July 15, 1952 M. P. WINTHER 2,603,677

MAGNETIC POLE

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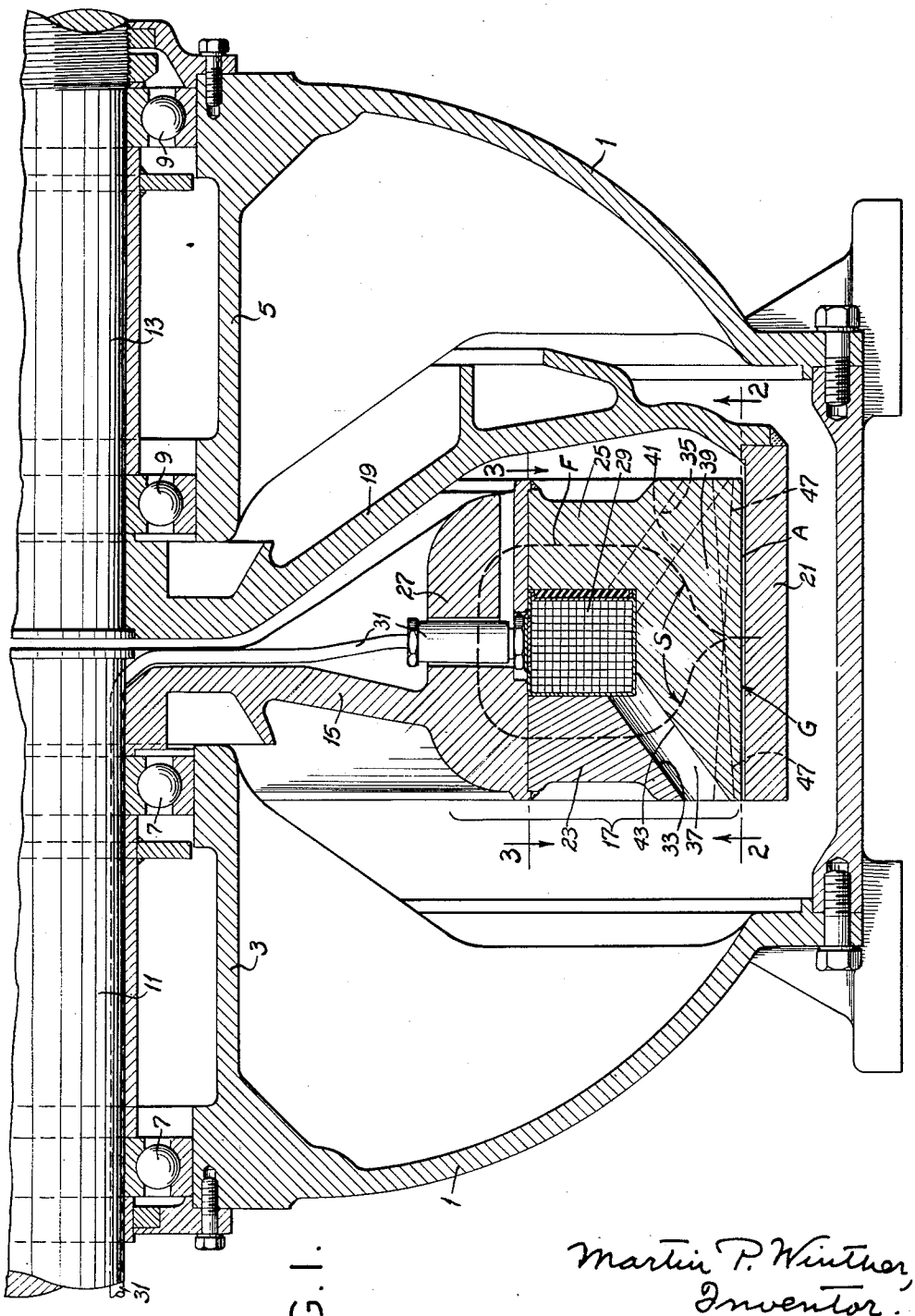


FIG. 1.

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FIG. 2.

