(No Model.)

E. THOMSON & M. J. WIGHTMAN.

DYNAMO ELECTRIC MACHINE.

No. 550,464. Patented Nov. 26, 1895.

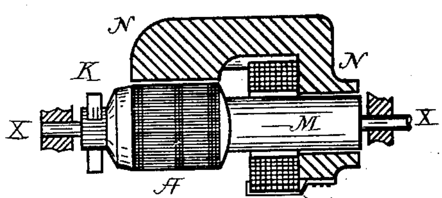

Fig. 1.

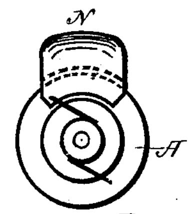

Fig. 2.

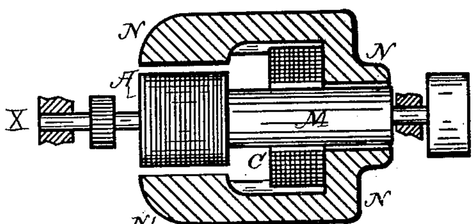

Fig. 3.

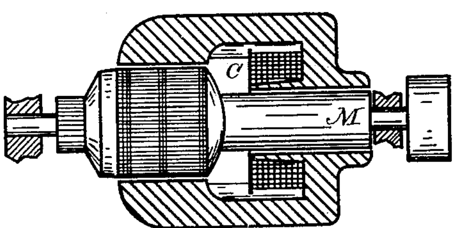

Fig. 4.

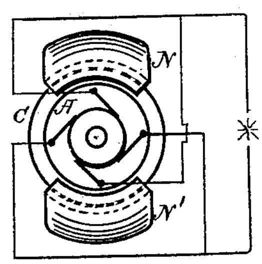

Fig. 5.

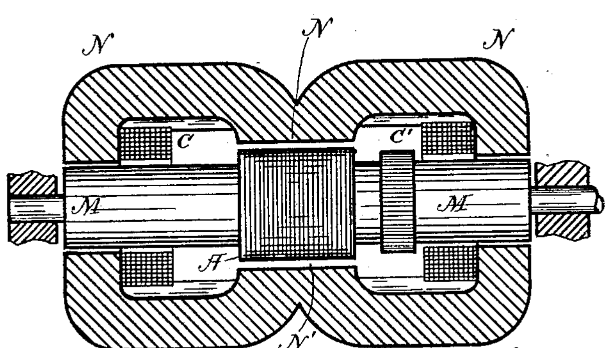

Fig. 6.

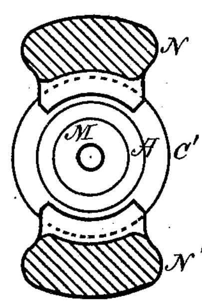

Fig. 7.

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(No Model.) 4 Sheets—Sheet 2.

E. THOMSON & M. J. WIGHTMAN.

DYNAMO ELECTRIC MACHINE.

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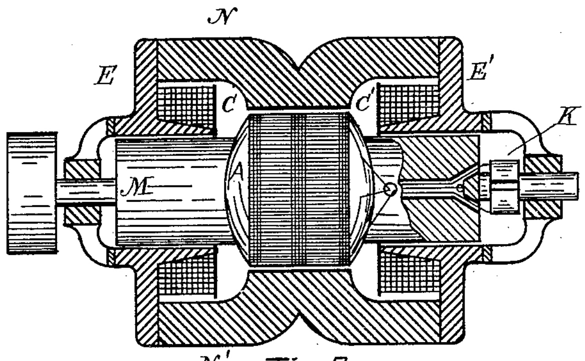

Fig. 8.

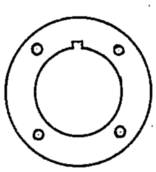

Fig 9.

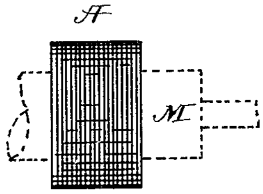

Fig 10.

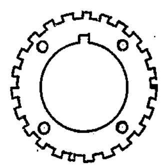

Fig 11.

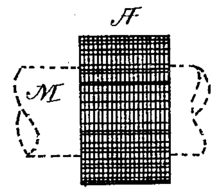

Fig 12.

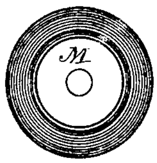

Fig 13

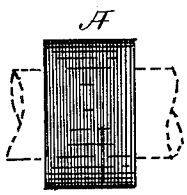

Fig 14.

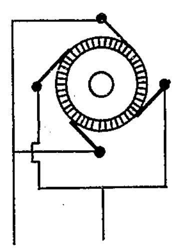

Fig 15.

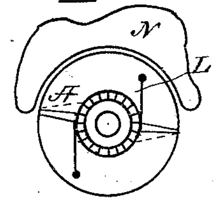

Fig 16.

