

May 15, 1956

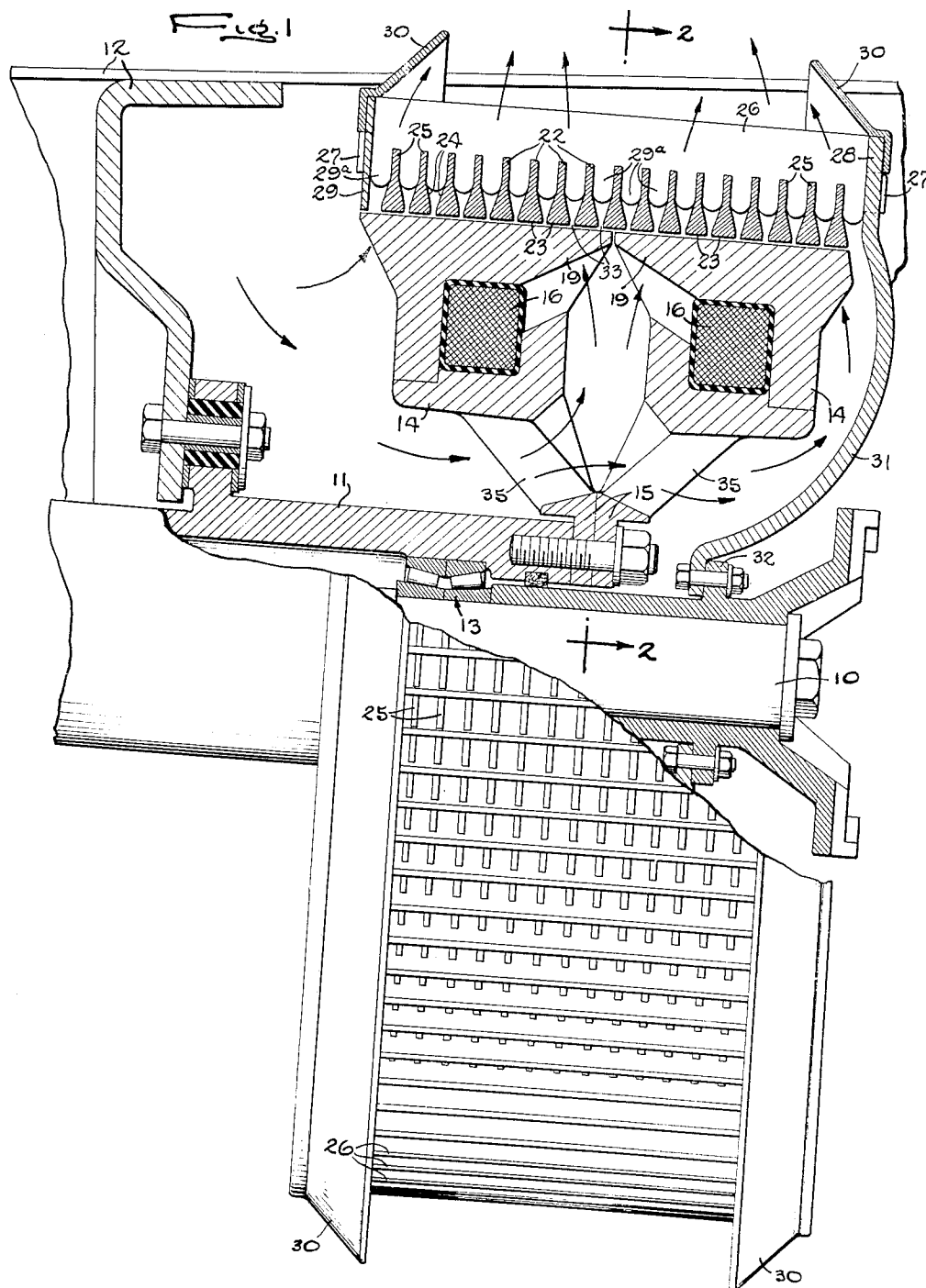
J. G. OETZEL

2,745,974

EDDY CURRENT TORQUE PRODUCING DEVICE

Filed March 26, 1952

6 Sheets-Sheet 1



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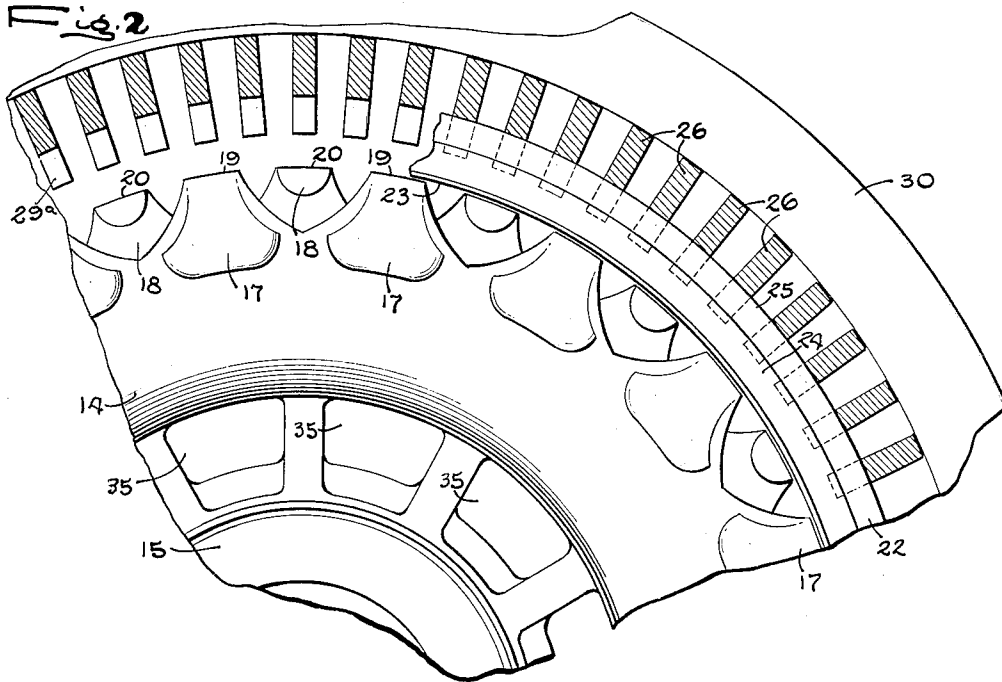
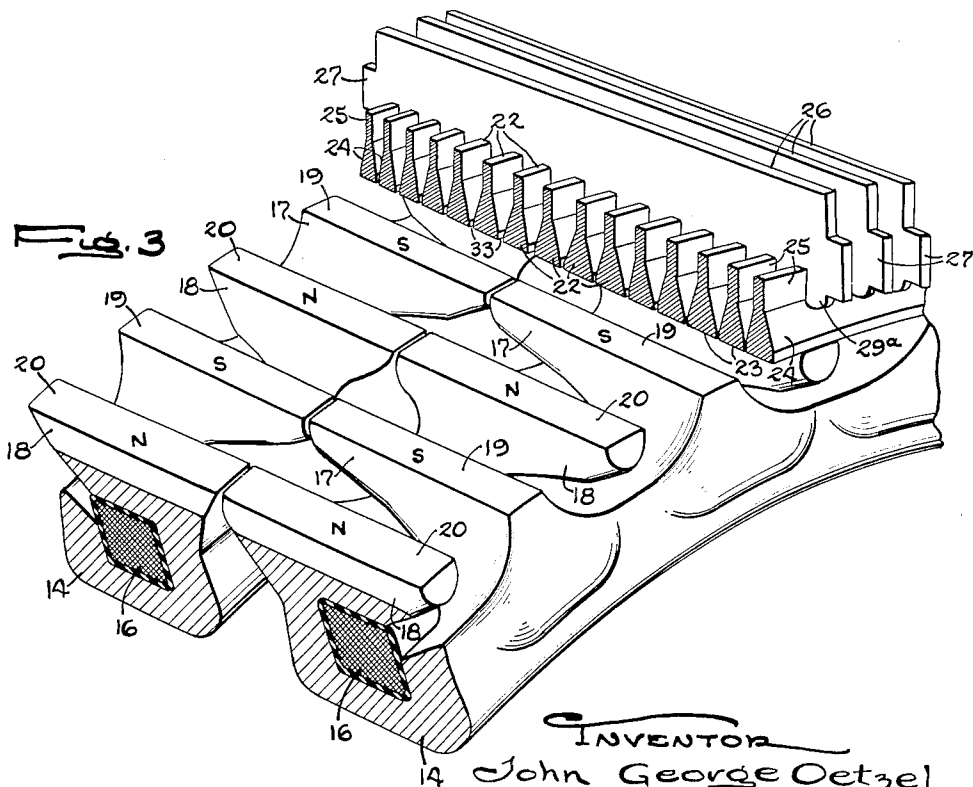
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EDDY CURRENT TORQUE PRODUCING DEVICE

