E. A. EDWARDS.

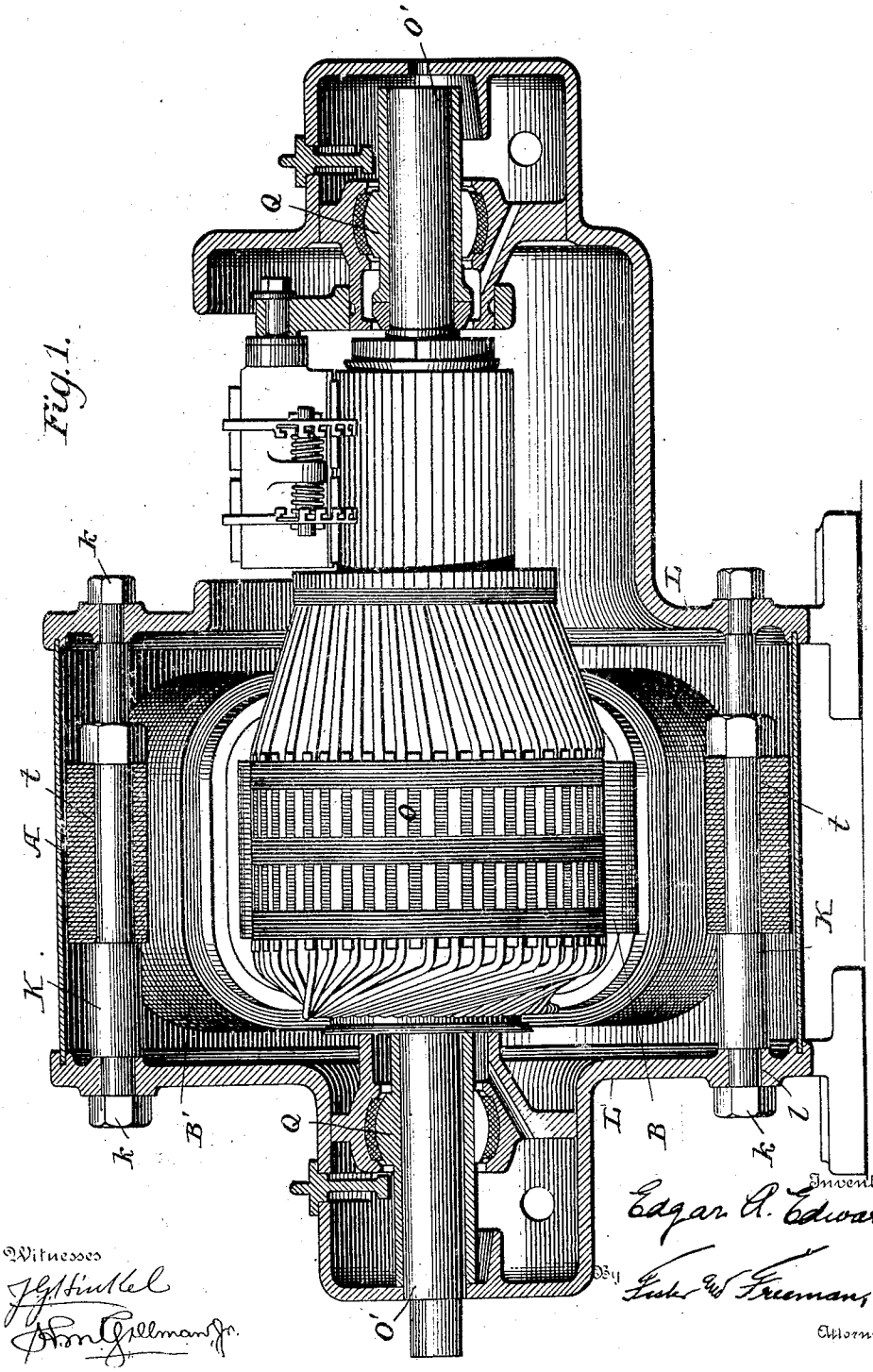
DYNAMO ELECTRIC MACHINE.

APPLICATION FILED NOV. 30, 1901.

996,571. **Patented June 27, 1911.**

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 3.