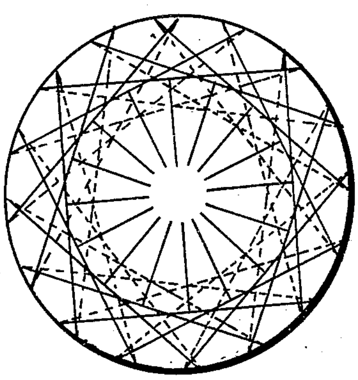

Fig 17.

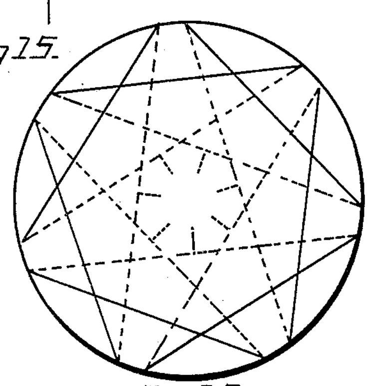

Fig 18.

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(No Model.) 4 Sheets—Sheet 3.

E. THOMSON & M. J. WIGHTMAN.

DYNAMO ELECTRIC MACHINE.

No. 550,464. Patented Nov. 26, 1895.

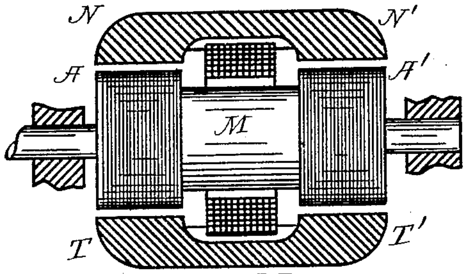

Fig. 19.

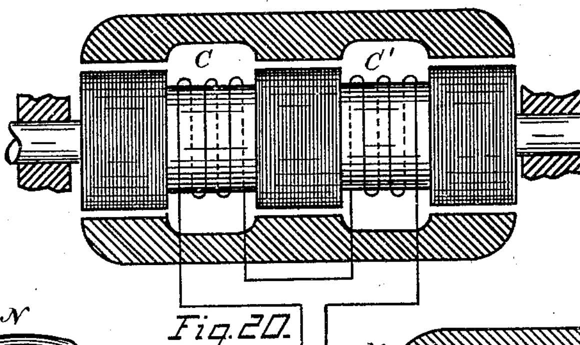

Fig. 20.

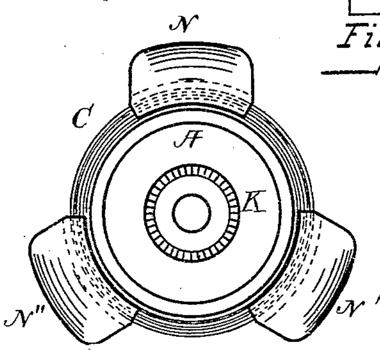

Fig. 21.

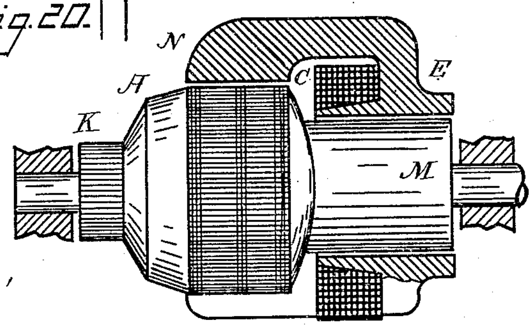

Fig. 22.

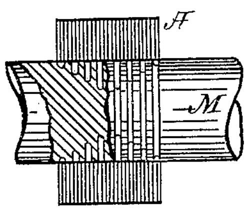

Fig. 23.

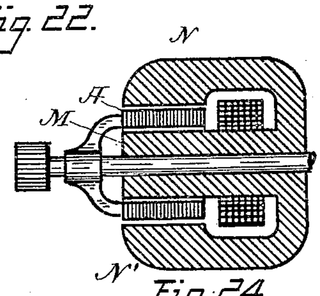

Fig. 24.

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(No Model.)

4 Sheets—Sheet 4.

E. THOMSON & M. J. WIGHTMAN.

DYNAMO ELECTRIC MACHINE.

No. 550,464. Patented Nov. 26, 1895.

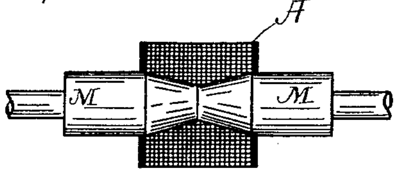

Fig. 25.

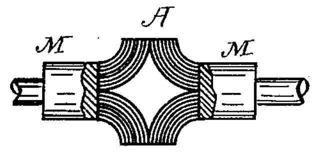

Fig. 26.