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6 Sheets-Sheet 2



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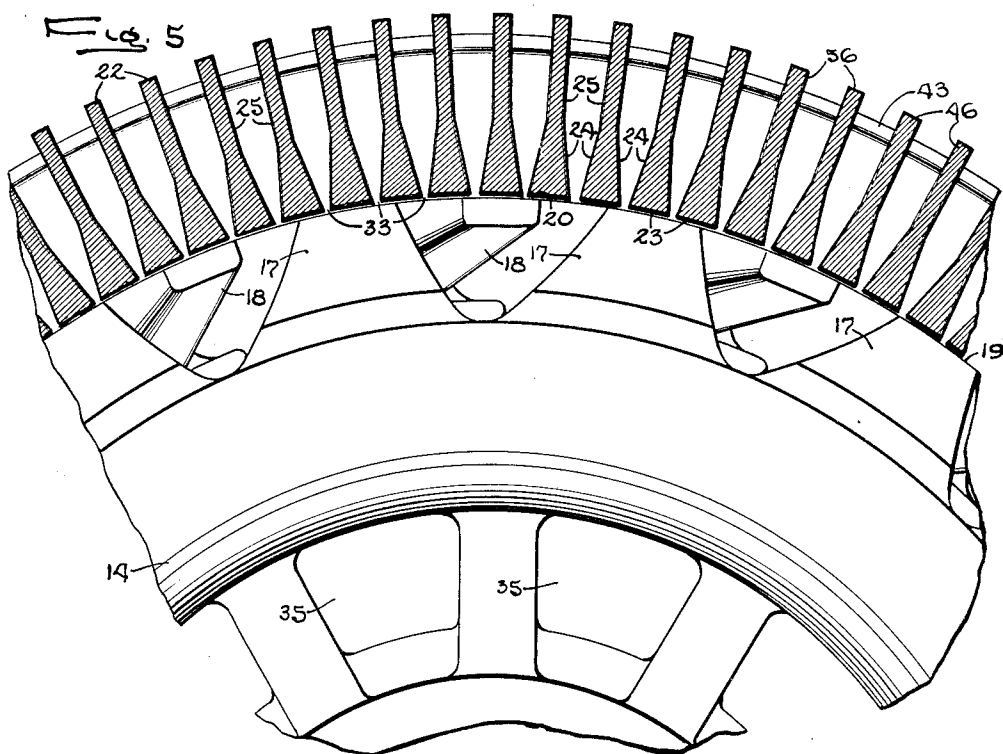
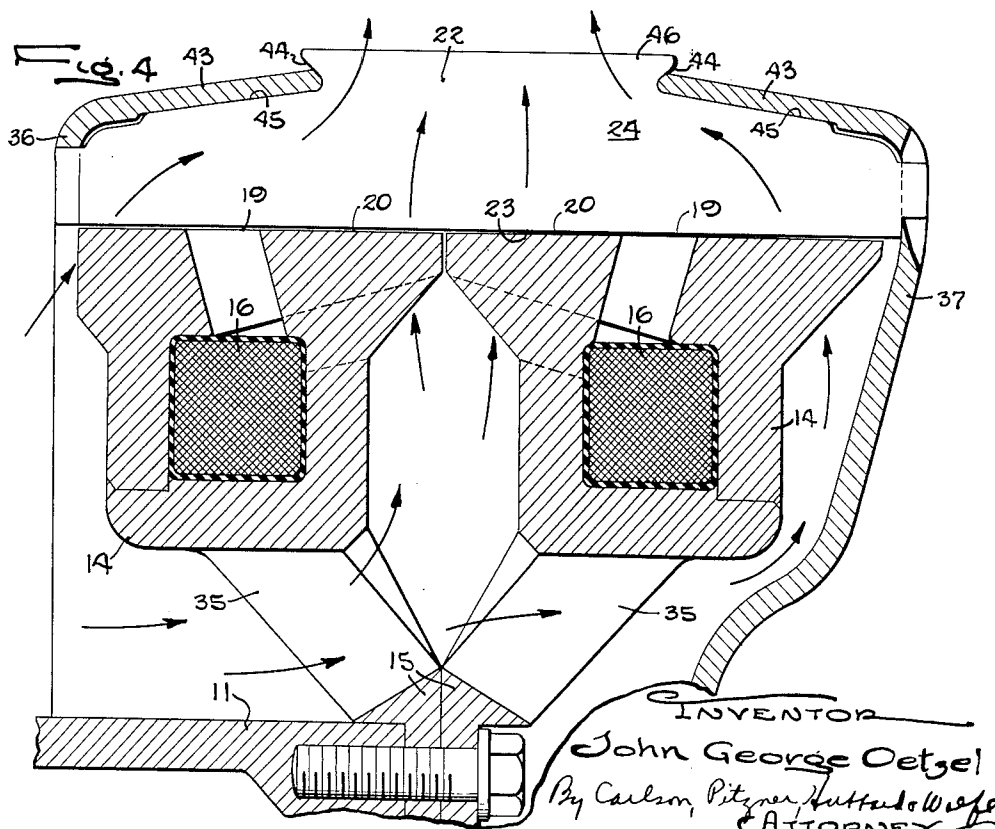
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EDDY CURRENT TORQUE PRODUCING DEVICE

