a brush holder and its support, with a tension spring for holding the brush against the commutator, and an insulating bushing for said spring to prevent the current passing through the same and thus destroying the elasticity of the spring, substantially as specified.

19. The combination of a pivoted brush holder, with its shaft or pivot *h*, a bolt or pin projecting therefrom through an opening in the brush holder, the tension spring attached to said bolt at one end and to the brush holder at the other, said bolt or pin serving also as a stop to limit the radial movement of the brush holder on its pivot or shaft, substantially as specified.

20. In an electric machine or motor, a pivoted brush holder furnished with a hollow counterbalance arm adapted to receive a counterbalance weight, substantially as specified.

21. In a dynamo-electric machine or motor, a pivoted brush holder, a carbon brush and a clamp for exerting pressure on said brush for the purpose of reducing its resistance and the contact resistance between said brush and said holder, substantially as specified.

22. In a dynamo-electric machine or motor, a pivoted brush holder supported at or near its center of gravity, substantially as specified.

HAROLD P. BROWN.

Witnesses:

H. M. MUNDAY,

EDW. S. EVARTS.