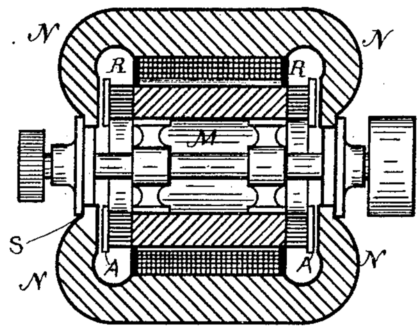

Fig. 27.

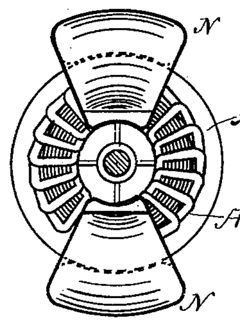

Fig. 28.

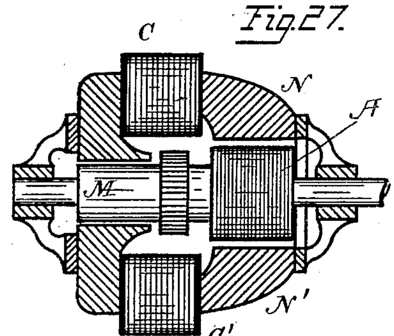

Fig. 29.

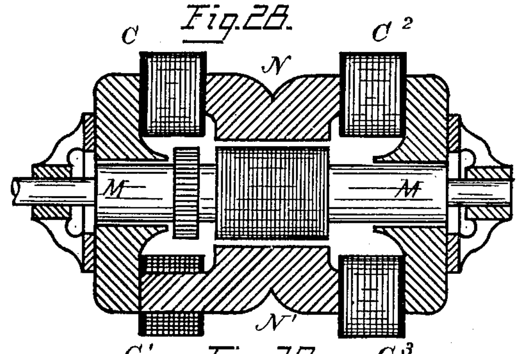

Fig. 30.

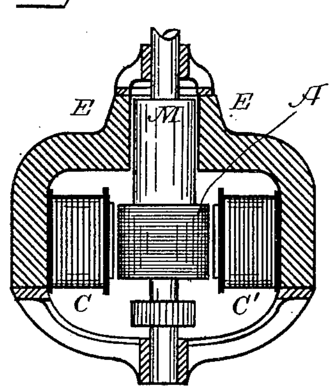

Fig. 31.

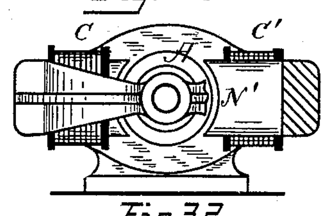

Fig. 32.

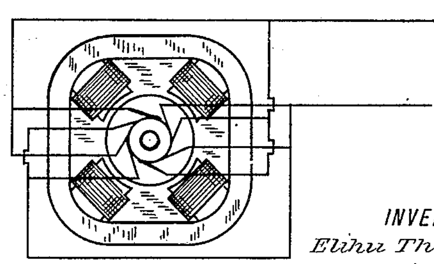

Fig. 33.

WITNESSES:

[illegible]

[illegible]

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UNITED STATES PATENT OFFICE.

ELIHU THOMSON AND MERLE J. WIGHTMAN, OF LYNN, MASSACHUSETTS, ASSIGNORS TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 550,464, dated November 26, 1895.

Application filed December 2, 1889. Serial No. 332,343. (No model.)

To all whom it may concern:

Be it known that we, ELIHU THOMSON and MERLE J. WIGHTMAN, citizens of the United States, and residents of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Dynamo-Electric Machine, of which the following is a specification.

Our present invention relates to an improved type of dynamo-electric machine useful in the generation of electric currents or as an electric motor.

A machine constructed in accordance with our invention differs from the type of machine at present in common use in that the magnetic polarities around the periphery of the revolving portion are the same in name at different positions, provision being made for the return of the magnetic circuit from the interior of the revolving portion, while, moreover, at all times during the action of the machine or at every instant of revolution the whole armature wire or conductor that is at any time active or traversing a magnetic field is connected back through other portions of wire or conductor not traversing a field, but passing over portions of the armature which are opposite neutral or dead spaces or spaces of no field instead of spaces of opposite field, as in previous types of machine.

As is well known in the ordinary types of machine, as constructed prior to our invention, currents may be produced in any given turn or convolution of wire by the cutting of lines of force on two sides of the armature or at different points of the armature currents of opposite direction or polarity will be produced by the opposite sets or portions of a convolution or sets of convolution. In our present invention, however, the current is obtained at all times from parts of the armature-winding cutting only lines of like polarity in one direction, while the other portions of armature winding or coils, which in prior types of machines would be cutting lines of opposite polarity or be generating current passing in the opposite direction with relation to the axis of the armature, are at all times inactive or moving in a dead field. We obtain in this way simplicity of magnetic circuit and secure a multipolar effect and therefore slow speed. We also secure a revolving structure, which is strong and may be made of large dimensions and, besides, which is the great advantage, the avoidance of much of the loss of energy due to reversals or change of magnetism producing Foucault currents or giving rise to hysteresis, such as exists in dynamo-electric machines of the ordinary patterns. Our invention, therefore, permits of the use of a very intense magnetic field. It may be embodied in a number of different forms or designs, some of which will be illustrated herein; but it is to be understood that these may be departed from both as to design, arrangement of winding, construction, &c., to a large extent, without impairing the action or departing from the spirit of the invention, the essential features of which may be preserved through a variety of changes or modifications.