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6 Sheets-Sheet 3



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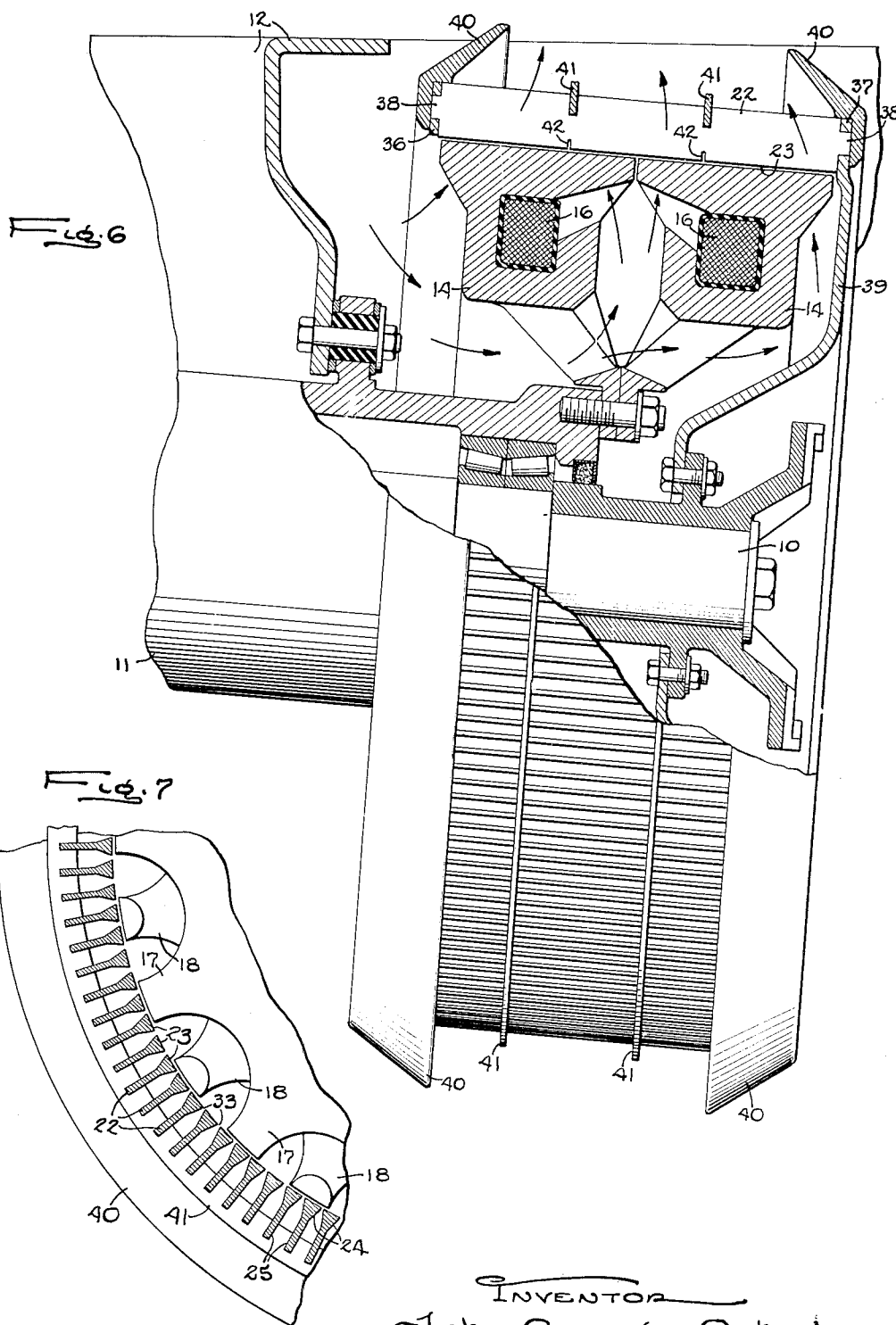
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EDDY CURRENT TORQUE PRODUCING DEVICE