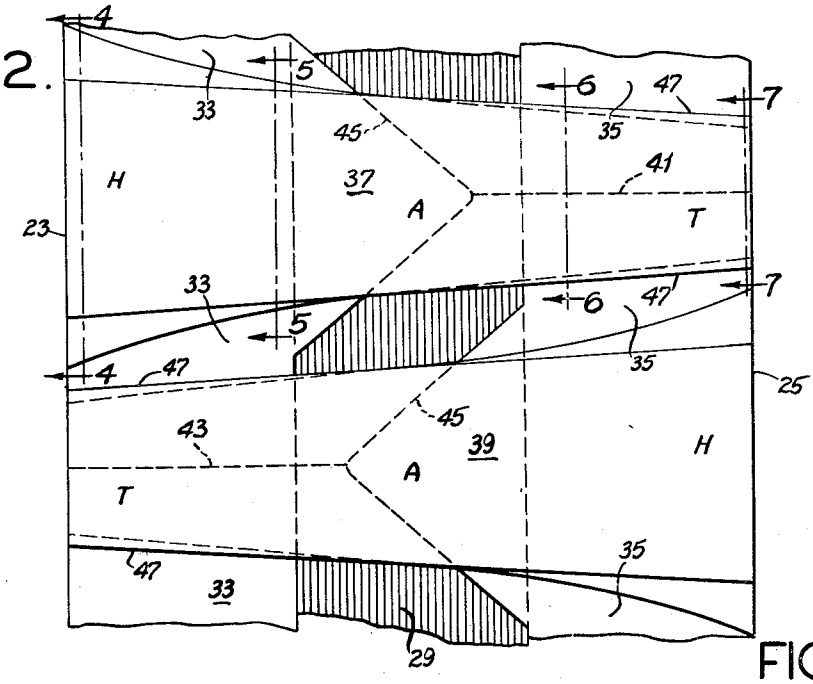


FIG. 3.

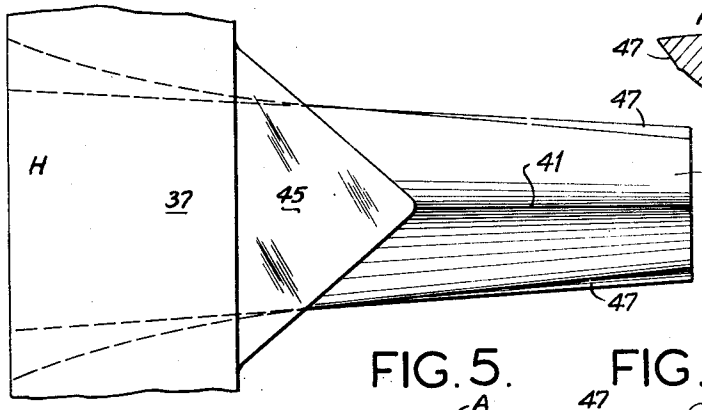


FIG. 7.

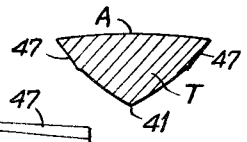


FIG. 4.

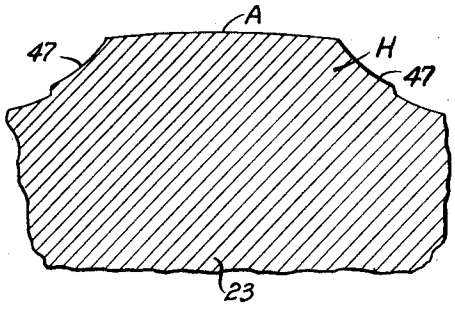


FIG. 5.

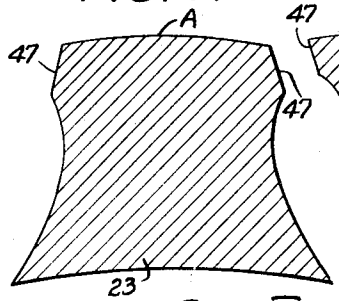
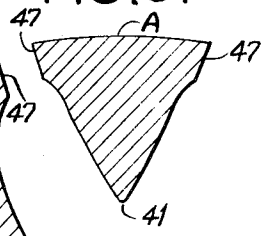


FIG. 6.



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FIG. 8.

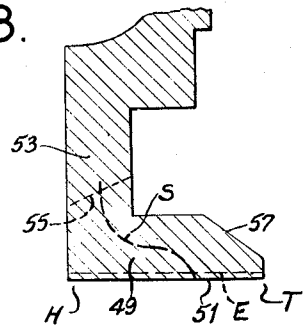


FIG. 9.

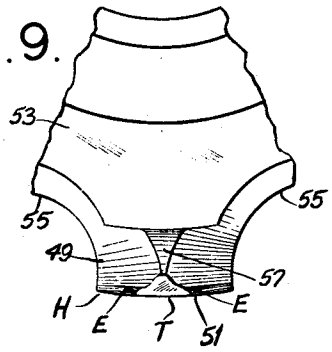


FIG. 10.