It will be our purpose to describe some simple forms and gradually develop them into the more perfect forms in which the invention may be embodied without restricting ourselves in any particular, however, as to any of the embodiments.

In the accompanying drawings, Figure 1 is a diagram of a machine of the simplest possible type embodying our invention. Fig. 2 is an end view of the same. Fig. 3 is a slightly more developed type, showing the field-magnet circuit. Figs. 4 and 5 are the same as Fig. 3, but show the positions occupied by the generating, winding, and the commutator brushes. Figs. 6 and 7 show still another modification. Fig. 8 shows a form similar to Fig. 6, but more highly developed. Figs. 9, 10, 11, 12, 13, and 14 relate especially to the construction of the revolving portion which receives the wire or conductor in whicq the currents are generated. Figs. 15 and 16 relate to the commutation which takes place in some forms of machine. Figs. 17 and 18 are explanatory of the kind of winding of the revolving portion which is applicable for use with our invention. Fig. 19 is a modification in the form and disposition of the parts. Fig. 20 is a further modification. Figs. 21 and 22 show the development of the invention giving the effect of six poles. Fig. 23 is a detail of the revolving portion. Fig. 24 shows a modification in which the revolving portion is made much smaller than in the preceeding figures. Figs. 25 and 26 show further modifications in the construction of the revolving portion which carries the generating-coils. Figs. 27 and 28 exemplify still another modification in the disposition of the parts. Figs. 29, 30, 31, 32, and 33 illustrate changes in the application of the energizing helices or coils for providing the field magnetism.

In Fig. 1 we have shown a simple form of apparatus not so practical as those which follow, but intended to illustrate the principle only of our invention. Mounted on any suitable support is a body of iron M, preferably in the form of a cylinder and having in magnetic connection or proximity the generative portion A of the machine. Preferably the part A is attached to M, and both rotate together, the cylinder M being for that purpose mounted on a suitable shaft X X. The part A or generative portion is rotated by this means, although any other construction or arrangement whereby such part A may be rotated either with or separately from M might be employed.

K is the commutator for the generative coils or conductors wound on A in the manner to be presently described. Surrounding the outer end of the cylinder M is a body of iron N, which is extended over at the top, so as to convey lines of magnetic force to one side only of the part A, as shown in Fig. 2. An energizing-coil C is mounted in such a way as to surround the cylinder M and magnetize it.

The construction of the revolving portion A is substantially as follows: It is made of iron and constitutes an enlargement or expansion of the cylinder M outwardly to a larger diameter. It consists, preferably, of laminated plates or iron wire wound around or placed around the iron cylinder M, constituting, therefore, a separate laminated ring surrounding the same. Upon the exterior of this ring in Fig. 1 coils are wound in substantially the same manner as in a Siemens drum-armature or any other kind of armature-winding which would by revolution in an ordinary bipolar field produce currents. The connection to the commutator would be the same, for example, as in the Siemens armature; but there is only a single field-pole external to the armature at N, and the part A M is indeed as much a field-magnet as it is an armature, and currents are developed only in that portion of the winding which passes under the pole N, there being no effect produced on the other side of the armature or structure A, revolving with the part M. The iron plates or laminations under the wire of A are not therefore subject to any reversal of polarity, and the effect is purely that of a cutting of lines of magnetic force at one space only around the exterior. The magnetic effect may be made double the ordinary power by increasing the intensity of the single magnetic pole, and the results will be substantially the same as though two poles had been used as in the ordinary machines, but of half the strength. At the same time the structure is quite simple and the exposure of the generating-coils to the air for ventilation and cooling is very much greater. The chief objection, however, to Fig. 1 as a machine is that it would have an upward thrust of magnetic attraction tending to force the portion A against the upper pole. It is therefore unbalanced in magnetic attractions and is not mechanically a good form. This objection, however, is removed by adopting the arrangement shown in Fig. 3, in which instead of a single pole outside the revolving generating portion A there exists an upper and a lower pole N N′, the remainder of the structure being very much the same as in Fig. 1, with this exception that the winding on the generating portion is now changed to correspond to a four-pole winding such as that to be used on ordinary drum-armatures—that is, each convolution instead of passing diametrically across the armature will now pass obliquely; or, in other words, the convolutions will be wound in such a way as to have a portion of wire running in one direction extended and connected to a portion of wire running in the opposite direction, but at a position about ninety degrees removed around the circumference of the revolving part A, as hereinafter more fully explained.

Fig. 3 shows only the magnetic portions, partly in section, with the energizing-coil C surrounding the part M, as in Fig. 1, while Fig. 4 shows the same arrangements with the winding in place on the portion A or laminated extension of the bar M.