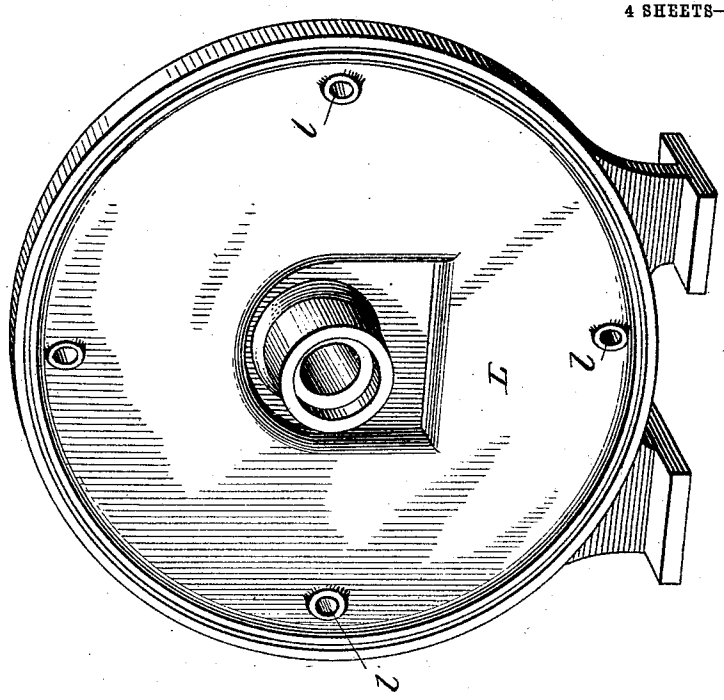
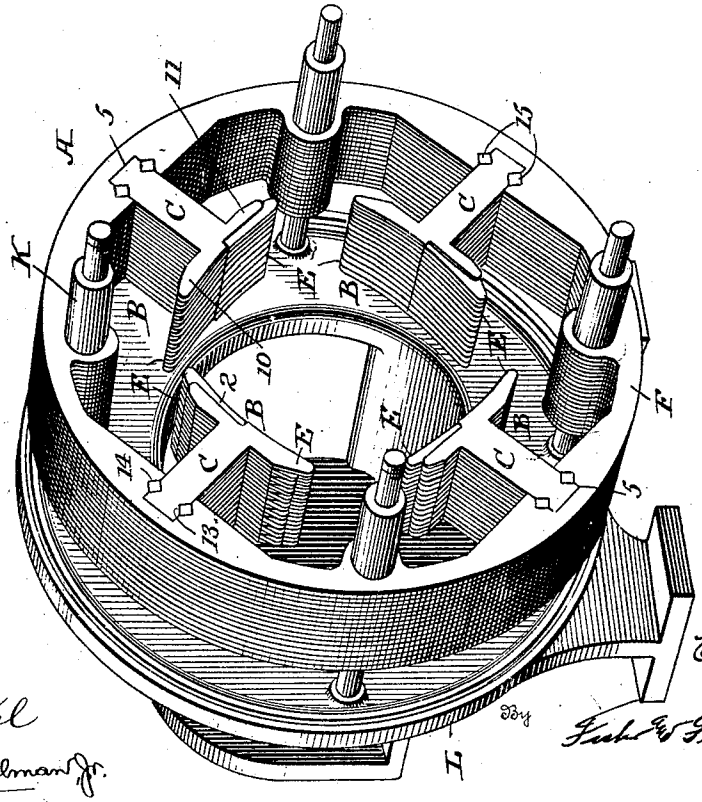


Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 4.