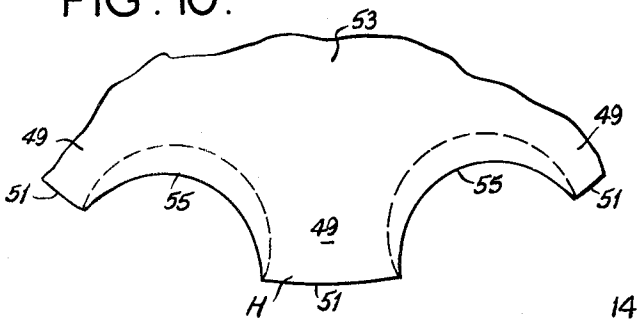


FIG. 11.

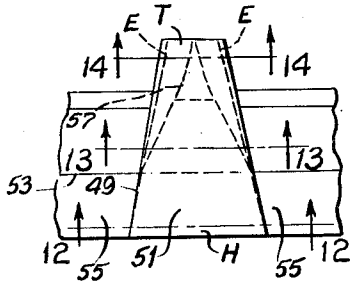


FIG. 12.

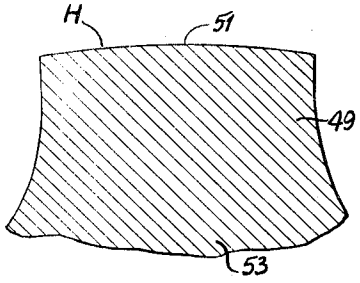


FIG. 13.

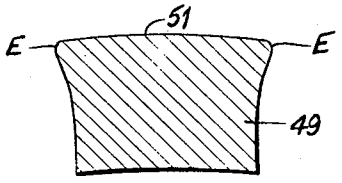
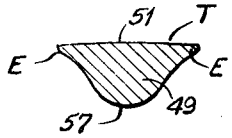


FIG. 14.



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Patented July 15, 1952 2,603,677

UNITED STATES PATENT OFFICE

2,603,677

MAGNETIC POLE

Martin P. Winther, Gates Mills, Ohio, assignor to Martin P. Winther, Waukegan, Ill., as trustee

Application October 30, 1950, Serial No. 192,942

3 Claims. (Cl. 172—284)

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This invention relates generally to magnetic poles for dynamoelectric machines, and more particularly, but without restriction, to such poles for pole rings of toroidal magnet fields of dynamoelectric machines operating by means of eddy currents in inductor drums.

The invention is an improvement upon constructions such as shown in the U. S. patent of Anthony Winther and myself, No. 2,470,596, dated May 17, 1949.

Among the several objects of the invention is the preservation of the efficient magnetic circuit disclosed in said patent but at the same time to reduce flux density at the magnetic gap of the machine, thereby reducing the magnetomotive force required to force the magnetic field across the gap and also reducing the eccentric pull-over between the magnetic field and rotor members of apparatus of the class described. Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a half longitudinal section of eddy-current apparatus embodying the invention;

Fig. 2 is a development of several pole faces on an enlarged scale, being taken on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary detail taken on line 3—3 of Fig. 1, showing a bottom plan view of one of the poles illustrated in Fig. 2;

Figs. 4, 5, 6 and 7 are cross sections taken on lines 4—4, 5—5, 6—6 and 7—7 of Fig. 2;

Fig. 8 is a cross section of an alternative form of pole;

Fig. 9 is an end elevation of the pole shown in Fig. 8, viewed from its toe-end;

Fig. 10 is a rear elevation of the pole shown in Fig. 8, viewed from its heel-end;

Fig. 11 is a plan view of the face of the pole of Fig. 8; and,

Figs. 12, 13 and 14 are enlarged cross sections taken on lines 12—12, 13—13 and 14—14 of Fig. 11.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now more particularly to Fig. 1, there

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is shown a longitudinal section of one form of dynamoelectric apparatus to which the invention applies. At numeral 1 is shown the supporting frame, in which are two coaxial sleeves 3 and 5 in which are bearings 7 and 9, respectively. The bearings 7 support a rotary drive shaft 11 and bearings 9 support a rotary driven shaft 13. It will be understood that as is the case in all apparatus of this class, the driving and driven relationship of shafts 11 and 13 may be reversed, this constituting a mere inversion. It will also be understood that the driven shaft may be stationary as in the case of a dynamometer or brake.

Keyed to shaft 11 is a spider 15 for supporting an annular field member shown generally at 17. Keyed to the shaft 13 is a spider 19 for supporting a magnetizable eddy-current inductor drum 21 composed of ferrous material.

The annular field member 17 is composed of two magnetizable field rings 23 and 25, composed of ferrous material. These are welded to a magnetizable rim 27 of the spider, also composed of ferrous material. Between the rings 23 and 25 is an annular field coil 29 which is variably excited by means of a suitable circuit led in through a conduit means 31 from collector rings associated with the shaft 11. The collector rings are not shown and require no further description, being common in apparatus of this class.