Fig. 5 shows an end view with the commutator-brushes—four in number—placed at ninety degrees apart or just under the edges of the field-poles N N′. Suitable connections may be, as is well known, taken away and two brushes only at right angles be used to collect the whole of the current developed. In the form shown the diametrically-opposite brushes being of the same polarity may be connected as indicated by the lines, so as to give to the apparatus but two discharge-points, or the opposite brushes might be used separately to feed different circuits. These are matters well understood in the art at present, however, and need not further be enlarged upon.

Fig. 6 is an extension of the forms shown in Figs. 4 and 5, the laminated or generative portion A being mounted at the middle of the bar M M, upon which or near which two energizing-coils C C′ are placed, as shown, so as to energize said bar, while themselves being stationary or revolving with said bar. In this case there are substantially two poles N N′, Fig. 7, surrounding the revolving portion on the exterior, and they are formed by the combination of magnetic lines proceeding from each end of the bar M M into the structure N N′ of iron extending from and forming the poles mentioned. Here the effect is the same as in Figs. 4 and 5, but the machine is more self-contained.

In Fig. 8 we have a development of the same machine, (shown partly in section,) in which the field structure is made up of the middle structure or cylinder M, as before. The generative structure is mounted at the middle thereof and wound in any desired way, and the leading wires are carried through the cylinder M at the commutator end by boring and providing openings. K is the commutator, mounted outside of and beyond the magnetic system. E E′ are iron end plates surrounding the overlapping part M and clearing it by a small space and being in turn surrounded on their faces by the energizing-coils C C′, which provide the magnetism. The outer ends of the plates E E′ are connected up to polar extensions N N′, one above and one below, as shown, leaving open spaces between them, as in Fig. 7 just referred to, which open spaces are dead parts of the generative structure. In such a machine the effect is that of two powerful poles of like polarity oppositely placed and two vacant spaces of no polarity at right angles thereto, and it depends on the winding only to make such a structure a generating structure for currents.

Fig. 9 indicates a plate or ring, which may be used to build up the laminated portion on which the generative coils are placed, the laminated portion being that portion which revolves directly in front of the outer field extensions or poles. Fig. 10 shows how this portion A, which may be considered to be the interior laminated pole, is related to the cylindrical revolving portion M of the magnetic circuit. Fig. 11 shows, also, that instead of a plain ring of laminæ each piece may be notched or made with projections or spaces, the spaces between which projections are filled with the winding in which the currents are to be generated. Fig. 12 gives a side view of the same notched laminated ring structure carried on the part M.

Fig. 13 shows that surrounding the part M we may wind a body of iron wire, circumferentially building it up until it takes the form, as seen sidewise in Fig 14, of a subdivided ring of magnetic material similar to that at A, Fig. 10.

Fig. 15 simply shows the commutator separate with its brushes applied in the arrangement which would be used in cases like Fig. 6 or 7, with two poles of one polarity at opposite portions of the revolving laminated generating structure.

Fig. 16 simply shows the revolving structure with only one external pole, the relation of the commutator-brushes thereto, and the winding, which is in this case diametrical. The winding, however, in such cases as Fig. 6 or 7 requires that the convolutions be so laid as to give an active portion while another or return portion is inactive on the outside surface of the revolving structure. The winding would, therefore, be one in which the wire was laid on, as it were, in hollow rectangles, which fit over the circular laminated body to a limited extent, such that a wire of a convolution lies at positions ninety degrees apart, or nearly that, and parallel to the axis, including as the wire those portions of conductor which cut lines of force and are situated, therefore, on the periphery of the revolving structure, where it passes in front of or under the polar portions N N′. The winding can be made in continuous closed circuit, each set of convolutions or each convolution being displaced a certain angular amount in proceeding around the laminated ring structure, as is well understood in the art. This is indicated in Fig. 17 and will be readily understood by tracing out the lines, such figure being a common conventional sign for a winding of the character mentioned. The connections to the commutator may be led off from each convolution or loop directly or from every certain number of convolutions, the winding shown being identical with that which can be used in a drum-armature where there are north and south poles—four in number—alternating around the circumference. Fig. 18 shows the same winding with fewer convolutions, which would therefore give fewer commutator-segments.

Fig. 19 shows an arrangement in which the energizing-coils C are situated midway on the magnetizable bar M, which revolves with the shaft. At each end of this bar are supported two sets of laminated rings, constituting two supports for revolving coils A A′. Outside and with small spaces or clearances from the laminated revolving portions are supported in any desired way the pole-carriers or outside pole-faces N N′ T T′. The polarity in the revolving portions to the left will be, say, north and to the right south, and by induction the outer pole-faces will acquire opposite polarities, those to the left, for example, being south and those to the right north. It must be understood that as before the outer pieces shown in section N N′ T T′ extend over only a fraction of the periphery and that with windings such as are described in connection with Figs. 15, 17, and 18 there would be a pole-face opposite each portion A A′, with vacant spaces covering about a quarter of the circumference between them, with a winding such as would be used in a six-pole machine of the ordinary type there would be three polar masses outside, and so on.