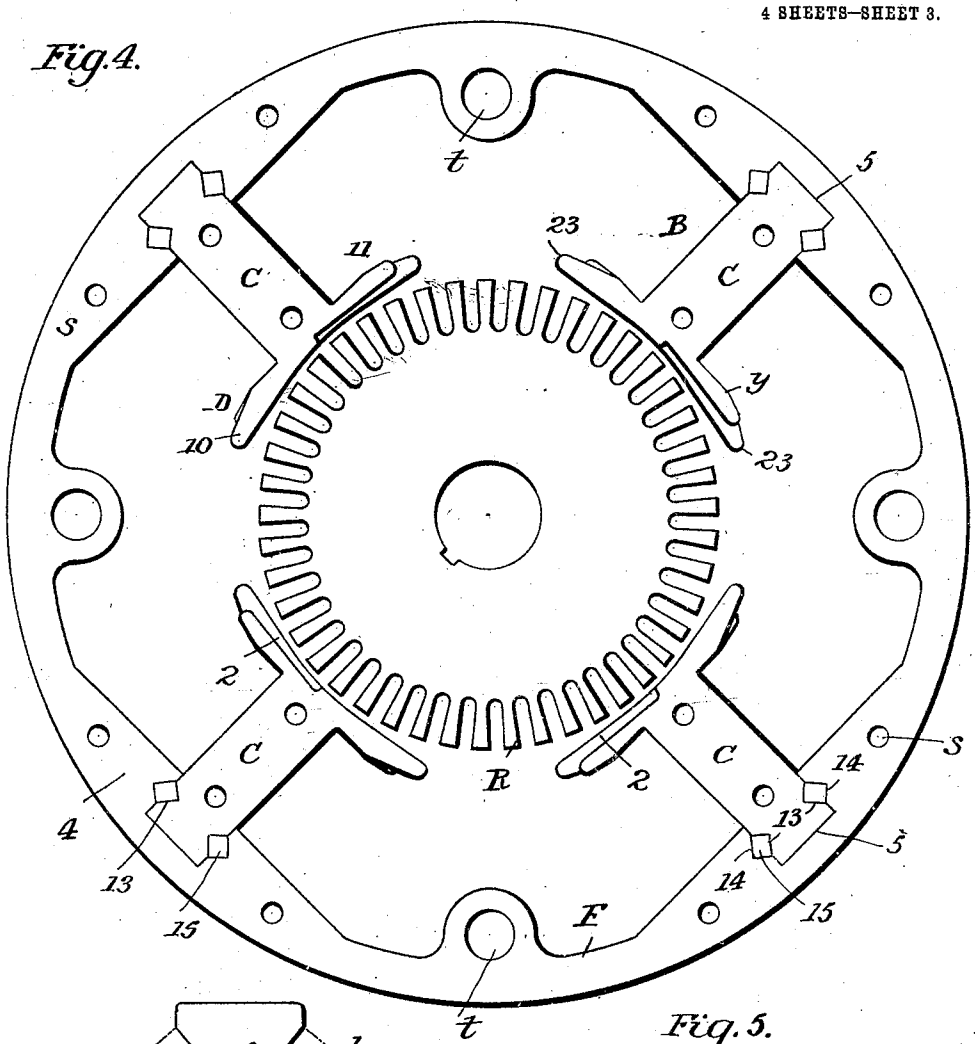


Fig. 6.

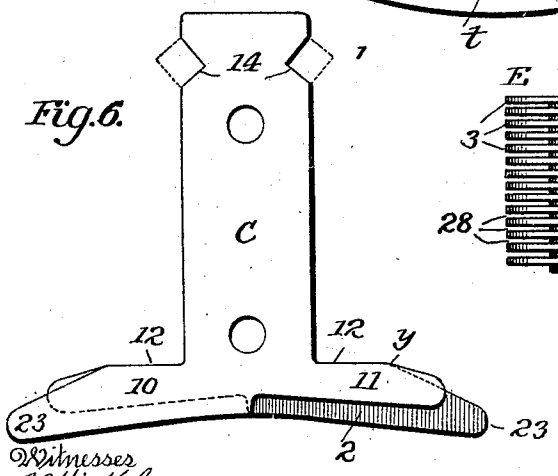
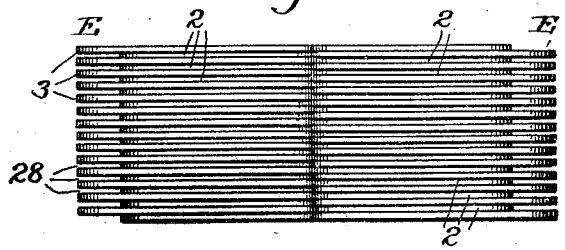


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 7.