The rings 23 and 25 are provided with notches, those for ring 23 being shown at numerals 33, and those for ring 25 being shown at 35. The notches become wider and deeper along their lengths in the direction of coil 29. Each ring 23 and 25 between its notches has axially extending polar teeth of the so-called claw type, those for ring 23 being indicated at numerals 37 and those for ring 25 being indicated at numerals 39. These teeth extend in opposite directions to envelope the field coil 29 and interdigitate as indicated in Fig. 2. The bottoms of the notches 33 and 35 slope at an angle, for example, 35° to the axis of the machine. Likewise, an equal slope is given to the bottom edges 41 of teeth 37 and bottom edges 43 of teeth 39. Thus constant spacing is left between these edges 41 and 43 and the bottoms of the notches 35 and 33, respectively.

When the coil 29 is excited, a toroidal flux field is established, as indicated by the dash lines F. If the teeth 39 are considered to be of north polarity, then this toroidal field may be traced as follows (see diagrammatic mean line F): from ring 25 through teeth 39, into the drum 21, back to teeth 37, ring 23, rim 27 and back to ring 25. As shown at G, there is an air gap between

the bounding cylinder of field member 17 and the inside cylindric surface of inductor 21 which is established by machining at a relatively small value, for example, .020 inch. Upon relative movements between the field member 17 and drum 21, the north and south polarizations of the teeth 39 and 37 sweep relatively through the drum, causing eddy currents with a reactive field which effects a magnetic coupling, thus establishing the driving and driven relationship between shafts 11 and 13 or vice versa.

The invention lies in the improved form of the teeth 37 and 39 extending from the rings 23 and 25. Fundamentally each tooth is anvil shaped and made according to the principles set forth in said Patent 2,470,596. That is, each tooth is so formed that the flux density through any tooth cross section, which cross section is substantially normal to the S-shaped parts of the mean flux path F, shall carry substantially a constant flux density. The indicated S-shaped flux paths are shown at S. It will be understood that with any two adjacent poles such as constituted by teeth 37 and 39 there is interpolar flux leakage and the stated cross sections are such that after said leakage has been taken into account, the flux density in each stated cross section is the same as the flux density for any other cross section. This makes most efficient use of the metal constituting the toothed poles and reduces weight. This feature of itself is not new herein, but is referred to in order to show the point of departure of the present invention.

As in said Patent 2,470,596, one way of obtaining sections as specified in the paragraph above is to form the teeth as shown in Figs. 2, 3 and 4. These teeth have substantially right-triangular bottom portions 45 lying adjacent the coil 29. From the apexes of these triangles are the sloping edges 41 or 43, as the case may be. This results in the extending toe-ends T of the teeth flaring toward the inductor 21. At the heel portions H, by reason of the shape of the notches 33 and 35, the teeth flare away from the inductor 21 in the regions of the ring 23 or 25, as the case may be. Further details may be obtained from said Patent 2,470,596, it being unnecessary to repeat them here.

The point of departure of the present invention is that instead of the face areas A of the teeth also carrying the same flux density as the flux density throughout tooth sections normal to the S-shaped mean flux path, the face area of each tooth right at the gap G is enlarged, so that the flux density in this face area exclusively is reduced below what it is in every other of said sections. One manner of enlarging this face area of a tooth is illustrated in the form of the invention shown in Figs. 1–7, wherein flanges 47 are superimposed along the leading and trailing edges of the teeth. Each flange, as shown in Figs. 4–7, follows the tooth contour from the region in which it flares away from the inductor 21 to where the tooth flares toward the inductor 21. For example, in Figs. 3 and 7 the bottom of tooth 37 is shown extending from the pole ring 23. The toe T of this tooth flares toward the inductor (Fig. 7) and the heel H flares away from it (Fig. 4). The flanges 47 extend along the edges in the heel and toe and substantially exclusively enlarge the pole face.

Figs. 8–14 show an alternative form of the invention, only one pole tooth being shown with adjacent notches of the coil being removed. In this case the pole is numbered 49. Its face adjacent the gap is shown at 51, the toe at T and the heel at H. A fragment of the pole ring is shown at 53, with the notches at 55. The notches again have sloping bottoms and they are conically shaped so that the polar tooth flares away from the inductor in the region of the heel portion H. The tooth flares toward the inductor in the region of the toe portion T (Fig. 14). Underneath the toe T, the tooth slopes as shown at 57 for substantial parallelism with the slope of the opposite notch 55.