Fig. 20 shows a modification in which there are two energizing-coils C C′, wound reversely, producing a consequent pole at the middle between them, where there is located a laminated coil-carrying structure, and individual opposite poles at the ends of the core structure, where there are also located laminated coil-carrying portions. This structure is practically the same as Fig. 19, in that in both the magnetism is, as it were, used twice or the magnetic circuit is interrupted at two points, each of which is traversed by coils carried on laminated structures. In the former figures the magnetic circuit is interrupted at two points and at only one of these positions generating-helices are revolving or carried.

Figs. 21 and 22 show the arrangement of poles around the revolving portion A, carrying the generating-coils and commutator K, when the effect of a six-pole machine of the ordinary north and south polarity type is to be obtained. Here they are situated at one hundred and twenty degrees apart from their centers, three iron masses of like polarity N N′ N″ existing as branches from the end plate E, which surrounds or overlaps the revolving core M. In this case the commutator-brushes will be six in number and will be located approximately just under the edges of the field-poles N N′ N″, where the active sides of the coils on A are entering and also where they are leaving. There will be six points of collection then on the commutator or six neutral lines marking the points at which the active sides of the windings pass out of or into the arc of revolution, in which were the coils continuously and properly connected up to the circuit a current of the opposite polarity to that generated by passage under the pole would be produced. In this instance it will be obvious that the winding of the coil or conductor on the armature will be correspondingly modified from that which would be required for two poles of like polarity, and whereas in the case of two poles the winding passes obliquely, so that the portion of wire or conductor which is excited or active under the influence of the magnetism is connected back through a portion of wire or conductor removed ninety degrees, in the case of the six-pole machine the connection would be through a bobbin of wire or conductor running in the opposite direction at a point or position on the periphery of the armature removed sixty degrees from the active or generative portion.

In Fig. 23 is shown a preferred method of preparation of that portion of the revolving core M over which the laminated ring structure A has been slipped or is to be slipped.

In order to avoid any possibility of the circulation of currents in the mass of iron immediately under the laminated ring structure, which currents would be produced by the intense magnetizing force traveling in the iron, a number of circumferential slots or slots substantially at right angles with the axis are made, the deepest of them being toward the center of the ring structure A, from which point they gradually get shallower and shallower until we reach the outer edge of the structure, as shown. This does not hinder the passage of magnetism to an appreciable degree if the slots are narrow; but it effectually gets rid of induced currents moving transversely to the slots, which is the direction in which such currents, if induced, would move. The arrangement shown in Fig. 23 is applicable to such structures as Figs. 6, 7, and 8, in which the magnetism is fed into the core from both sides or in which the pole produced in M at the middle is a consequent pole. In the single-pole structure—such as Figs. 1, 3, and 4—and in Figs. 19, 21, and 22, the slotting would not begin deepest at the middle, as in Fig. 23; but the deepest slots would be made on that end of the piece M not surrounded by the stationary magnetic carrier on the side of the field energizing-coil; or, in other words, the slotting would be deepest near the commutator end and the slots would gradually run out shallower and shallower as that end is left in going toward the opposite portion upon which the laminated ring structure is carried. The same effects could be obtained by cutting a deep screw-thread on the core-piece M, with the thread deepest at those points farthest from the energizing sources of magnetism, which is in the middle in the consequent-pole type and at the outer end in the single magnetic-circuit type.

Fig. 24 shows a structure which avoids the revolution of that portion of the magnetic circuit corresponding to M in the previous figures. Here the laminated structure A is alone revolved, while the part M becomes a stationary extension from the outer pole masses N N′, the shaft of the machine being centrally located in the part M now stationary. In this case the field energizing-coils are wound directly on the part M and supported thereby, while the laminated coil-carrying structure A is borne upon a separate overhanging spider strung upon the shaft. This form, while more difficult to construct, does not differ much in principle from the preceding forms and offers the most efficient construction, as the mass of iron which is revolved is extremely small, and therefore the losses which may be expected in it are relatively also small, while the degree of magnetization may be very great in such a structure. The coils may be wound or applied to the laminated structure in any desired manner, so that currents will be set up in the coils by the revolution of the parts, due attention being paid to the application of the coils in the manner before explained with reference to Figs. 17 and 18, the plane of winding or its obliquity to any radial plane of the armature-core intersecting one side of the coil being dependent upon the number of external poles.

Fig. 25 indicates that the laminated structure may be replaced by a wire winding of the form shown, in which case it is best to cone down the bar M M at the middle, as indicated. This gives an effect similar to what has been described in Fig. 23 with wire used instead of plates.