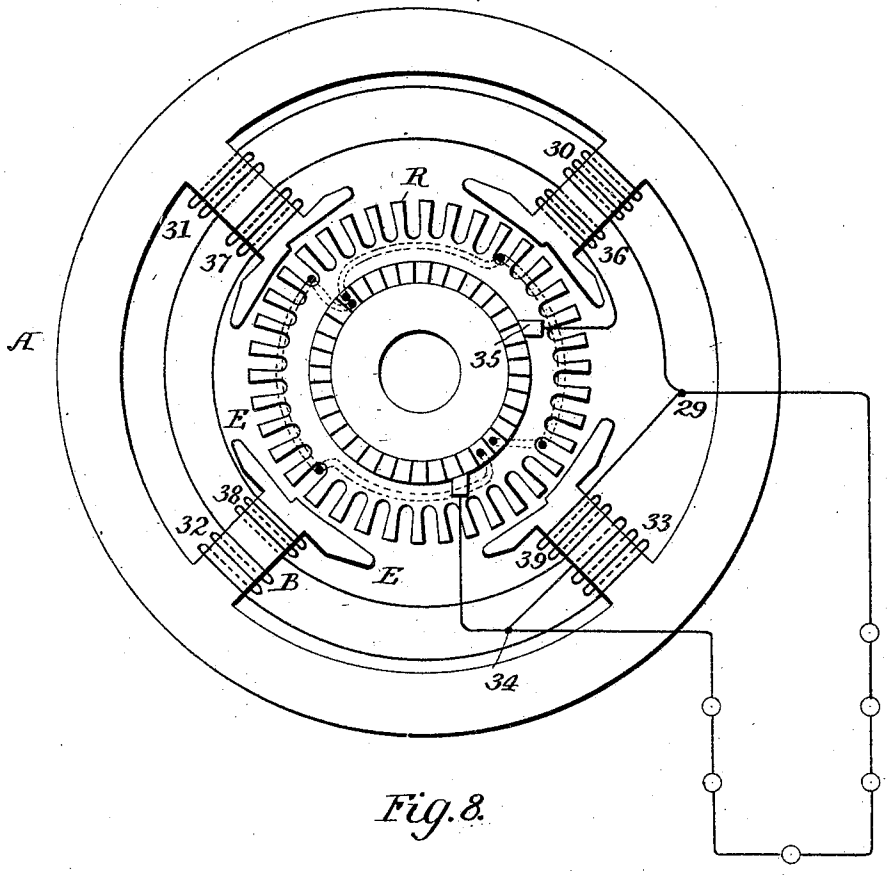
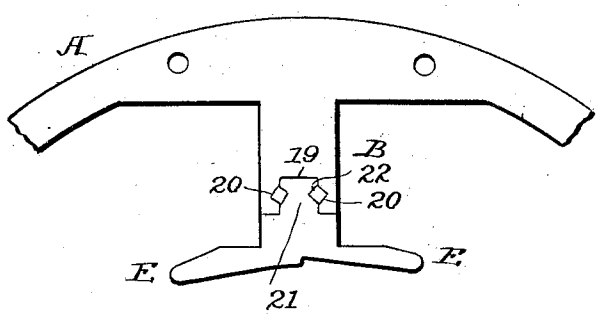


Fig. 8.



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UNITED STATES PATENT OFFICE.

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DYNAMO-ELECTRIC MACHINE.

996,571. Specification of Letters Patent. Patented June 27, 1911.

Application filed November 30, 1901. Serial No. 84,276.

To all whom it may concern:

Be it known that I, EDGAR A. EDWARDS, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a specification.

My invention relates to dynamo electric machines, and consists of means for preventing sparking at the brushes, and in constructing the apparatus to facilitate manufacture, as fully set forth hereinafter and as illustrated in the accompanying drawings, in which:

Figure 1 is a vertical longitudinal section of a dynamo electric machine embodying my invention; Fig. 2 is a perspective view of the yoke and field poles, with the armature and field coils removed; Fig. 3 is a perspective view of one end frame of the machine; Fig. 4 is a representation of the armature core, yoke and pole-pieces, showing the relative arrangement and construction of the parts; Fig. 5 is a face view of one of the pole-pieces; Fig. 6 is a detail view showing two of the superposed lamination pieces of which the poles are constructed; Fig. 7 is a diagrammatic view showing the circuits in a differentially wound dynamo provided with my pole-pieces; and Fig. 8 is a detail view showing a modification wherein the shoes of the field poles may be detachably connected to the cores.