Filed March 26, 1952

6 Sheets-Sheet 4



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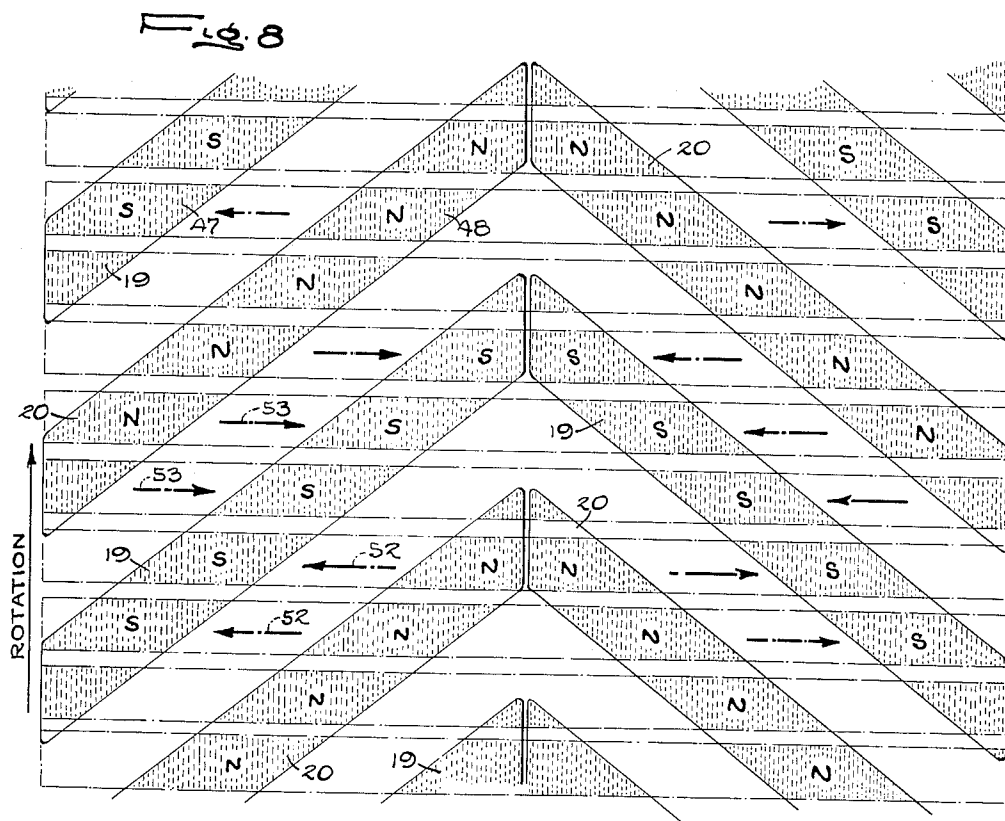
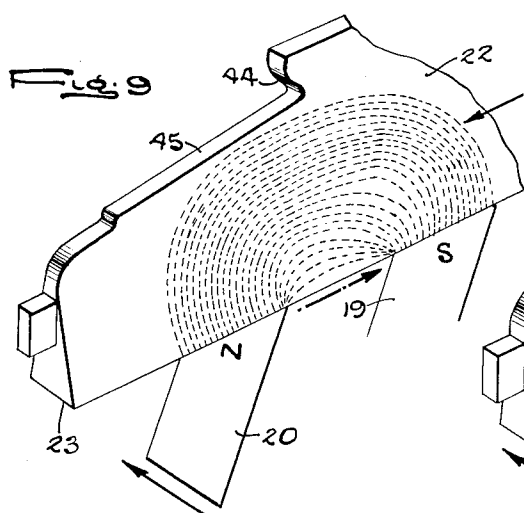
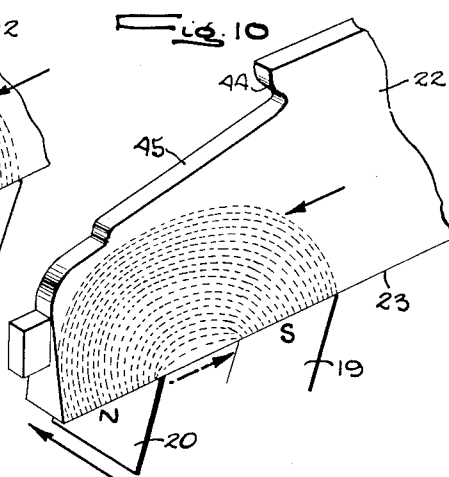
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EDDY CURRENT TORQUE PRODUCING DEVICE

Filed March 26, 1952

6 Sheets-Sheet 5



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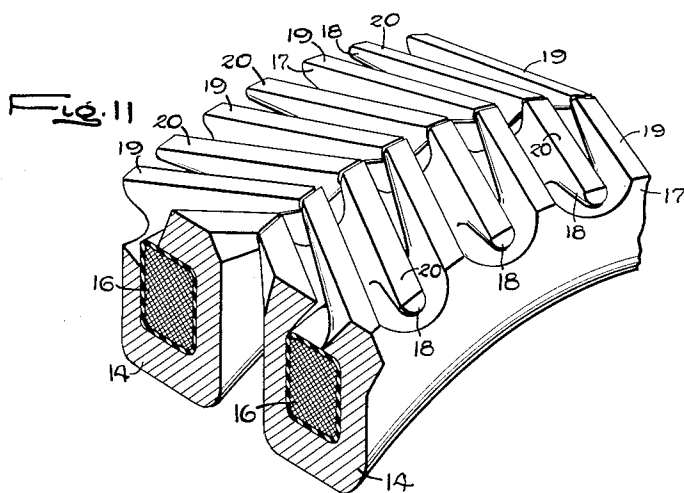
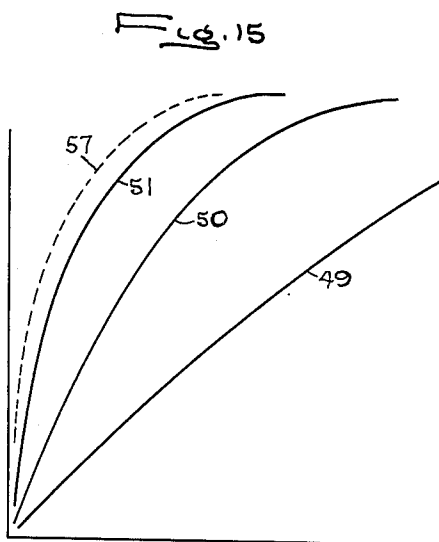
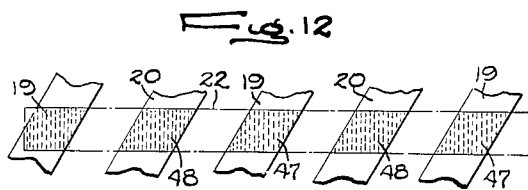
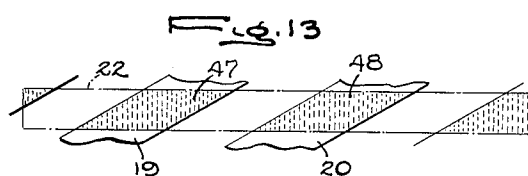
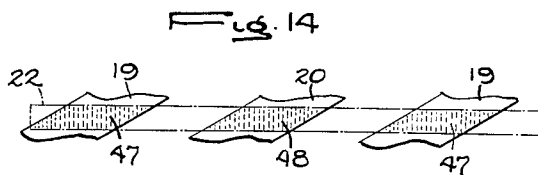
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EDDY CURRENT TORQUE PRODUCING DEVICE