It is obvious that in place of the laminated or subdivided wire winding, Fig. 25, any other laminated structure either built up upon the reduced part of the bar M M might be employed or that the core M, made in two pieces, as indicated by the transverse line, might be slipped into the laminated structure, however made.

In Fig. 26 another ideal method of construction is shown, which, however, is almost impossible to make in practice. Here the core-piece M is supposed to be laminated and constructed of two pieces facing each other at the center. The laminæ, however, are supposed to be pulled out or spun out, so as to gradually turn from parallelism at the axis into planes transverse to the axis, giving the effect outwardly at A of a set of laminations inserted transversely to the axis. It is evident that this is difficult of construction, though perhaps not impossible.

Fig. 27 shows a modification in which the revolving core-piece M is hollow, mounted suitably on a shaft, and has its ends in each direction terminating in a series of rings of thin iron, forming a compound hoop or band, such as could be made by winding up sheet metal in strips or hoop-iron into a ring with its laminæ parallel to the axis. The faces of these rings, which are marked R R, carry generating-coils and are more clearly shown at A A, &c., Fig. 28. Overhanging these coils and existing at stationary positions in front of them are the outside field structures N N, there being shown two such structures, though more might be used. They simply carry the magnetism developed in the revolving part M outwardly and over the outside, so as to cause it to pass at certain points only and produce a field in which the coils are revolved. The rotating coils in Fig. 27 are indicated, also, by the letter A, as in Fig. 28. It is not essential that the magnetizing-coil be made to surround the bar M, as has been shown in most of the figures preceding, but it may be equally well made to surround the polar extensions, and this is shown in Fig. 29, where C C′ are the energizing-coils, which energize separately the outer poles N N′ of a like polarity, the return circuit of magnetism being through the bar M, as before, and through the magnetic structure on which the generating-coils are carried. In Fig. 30, in the same way, a structure having consequent poles at its middle is energized by four coils placed on the outer iron portions leading to the poles N N′, the four poles being marked C C′ C^2 C^3, and the return circuit of magnetism being completed at each end through the bar N to the laminated interior generating-coil carrier as before. Again, the arrangement may be modified to involve the use of salient poles, around which the coils are wound, as in Fig. 31 at C C′. The pole-pieces are branched and are extensions from an iron portion E, surrounding the bar M, the only difference between this and preceding figures being the situation of the coils C C′ for energizing.

Fig. 32 is an end elevation of the same structure, Fig. 31, the coil C′ being shown in section with its salient pole or core surrounded by the coil and presented to the revolving structure A, the coil C being shown full and the pole which it energizes being presented to the other side of the revolving structure. Fig. 33 is a diagram showing that this arrangement of salient poles may be extended to four or more, all mounted on a common iron coil or carrier, it being understood that in all these cases the polarities of the poles are alike and that the return magnetism goes through the generating portion outwardly at the ends, as seen at E E, Fig. 31.

We are aware that it has heretofore been proposed to revolve an armature under a single magnetic pole; but in such cases there was no provision for carrying the magnetic circuit out from the interior of the armature so as not to affect the coils at the part thereof diametrically opposite the pole, and, in fact, the coils of the armature would be subjected to the same action as in the case of two diametrically-opposite poles—one north and the other south—and there would of necessity be reversals of current and of magnetism in the core as its sections passed the theoretical line of reversal of current in the coils.

While we have described certain forms of magnets and armatures combined and organized to produce a machine embodying the principles hereinbefore described, we do not limit ourselves to these special forms, since the invention consists, essentially, in making the current return for each revolving coil or portion of coil on the carrier through dead points or points of no polarity in the path or field through which the coil-sections are revolved. In our invention the coil-sections may be connected in series, which could not be done in the ordinary types of unipolar machine. In effect we by our invention produce a machine with a continuous current winding and commutator which has the advantages and characteristics of the unipolar machine in that there is but one polarity of field for the armature and there are virtually no reversals of magnetism in the armature structure or part which carries the coils in which current is excited.

While we have described our invention as a dynamo-generator, it is obvious that the same structure might be used as a motor and that either part of the same or both parts might be revolved, as well understood in the art.

What we claim as our invention is—

1. In combination with a series of like poles surrounding a generating structure with dead spaces intervening, an armature winding in which all the active wire at all times leads in one direction in front of the field poles and returns along another portion of the armature in a dead space between the poles before again traversing the space under a pole, and a commutator having brushes applied as described to collect current in such active wire.

2. An armature or generating structure in which at all times all the armature winding which is actively generating current has its wires led in the same direction on the exterior of the armature with the dead or return conductor leading in the opposite direction on the exterior of the armature or coil carrier and not subjected to any magnetic action, in combination with a commutator having brushes applied at positions corresponding to the points where the active conductor passes from a dead space into the magnetic field and from said magnetic field into a dead space.

3. In a dynamo electric machine or motor, a single pole or series of poles all of the same polarity with intervening dead spaces, in combination with an armature having a set of connected coils or windings and therefore so located thereon that when one portion thereof is under a pole the return portion will be in a dead space so that all of the wire that is at any time active is of the same polarity.