Referring to the drawings: the yoke A, is of any suitable construction, being shown as circular, and within the said yoke are the field windings B′, and a plurality of salient pole-pieces B, each of which has a stem C, from the inner end of which extend two wings, forming pole shoes D, the inner faces of these wings opposite the periphery of the armature O, being nearest the armature at the center and gradually diverging or flaring away therefrom toward the tips of the wings, as shown diagrammatically in Figs. 4 and 7. These wings are provided with gaps of a character commonly known as "air-gaps", although this term is applied to a gap in the magnetic circuit not necessarily due to the presence of air, and these gaps instead of being parallel to the longitudinal axis of the apparatus, are arranged in a direction transverse thereto. The gaps are shown in the form of grooves 2, Figs. 2 and 5, each extending from the center of the pole shoes D, toward the pole tips, for a limited depth, and adjacent to the tips the grooves are increased in depth so as to extend completely through the tips, with the result that each tip consists of a series of parallel, separated projections or blades 3, as shown in Fig. 5. The gaps or grooves 2, of one wing are opposite the blades 3, of the adjacent wing of the same shoe D, so that the gap extending across the face of one wing terminates at the center of the pole shoe. In other words, the gaps in the two wings of a pole shoe are staggered instead of extending directly across both wings in a straight line. This particular arrangement of gaps, however, only results from the use of a series of blanks or laminations in building up the pole-pieces.

The wings of each shoe are not of uniform width between their junction with the stem and the tips, but gradually increase in thickness between the outer and the inner faces from the junction with the stem to a point *y*, Figs. 4 and 6, about midway of the length of the wings, and then decrease more abruptly toward the tips, so that the thickness of each wing is greater about midway of its length than at any other point, and diminishes much more sharply from the point *y*, to the tip than from the point *y*, to the point of junction with the stem.

In the construction shown the pole-pieces are laminated and each of the laminations is of a particular form, to be described, so that the ultimate magnetic masses of the pole-pieces formed by the laminations are of such shape and so arranged relatively to the armature when the pole-pieces, yoke and armature are assembled, that the cross-magnetizing effects which tend to cut down the flux at those pole tips, near which commutation takes place, are counteracted and a suitable flux is maintained at those pole tips for sparkless commutation.

Each lamination piece Fig. 6, is provided with a stem portion and outwardly extending arms or portions 10 and 11, of unequal length and unsymmetrical shape, the portion 11 being shown shorter and narrower than the portion 10. The outer edges of the portions 10 and 11 adjacent to the stem are shown substantially in alinement and form

shoulders 12, for the abutting of the field coils, while the portions 10 and 11 are narrowed toward the ends. The inner edges of the portions 10 and 11, are not in a continuous line, the edge of the portion 11, being on a plane farther from the axis of the armature than that of the portion 10. The inner edge of each portion 10, is preferably shaped as shown in Fig. 6, so that the ends 23, of the portions 10, flare away from the armature when the laminations are assembled to form a pole-piece.

In assembling the laminations they are placed side by side but in such manner that the longer and wider extending portion of one lamination is next to the shorter and narrower extending portion of another lamination, and so on alternately, as shown more particularly in Figs. 5 and 6. It will thus be seen that the face of the shoe of a pole-piece is formed with transverse gaps or grooves 2, of the character desired, extending into the pole-piece as far as the inner edge of the shorter and narrower extending portion 11, of each lamination, and with the slitted tips resulting from the projection of the portions 10, beyond the ends of the portions 11. It is this construction by assembling a series of laminations that results in the transverse gaps 2, in the faces of the pole-pieces staggered with relation to each other, and starting from substantially the longitudinal center of the face and extending outwardly to the pole tips, Fig. 5. These gaps pass completely through the pole tips and reach to the ends of the shorter extending portions of the laminations. I am thus enabled to build up a pole-piece from a series of laminations and to form the gaps in proper position in the face of the head of the pole-piece and to form the projecting blades 3, at the tips by simply assembling together in reverse position a series of laminations each of the shape shown in Fig. 6. It will be understood, however, that my invention is not limited to an apparatus in which the pole-piece is thus made, as the said pole-piece may be formed from a single piece having the external shape shown, and mitered, sawed or chiseled out to produce the desired gaps and projections.