Filed March 26, 1952

6 Sheets-Sheet 6



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2,745,974

EDDY CURRENT TORQUE PRODUCING DEVICE

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Application March 26, 1952, Serial No. 278,662

15 Claims. (Cl. 310—93)

This invention relates to eddy current brakes and clutches of the type having an inner stator with so-called imbricated or overlapping poles enclosed by an inductor in which eddy currents are induced and from which heat is absorbed by air induced to flow outwardly by the action of fan elements rotatable with the inductor.

The general object is to provide an eddy current device which, as compared with prior devices, is substantially more efficient, is effectually cooled with a minimum consumption of driving power, and yet is simple and inexpensive in construction.

Another object is to construct the inductor element of the device in a novel manner to force wider distribution of the eddy currents within the metal of the inductor and thereby reduce the length of the path through which the generated heat must be conducted before reaching the heat dissipating surfaces.

A more detailed object is to divide the inductor into a series of elongated teeth of tapered cross section each having side surfaces which converge radially and outwardly away from the tooth face opposing the pole faces of the stator.

A further object is to provide for expansion of the cooling air as it flows radially between adjacent sides of the inductor teeth whereby to increase the heat absorbing capacity of the cooling air.

Another object is to arrange the teeth of the inductor and the faces of the imbricated poles in a novel angular relationship so as not only to change the direction of the flux in each inductor tooth rapidly but also to shift the flux along the tooth whereby to obtain optimum eddy current and hysteresis effects.

Still another object is to utilize the inductor teeth themselves as fan blades for inducing the circulation of cooling air.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is an elevational view partly in section of an eddy current device embodying the novel features of the present invention.

Fig. 2 is a fragmentary sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary perspective view of the stator and part of the inductor.

Figs. 4 and 5 are fragmentary views similar to Figs. 1 and 2 showing a modification.

Figs. 6 and 7 are views similar to Figs. 4 and 5 showing a modification of the latter form of the invention.

Fig. 8 is a development of the faces of the stator poles and the inductor teeth.

Figs. 9 and 10 are fragmentary perspective views of the stator poles and inductor teeth showing the progress of the magnetic flux along the teeth.

Fig. 11 is a fragmentary perspective view of the stator of the device shown in Fig. 6.

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Figs. 12, 13, and 14 are diagrammatic views illustrating various relative inclinations of the pole faces and stator teeth.

Fig. 15 shows typical performance curves.

In the forms shown in the drawings, the improved eddy current device is especially adapted for use as a brake in heavy duty automotive vehicles for applying a retarding torque to a rotary part such as a shaft 10 projecting from a stationary housing 11 mounted on the vehicle frame 12 and supporting the shaft bearings 13. The stator or field member of the brakes shown in Figs. 1 to 3 comprises two hollow magnet rings 14 arranged end to end and having internal flanges 15 bolted together and to the end of the housing 11. Each ring 14 encloses an annular multiple turn coil 16 and its outer periphery flares outwardly and is divided into separated or so-called imbricated and axially tapered projections 17 and 18 extending from opposite ends of the ring and terminating in circumferentially spaced substantially parallel faces 19 and 20 which are oppositely polarized substantially to the point of flux saturation when the winding 16 is energized and which lie on a cylinder of revolution centered on the axis of the shaft 10. The pole projections cooperate to define air passages through which air entering between or at the ends of the rings 14 may circulate freely and outwardly between the adjacent pole faces and from the periphery of the stator.

Concentric with and closely encircling the rotor pole faces is an annular rotary inductor formed in accordance with the present invention by a series of closely spaced elongated teeth 22 overlapping at least two of the pole faces 19 and 20 in all positions of the inductor and constructed of novel cross section so as to force a wide distribution of the flux close to heat radiating surfaces of large area. In the brake shown in Figs. 1 to 3, the inductor teeth 22 comprise complete rings of magnetic iron only slightly larger in internal diameter than the stator and joined together to form a rigid unit. Each ring is of substantial radial thickness and tapers outwardly from a maximum width at its inner cylindrical face 23 to a relatively thin section which extends over a substantial part of the radius of the ring at the outer edge thereof. While the outward convergence of opposite side surfaces 24 of each ring may extend over the full radial width, it is preferred as shown to extend the taper over about half of the ring radius leaving the outer half portion 25 of substantial uniform width. Thus, in the form shown, the inner half of the inductor tooth is of substantially triangular section while the remaining outer half is parallel sided and of a thickness substantially less than half that of the inner face 23 of the tooth.

Since each of the teeth 22 encircles the entire periphery of the stator, the successive circumferential lengths of the tooth extend across and overlap the adjacent pole faces 19 and 20 and thus provide separate low reluctance paths through which flux may thread from pole to pole, the longitudinal path between each pair of stator poles shifting around the ring as the inductor rotates. As will be described more fully later, the cross sectional area of each inductor tooth and the areas of overlap with the adjacent pole faces 19 and 20 are correlated in a novel manner to force a wide distribution of the flux throughout the cross section of each tooth so as to facilitate rapid dissipation of heat from the tooth surfaces.