The pole tooth as shown in Figs. 8–14 is used analogously to the showing in Fig. 1, and an analogous toroidal flux field will be set up having an S-shaped mean path through each tooth as shown at S. The various sections of the pole perpendicular to the S-shape of this field will, after leakage flux between poles is accounted for, have a substantially constant flux density. Enlargement of the face area 51 is arranged in order to have a flux density through the face 51 less than the flux densities throughout the other sections specified. The enlargement is shown at E.

From the above, it will be clear that broadly the new pole is of anvil shape, the heel of the anvil being associated with the adjacent pole ring and its toe extending toward the opposite pole ring. The bottom of the toe and adjacent flaring notch are essentially parallel. The primary qualifications for the shape of the anvil are that the toe portion shall be narrower than the heel portion, thereby providing a tapering pole face. The parts of the pole under the toe flare toward the pole face. The parts under the heel flare away from the pole face toward the pole ring. The flanged or overhung edges which lead and trail in movement relative to the inductor enlarge the face area of the pole beyond the area of each other section of the tooth which is normal to the S-shaped mean flux path through the pole. As a result all of said other sections carry a constant flux density while the face exclusively carries a lower flux density

One of the advantages is that a very efficient flux field is provided, minimizing the magnetizable material required. This is because all sections normal to the S-shaped mean flux path carry a constant flux density after leakage flux has been taken into account; except that the flux density through the pole face and across the flux gap into the inductor is reduced. The reduction in flux density is substantially exclusive to this pole face. The result is that a reduced amount of magnetomotive force is required to force the field across the gap G and the eccentric pull-over force normally associated with field members of this type having very small air gaps is reduced. Thus the gap can be held to smaller dimensions without introducing troubles under slight mechanical eccentricities.

It should be observed that in the form of the invention shown in Figs. 1–7, the overhang at 47 is constituted by flat ribs which, as shown in Figs. 4–7, also flare away from the broader portion of the pole face in the heel region and flare toward the narrower portion of the face in the toe region. That is, they have a surface twist. In the form of the invention shown in Figs. 8–14, the overhang at 47 is not constituted by such a particular form of rib but by what in effect amounts to a simple enlargement starting just under the pole face 51.

The invention is particularly useful in apparatus such as eddy-current clutches, brakes, dyna-

mometers and the like. Since eddy-current brakes and dynamometers are actually special forms of eddy-current clutches in which one member is stationary or nearly stationary, the term clutch as used herein comprehends brakes, dynamometers and the like.

It will also be understood that although in the examples shown the field member 17 is shown as being inside of the inductor member 21, this relationship may be reversed, as is the case in Patent 2,470,596, this also being simply an inversion.

Reference is hereby made under the provision of rule 78 to a related invention disclosed and claimed in the U. S. patent application of Ralph L. Jaeschke, Serial No. 193,417 for Magnetic Pole, filed November 1, 1950.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. For use in a dynamoelectric machine having a rotary inductor and a rotary field member composed of an annular field-producing member partially surrounded by magnetizable material including notched pole rings adjacent to the field member with magnetizable polar teeth of the claw type extending from the pole rings and interdigitating across the field member and adjacent to the inductor; a form of said polar teeth wherein each comprises a relatively wide heel portion and a relatively narrow toe portion presenting a pole face adjacent the inductor which tapers in its direction of extension from its pole ring, the adjacent notches in its pole ring comprising valleys which are substantially conical and increase in size in the direction of the annular field member to effect a general radial flare

of the heel portion away from the pole face in the heel region, the extended portion of the pole beneath its toe portion being tapered down axially but flared radially toward the narrower pole face, the arrangement being such that cross sections taken through the pole substantially normal to the resulting mean S-shaped path of flux passing therethrough carry a substantially constant flux density, the peripheries of the pole face having overhanging narrow edges adapted to enlarge the pole face area substantially exclusively at and in the area of the pole face so as substantially exclusively to reduce the flux density passing therethrough below that of any of said cross sections.

2. Apparatus made according to claim 1, wherein said overhanging edges are constituted by rib extension portions.

3. Apparatus made according to claim 2, wherein the lateral faces of said rib portions also flare away from the broader portion of the pole face in the heel region and also flare toward the narrower portion of the pole face in the toe region.

MARTIN P. WINTHER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,052,535	Volkers	Feb. 11, 1913
1,502,527	Reichel	July 22, 1924
2,470,596	Winther	May 17, 1949

FOREIGN PATENTS

Number	Country	Date
235,395	Germany	June 9, 1911

OTHER REFERENCES

Alternating Current Machinery, Thompson, pages 116–117, published by Spon and Chamberlin, London, 1904.