If desired, the yoke A, may be cast solid and the pole-pieces B, formed integral therewith, but preferably the yoke has a series of longitudinal grooves or sockets 5, Figs. 2 and 4, in its inner periphery to receive the ends of the stems C, of the pole-pieces, and as the securing of the pole-pieces to the yoke in the usual manner by bolts extending radially through the stems prevents the removal of the field coils without removing the armature and is unsuitable particularly in laminated constructions, I connect each pole-piece with the yoke by forming in the opposite sides of the end of the stem channels or grooves 13, which when the stem is in place in the socket 5, coincide with grooves 14, in the faces of the socket and form channels, and I then drive keys 15, through these channels, thereby securely bolting the pole-pieces to the yoke while permitting their ready detachment by withdrawing the keys. In the construction shown the channels in the stems and the pole-pieces are angular, with sides of unequal width, so that when a square key is driven into the said channels there will be sufficient space at one side to permit of a movement that will draw the stem downward into its socket and secure perfect fit.

I am not to be understood as limiting myself to the particular form of key and key-way shown, as any equivalent construction whereby the pole-pieces may be removably attached to the yoke will fall within the scope of my invention.

In the construction shown the armature core is laminated, a lamination plate R, being shown in Fig. 4, and the yoke is preferably laminated, the lamination pieces F, of the yoke being preferably stamped out of sheet metal of the form shown in Fig. 4, each piece being provided with thickened portions 4, having recesses therein, so that when the lamination pieces are assembled to form the yoke the corresponding recesses in all the pieces form a continuous groove or socket in the inner periphery of the yoke. Each recess in the lamination pieces has side notches, which when the laminations are assembled constitute the key grooves.

In constructing the machine the field windings are first placed upon the pole-pieces and then the poles are attached as described, by means of the keys, to the yoke.

It will be seen that with my construction, since the pole-pieces are moved longitudinally to remove them from the yoke, any one pole-piece and its field coil may be removed without removing the armature, and this provides a convenient and handy construction, suitable for making repairs or for assembling the parts.

In a modified form of construction a portion of the stem of a lamination piece may be stamped integral with the yoke, as in Fig. 8, this portion being provided with a recess 19, having notches 20, while a shoe piece, provided with extensions which ultimately form the shoe of the pole-piece is also provided with a tongue 21, having notches 22, corresponding to the notches 20. Then when the shoe pieces are assembled to form the shoe of the pole-piece, this shoe may be slipped longitudinally into the groove formed by the recesses 19, in the assembled lamination pieces of the yoke. In this construction the field coils are first placed upon the stem of the pole-piece connected with the yoke, and then the shoe is

connected to the pole-piece by the keys. In this construction the field coils cannot be removed without removing the armature.

To connect the lamination, pieces of the yoke holes *s* are provided through which binding pieces, as rivets, may be passed, and holes are also provided in the laminations of the pole-pieces for receiving bolts to secure them together. The yoke and pole-pieces are suitably supported by a frame. In this instance bolts K, are shown adapted to support the yoke between end frames L, these bars preferably passing through holes *t* in the laminations of the yoke and adapted to be secured to the end frames L, by any suitable means, as holes *l* and nuts *k*.

The armature O, is provided with bearings Q, for the armature shaft O′, in the end frames L, and it will be seen that when the frames L, yoke, pole-pieces and armature are assembled a light, strong and compact dynamo electric machine is formed.

By arranging the parts so that the pole tips E, flare away from the periphery of the armature, there is provided a larger air-gap opposite the pole tips than is provided at the center of the pole faces. Owing to this increased air-gap opposite the pole tips the effect of cross-magnetization in demagnetizing the pole tips is greatly reduced, which tends to maintain a suitable magnetization in those pole tips near which commutation takes place, thereby causing sparkless commutation.