In the form shown in Figs. 1 to 3, the ring type inductor teeth 22 are joined together by a series of closely spaced parallel bars 26 spanning the outer edge portions of the teeth and constituting fan elements for inducing the flow of a large volume of air outwardly between the pole projections 17 and the rings 22. The bars are of uniform thickness and comparatively thin and disposed in radial

planes uniformly spaced around the inductor. Lugs 27 at opposite ends of each bar project into and fit closely in holes in generally flat rings 28 and 29 to which the bars are secured rigidly as by copper brazing at all of the adjoining surfaces.

To join the bars 26 and the teeth 22 in good heat conducting relation, the inner edge portion of each bar is notched to receive the outer edge portion 25 of the teeth and form lugs 29^a which fit closely between the sides of the adjacent teeth and are joined thereto as by brazing. Preferably, each lug 29 extends inwardly over substantially the full width of the flat parts of the inductor teeth. The teeth and the bars are thus joined into a rigid unit which constitutes not only a tooth annular inductor with air passages between adjacent teeth but also the cage of a fan which operates efficiently by turning of the inductor to induce an outward flow of air at a high volumetric rate. Baffle rings 30 are preferably provided at opposite ends of the fan cage to minimize the loss of efficiency due to aspiration of external air into the fan discharge at the outer ends of the passages between the adjacent bars 26. These rings are welded or brazed to the end rings 28 and 29 and preferably converge toward each other outwardly from the ends of the fan blades.

It will be observed that owing to outward tapering of the inductor teeth 22, the air passages between adjacent teeth increase in width outwardly from the inlets 33 which comprise relatively narrow slots between the adjacent edges of the teeth at their inner faces 23. Thus, the air drawn outwardly through the slots 33 expands as it continues outwardly across the adjacent diverging sides 24 of the teeth. Due to such expansion of the air, the heat absorption capacity thereof is increased substantially.

The combined inductor and fan unit may as shown be supported from one end and attached to the shaft 10. For this purpose, the end ring 28 constitutes the outer portion of a disk 31 which curves inwardly around the inner periphery of the adjacent magnet 14 and at its inner edge is bolted to a flange 32 on the shaft 10. The inner edge portion of the disk may be apertured to permit the free entry of air to the interior of the adjacent magnet ring 14 whose flange 15 has angularly spaced holes 35 formed therein. Similar holes are formed in the mounting flange of the other magnet ring thus permitting the free flow of air outwardly through and around the rings 14, the pole projections 17 thereof, the inductor teeth 22, and the fan blades 26 as indicated by the arrows in Fig. 1.

In the modified forms shown in Figs. 4 to 11, the construction of the inductor is simplified by utilizing the teeth 22 themselves as the fan elements. To this end, the teeth, which may be of the same cross section as the teeth previously described, are disposed in radial planes so as to extend across the periphery of the stator preferably parallel to the axis thereof. Thus, the teeth take the form of bars of lengths equal to the axial width of the pole faces 19 and 20 of each stator magnet 14. The internal faces 23 are preferably concaved slightly in a circumferential direction to conform closely to the curvature of the pole faces 19 and 20 so that the air gaps between the two are of uniform minimum thickness at all points.

At opposite ends, each tooth 22 abuts against and is copper brazed to the sides of flat rings 36 and 37 which are apertured to snugly receive lugs 38 formed on the bar ends. The ring 37 comprises the outer peripheral part of a disk 39 similar to the disk 31 previously described and mounted on the shaft 10. Baffles 40 (Fig. 6) secured to the rings 36 and 37 project outwardly beyond the outer edge portions 25 of the teeth and converge toward each other for the purpose previously mentioned. If desired in order to reinforce the bars 22 against radial warping, the latter may be joined intermediate their ends and at several points by rings 41 seated in notches in the outer edge portions of the bars and secured to the latter by copper brazing. To render the thickened inner

edge portions of the bars somewhat flexible and thus reduce the danger of thermal warping, shallow notches 42 may be formed along these edges and extended transversely across each bar.

In the form shown in Fig. 4, the end rings 36 and 37 themselves form the baffles at the ends of the fan outlets and also serve to join the teeth together at points spaced inwardly from the rings. To this end, the rings are formed with flanges 43 turned inwardly toward each other and overlying opposite end portions of the teeth which slope outwardly as indicated at 45 to notches 44 in which the inner edges of the flanges 43 are seated. Preferably, the central part 46 of each tooth projects outwardly between the adjacent inner edges of the flanges 43 thereby increasing the radial width of the fan blades formed by the teeth 22.

It will be observed that the radially disposed and circumferentially spaced teeth mounted as described constitute fan blades which, during rotation of the inductor, induce a high rate of air flow into the narrow slots 33 between the teeth and their inner faces 23. In passing outwardly, the air expands along the diverging sides 24 of the teeth and finally is discharged from the outer ends of the passages defined by the flat outer edge portions 25 of the teeth.

As shown in Figs. 4, 6, and 11, the stator of the modified eddy current device is constructed and mounted the same as the stator first described. To enable each tooth 22 to always provide a low reluctance flux path between two pole faces of opposite polarity in all positions of the inductor, the stator pole projections 17 are inclined relative to the inductor axis at an angle such that the inner face 23 of each tooth always extends across and overlaps one pole face 19 and an adjacent face 20 of opposite polarity as indicated by the hatched areas 47 and 48 in Figs. 8, 12, 13, and 14. The desired inclination is achieved simply by milling out the magnet ring casting to separate the pole projections 17 and leave the rectangular pole faces 19 and 20 disposed at the proper angle. While the pole faces of the two magnets may be inclined at the same angle and the corresponding faces aligned with each other, it is usually preferable to employ opposite inclinations and arrange the faces herringbone fashion as shown in Figs. 8 and 11.

The particular inclination selected is determined by the widths of pole faces 19 and 20 and the tooth faces 23, the permissible axial length of the magnet, and also by the performance characteristics desired with the inductor speed prevailing in a given installation. As shown by Figs. 12 and 13 in which the pole faces are inclined at 60 and 30 degrees respectively, it will be observed that the greater the inclination the shorter may be the axial length of the magnet rings 14. Also, the speed at which the overlapped areas 47 and 48 progress along the tooth will vary inversely with the inclination of the pole faces. If a substantially straight speed torque curve is desired as indicated at 49 (Fig. 15), the stator poles would be inclined at a large angle as shown in Fig. 12. Reducing the angle as shown in Fig. 8 to increase the rate at which the overlapped areas 47 and 48 progress along the pole faces and teeth results in a more rapid increase in torque with speed as indicated at 50 followed by more abrupt flattening of the curve as maximum speed is attained. A further increase in the slope of the speed-torque curve as indicated at 51 will result from a still further decrease in the inclination of the pole projections 17 as shown in Fig. 13. The speed torque characteristic may also be varied by changing the number of stator poles per unit of stator circumference or by changing the size of the overlapped areas 47 and 48 as by reducing the widths of the teeth 22 as shown in Fig. 14. As the number of poles is increased, the angle of inclination may be decreased while retaining a desired overlapped area of the pole and tooth faces.