4. In a dynamo electric machine or motor, the combination substantially as described, with a set of field poles of the same name having intervening dead or non-magnetic spaces, of an armature having a connected set of coils or windings in which all of the wires that are at any time active lead in one direction past the field poles and have their return portions located in dead spaces.

5. In a dynamo electric machine or motor, a revolving structure carrying coils suitably connected and wound, outside of which is located a set of poles of like polarity alternating with free spaces of considerable extent around the coil structure, in combination with means such as a coil of wire traversed by an electric current for energizing the iron masses magnetically in one direction, means for collecting the currents of the same polarity only generated in the active portion of the armature wire subjected to the operation of said poles, and a current return for such active portion formed at all times through a portion of armature winding which is in a free space.

6. A dynamo electric machine containing the following elements combined; a closed circuit continuous winding, a revolving mass of iron upon which the generating coils are wound or carried, an energizing helix traversed by an electric current for energizing or magnetizing such mass of iron either directly or indirectly, a set of poles with like polarity with spaces or gaps between of no polarity, such spaces or gaps being proportioned to cover those portions of the armature winding through which the active portions find return circuit, and a commutator brush or brushes applied as described to take the current from active portions of the armature conductor in which currents of the same name only are generated the opposite portions or sides of each coil or conductor being in dead spaces.

7. In a dynamo electric machine, the combination of a revolving generating structure carrying a conductor wound suitably, a surrounding set of poles of like polarity alternating with spaces of no polarity, and a commutator the brushes of which are placed at or near the points corresponding to the positions where the active wire of the winding leaves and enters the open spaces between the poles proper.

8. In a dynamo electric machine, a revolving core piece surrounded by energizing coils near each end, a middle laminated or subdivided iron coil carrier, an outer iron structure completing the magnetic circuit over the outer ends of the middle core structure and providing a series of poles external to the laminated coil carrying portion, which poles are of like polarity and are alternated with dead spaces, armature windings the whole active portions of which have at all times a return through a portion of winding moving in a dead space, and a commutator having brushes applied as described to form connections with opposite terminals of the series of active coils.

9. In a dynamo electric machine, a set of end plates inclosing a revolving core piece M, upon which is mounted a divided or laminated coil carrier for the generating conductor, field energizing coils supported on the end plates or extensions thereof, and magnetic masses constituting separate outer poles of the machine presented to the generating revolving portion and having intervening dead spaces, the said poles being of the same polarity around the revolving portion in which the currents are generated.

10. In a dynamo electric machine, a coil carrier consisting of a laminated ring structure for the generation of currents by revolving in front of like poles, such ring structure being mounted around a magnetic core, and a series of slots in the core directly under the laminated structure, as described.

11. In a dynamo electric machine or motor, the combination with the one or more field magnet poles of the same name and alternating dead or inactive spaces, of armature conductors whose current return to and from an active part is at all times through a conductor disposed on a carrier or support in the same way as such active conductor but located, during the whole time of activity of the latter, in a magnetically inactive or dead space, and two commutator brushes for the active portions of armature conductors in the field of each pole.

12. The combination with an armature in a dynamo machine or motor, of a mass of iron M, extending laterally outward from the center of the armature and slotted circumferentially beneath the poles, and means for magnetizing said iron mass, as and for the purpose described.

13. The combination in a dynamo machine or motor, of an armature having a continuous current winding and commutator, a series of poles of like name presented to such

armature and having intermediate dead or non-polar spaces, and a pair of commutator brushes or collectors applied as described to connect with the terminals of the portion of winding which is passing at any time under a field pole, the opposite portions of winding passing at the same time through dead spaces.

14. The combination with a series of poles of like name presented to a coil carrying structure, of a closed circuit system of coils mounted on the exterior of such structure and having their sides removed on the periphery thereof to an angular distance one half the mean distance apart of the poles, a commutator to which said system of coils is connected at intervals in the ordinary way, and two commutator or collector brushes for each portion of the armature subjected to the action of each pole, as and for the purpose described.

15. In a dynamo electric machine the combination of a revolving iron structure having a coil surrounding it at or about its middle and prolonged into polar extensions at either side of the plane of the coil, and a stationary magnetic annulus having polar extensions located at either side of the plane of said magnetizing coil, the polar extensions of said annulus being presented to the polar portion of the revolving iron structure.

16. In a dynamo electric machine, the combination of a revolving iron structure forming an electro-magnet, an outer stationary iron structure provided with polar extensions over the ends of the revolving structure and completing with the latter the magnetic circuit, an energizing coil encircling the revolving iron structure at or about its middle, and suitable generating windings or coils in the field of the polar extensions, as and for the purpose described.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 20th day of November, A. D. 1889.

ELIHU THOMSON.
MERLE J. WIGHTMAN.

Witnesses:
JOHN W. GIBBONEY,
DUGALD MCKILLOP.