I have found that by the gaps 2, in the face of the pole-pieces, as described, the distorting and weakening of the field by the interference of armature reactions is greatly reduced, since the lines of force due to the cross-magnetizations from the armature must pass these transverse gaps 2. I have also found that when the pole-pieces terminate in a series of parallel blades 3, forming intermediate gaps 28, the demagnetizing effect of the armature reactions is counteracted by these gaps, and it will be seen that they also tend to limit the extent of the magnetic fringe under the pole tips and provide a suitable field for sparkless commutation.

Upon an inspection of the form of one of the pole-pieces it will be seen that radial sections as taken successively at one side or wing of the shoe of a pole-piece increase from the center outward to a maximum, at *y*, Figs. 4 and 6, and then decrease from the maximum to the pole tip E, but this decrease is in a greater ratio than the ratio of increase to the maximum. I have adopted this construction in order to aid in distributing and localizing the magnetic flux in the pole-pieces and to counteract the distorting effect of interference from armature reactions, and this aids in preventing sparking at the brushes.

It has heretofore been attempted to produce a constant current from a dynamo having a shunt field winding and a series coil wound to oppose the shunt coil, or in other words, from a differentially wound dynamo, but the great distorting effect of the differential coil on the field magnetization produces destructive sparking at the brushes. A differentially wound dynamo is preferable to a series wound dynamo for arc lighting, and efforts have been made to obtain regulation for constant current with such a differential machine without sparking at the brushes, but with indifferent results.

While the pole-pieces hereinbefore described may be applied to any dynamo electric machine, I have particularly designed their magnetic mass to meet the conditions found to exist and prevent sparking at the brushes in a differentially wound dynamo of the type employing series field coils wound to oppose the shunt field windings. By my improved construction I counteract the great distorting effect of the differential series coils at varying loads on the field magnetization, and at the same time greatly reduce the demagnetizing action of the armature reactions on the field, so that by adopting my field poles I am enabled to successfully make use of a differential dynamo run at constant speed to produce constant current, as for series arc lighting, without destructive sparking at the brushes. Thus Fig. 7 is a diagrammatic representation of the yoke, pole-pieces, and field windings showing my invention as applied in a differentially wound dynamo with pole-pieces formed and arranged in proper relation to the armature. As shown the main current passes from the positive brush 35, through the series coils 36, 37, 38, 39, to the working circuit, which may contain arc lamps in series, and from thence back to the negative brush. The shunt field is preferably of the species known as a "long" shunt, that is, it is not taken from points directly across the brushes but is derived from points on the main circuit outside of the brushes. This circuit is shown as starting from the point 29, and passing through the shunt windings 30, 31, 32, 33, and connecting again to the main circuit at 34.

In the differentially wound dynamo shown the initial magnetization of the field poles for starting up is adapted to be derived from the shunt field and not from the series field. By this arrangement the dynamo will pick up even though the circuit of the series field may be broken, and this arrangement is particularly adapted for supplying constant current to those forms of arc lamps wherein the carbons are not initially in con thereby leaving the work circuit open when the dynamo is started.

Without limiting myself to the precise

construction and arrangement of parts shown, I claim as my invention:

1. A field-magnet for dynamo-electric machines, composed of a plurality of laminæ having polar projections adapted to receive the field coils ready wound, a central section of the several polar projections being removable and made with flaring pole-tips, and means to secure said removable parts to their respective polar projections.

2. A field-magnet for dynamo-electric machines, composed of a plurality of laminæ having polar projections adapted to receive the field coils ready wound, each projection having a longitudinal pocket, and T-shaped head plates removably secured to said polar projections, the stems or tongues of which plates fit into said pockets forming parts of the poles, and the arms of which plates form flaring pole tips.

3. A field-magnet for dynamo-electric machines comprising a polar projection adapted to receive a field coil ready wound, said projection having a central longitudinal recess or pocket, and a removable T-shaped pole-piece, the stem of which fits within said recess or pocket and is removably secured therein, and the arms of which form flaring pole tips.

4. In a dynamo-electric machine, a plurality of pole pieces built up of laminations, each of said laminations having a stem portion and portions outwardly extending therefrom of unequal lengths and unsymmetrical shapes, said laminations being reversely placed thereby forming spaces in the face of said poles, each wing of said pole pieces diverging from the periphery of the armature from the center of the pole piece toward the tip of the wing, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDGAR A. EDWARDS.

Witnesses:

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