Referring now to Figs. 8 to 10, it will be apparent

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that each inductor tooth 22 provides a low reluctance path to which magnetic flux from one pole face 19 may thread to one end portion of the tooth face 23 and from which the flux may thread back to the area 48 of the adjacent opposite pole face which underlies the opposite end portion of the tooth face. Within the tooth and between the overlapped areas 47 and 48, the flux lines follow a path extending longitudinally of the tooth and progressing along the latter as indicated in Figs. 9 and 10. As better shown by the arrows in Fig. 8, the total flux path through any one tooth 22 shifts progressively to the right as the tooth advances by rotation of the inductor. So long as the tooth is overlapping two predetermined north and south poles, the direction of the flux through the tooth remains the same as indicated by the arrows 52. When the right end of a tooth passes one north pole and the other end starts to overlap the next north pole, the flux path is shifted to the other end portion of the tooth and the direction of the flux is reversed as indicated by the arrows 53. Moreover, the density of the flux within the inductor tooth changes as the tooth ends move off from and onto the ends of a stator pole face preparatory to changing the direction of the flux through the tooth. As a result of the rapid cutting of the stator flux by movement of the inductor teeth together with the reversal of the flux, its changes in density and the direction of its progress along the tooth, a substantial hysteresis effect is obtained along with the building up of eddy currents of substantial magnitude within the inductor teeth. The efficiency of the device in producing torque is thus increased substantially as compared to prior eddy current devices.

By making the end rings 36 and 37 of magnetic material, these rings constitute the seats of additional eddy currents and result in a further augmentation of the torque developed. This is due to the fact that arcuate portions of these rings form low reluctance magnetic connections between the ends of the inductor teeth, these connections being threaded by magnetic flux when an overlapped area 47 or 48 is approaching the end of a tooth 22 and is therefore decreasing in size. The heat thus generated within the end rings is absorbed by the cooling air flowing outwardly through the inductor teeth.

By outwardly tapering the cross section of the teeth 22 as described above and correlating the section area of the tooth with the areas 47 and 48 of overlap between the pole and tooth faces 19, 20, and 23, the magnetic flux threading the teeth 22 between these areas is forced into all parts of the tooth section thus causing the heat generated by the eddy currents to be distributed widely within the tooth cross section thus facilitating its rapid transfer to the air streams flowing outwardly between the inductor teeth. In general, the cross section of each tooth 22 is made substantially smaller than the overlap areas 47 and 48 and only sufficient in size to carry when substantially saturated all of the flux which threads across the air gaps between the overlapped tooth and pole areas 23, 47, and 48. The substantial width of the tooth faces required for this purpose while providing small enough cross section to approach saturation in the teeth 22 is achieved by converging the sides 24 of the teeth outwardly as above described. Wide distribution of the flux to the full depth of the teeth including the thin outer edge portion 25 is achieved by making the inner or triangular part of the tooth section too small in area to carry all of the flux entering the tooth from the areas 47 and 48. As a result, some of the flux is forced up into the edge portions 25 and the entire cross section of the tooth between the face areas 47 and 48 approaches magnetic saturation.

Since eddy currents tend to follow the surface of the metal part in which they are generated and also follow and surround the path of the magnetic flux, most of the heat resulting from the flow of these currents in the teeth

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22 will be created near the side surfaces 24 and will be conducted rapidly to these surfaces for immediate absorption by the air streams flowing outwardly between the adjacent teeth. Such wide distribution of the developed heat together with the efficient action of the fan in moving air over all of the tooth surfaces results in rapid disposal of the heat thus enabling the metal to be worked to maximum capacity with a minimum consumption of cooling air and therefore of power for driving the fan. The cooling effect of the air is further increased by virtue of the expansion of the air as it passes the restricted inlets 33 and passes outwardly between the diverging sides of the adjacent teeth. Since the heat generated by eddy current and hysteresis is distributed quite uniformly in the tooth sections, the possibility of warping of the teeth due to differential heating is effectually minimized.

If desired, the magnitudes of the eddy currents may be increased and disposal of the generated heat further facilitated by covering the surfaces of the teeth with a thin layer indicated at 56 in Fig. 5 of metal such as copper of better electrical conductivity than iron. This may be achieved for example by electroplating the parts before assembly or the entire inductor cage after assembly. By this addition the speed torque curve 51 for example may be raised as indicated at 57 in Fig. 15.

I claim as my invention:

1. A rotary inductor for an eddy current device comprising a series of circular rings of magnetic metal and equal size concentric with a common axis and disposed side by side in closed spaced relation whereby to define narrow annular slots between the rings, a series of cross bars circumferentially spaced around and spanning the outer edges of said rings so as to constitute fan blades operable during rotation of the inductor to induce air to flow radially and outwardly through said passage, each of said bars having teeth spaced along its inner edge and each projecting in between two adjacent rings and connected to the sides of the latter in heat conducting relation, and means rigidly joining said rings and bars and supporting the same for rotation about said axis.

2. A rotary inductor for an eddy current device comprising a series of circular rings of magnetic metal and equal size concentric with a common axis and disposed side by side in closely spaced relation whereby to define narrow annular slots between the rings, the opposite sides of each ring converging outwardly whereby to define between adjacent rings an annular passage flaring outwardly from one of said slots, a series of cross bars spanning the outer edges of said rings and disposed in substantially radial planes so as to constitute fan blades operable during rotation of the inductor to induce air to flow radially and outwardly through said passages, and means rigidly joining said rings and cross bars and supporting the same for rotation about said axis.

3. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying on a common cylinder of revolution, said pole faces being of equal size and equally spaced and being inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, a series of parallel substantially radially disposed teeth of magnetic material extending across and angularly spaced around the periphery of said member and having inner generally rectangular faces lying substantially on a cylinder concentric with said axis and disposed close to and opposing said pole faces, the inclination of said pole faces being such that each tooth face always overlaps and extends across at least two adjacent pole faces of opposite polarity, and means rigidly joining said rings and supporting the same for rotation about said axis, the opposite sides of each tooth converging outwardly to define between adjacent teeth outwardly flaring air passages.

4. An eddy current torque-producing device comprising a field member having an annular series of imbricated

pole pieces terminating in generally rectangular pole faces facing outwardly and lying on a common cylinder of revolution, said pole faces being of equal size and equally spaced and being inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, an inductor having a series of parallel rigidly joined teeth of magnetic material extending across and angularly spaced around the periphery of said rotor and having inner generally rectangular faces lying on a cylinder and disposed close to and opposing said pole faces, the inclination of said pole faces being such that each tooth face always overlaps and extends across at least two adjacent pole faces of opposite polarity, means rigidly joining said teeth at opposite ends and supporting the inductor for rotation about said axis, and means disposed intermediate the ends of said teeth and rigidly joining the latter together.

5. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying on a common cylinder of revolution, said pole faces being of equal size and equally spaced and being inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, an inductor having a series of parallel rigidly joined teeth of magnetic material extending across and angularly spaced around the periphery of said rotor and having inner generally rectangular faces lying on a cylinder and disposed close to and opposing said pole faces, the inclination of said pole faces being such that each tooth face always overlaps and extends across at least two adjacent pole faces of opposite polarity, and means rigidly joining said teeth at opposite ends and supporting the inductor for rotation about said axis.

6. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying on a common cylinder of revolution, said pole faces being of equal size and equally spaced and being inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, an inductor having a series of parallel rigidly joined teeth of magnetic material extending across and angularly spaced around the periphery of said rotor and having inner generally rectangular faces lying on a cylinder and disposed close to and opposing said pole faces, the inclination of said pole faces being such that each tooth face always overlaps and extends across at least two adjacent pole faces of opposite polarity, and means rigidly joining said teeth at opposite ends and supporting the inductor for rotation about said axis, each of said teeth being notched at points spaced along the inner face thereof.

7. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying substantially on a common cylinder of revolution, said pole faces being of substantially equal size and spacing and being inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, a rotary inductor comprising a series of parallel teeth of magnetic material having inner generally rectangular faces lying on a cylinder closely encircling said pole faces, and means rigidly joining said teeth and supporting the latter to turn about said axis, said tooth faces being inclined relative to said pole faces so that each tooth face overlaps and extends across at least two adjacent pole faces of opposite polarity whereby the flux path through the tooth between the overlapped areas of the pole faces shifts longitudinally of the tooth during relative rotation between said field member and said inductor, and the opposite sides of each of said teeth converging radially and outwardly.

8. A rotary inductor element for an eddy current

torque-producing device comprising a series of elongated teeth disposed side by side in closely spaced relation with their internal faces lying substantially on a cylinder of revolution and defining narrow inlet passages at their adjacent edges, and means rigidly connecting said teeth and supporting the same for rotation about the axis of said cylinder, the opposite sides of each tooth converging outwardly whereby the adjacent side surfaces of adjacent teeth cooperate to define air passages flaring outwardly from said inlets.

9. A rotary inductor element for an eddy current torque-producing device comprising a series of elongated teeth disposed side by side in closely spaced relation with their internal faces lying substantially on a cylinder of revolution and defining narrow inlet passages at their adjacent edges, and means rigidly connecting said teeth and supporting the same for rotation about the axis of said cylinder, the opposite sides of each tooth converging outwardly to a parallel side rib along the outer edge of the tooth whereby the adjacent side surfaces of adjacent teeth define air passages flaring outwardly from said inlets.

10. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying substantially on a common cylinder of revolution means for oppositely polarizing the adjacent pole pieces, a rotary inductor comprising a series of parallel teeth of magnetic material arranged side by side and forming an annulus closely encircling said field member with the face at the inner edge of each tooth inclined relative to said pole faces so that each tooth face in each position of the inductor overlaps and extends across at least two pole faces of opposite polarity, the opposite side surfaces of each tooth converging radially and outwardly to taper the cross section of the tooth, and means rigidly joining said teeth and supporting the same for rotation about said axis, the widths of said pole and tooth faces being correlated with the area of said tooth cross section whereby the maximum area of each overlap between said tooth face and pole faces is substantially greater than said cross section area whereby to force magnetic flux into the outer edge portion of the tooth section.

11. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in generally rectangular pole faces facing outwardly and lying substantially on a common cylinder of revolution, said pole faces being elongated in the direction of and inclined relative to the axis of said cylinder, means for oppositely polarizing the adjacent pole pieces, a rotary inductor comprising a series of parallel teeth of magnetic material arranged side by side and forming an annulus closely encircling said field member with the face at the inner edge of each tooth substantially paralleling said axis at an angle such that each tooth face always overlaps and extends across at least two pole faces of opposite polarity, the opposite side surfaces of each tooth converging radially and outwardly to taper the cross section of the tooth, and means rigidly joining said teeth and supporting the same for rotation about said axis, the widths of said pole and tooth faces being correlated with the area of said tooth cross section whereby the area of overlap between said tooth face and pole faces is substantially greater than said cross section.

12. An eddy current torque-producing device comprising a field member having an annular series of imbricated pole pieces terminating in pole faces facing outwardly and lying substantially on a common cylinder of revolution, means for oppositely polarizing the adjacent pole pieces a rotary inductor comprising a series of parallel teeth of magnetic material arranged side by side and forming an annulus closely encircling said field member with the face at the inner edge of each tooth being inclined

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relative to said pole faces so that each tooth face in each position of the inductor overlaps and extends across at least two pole faces of opposite polarity, the opposite side surfaces of each tooth converging radially and outwardly to taper the cross section of the tooth, and means rigidly joining said teeth and supporting the same for rotation about said axis, the maximum area of each overlap between said tooth face and pole faces being sufficiently greater than said cross section area to effect substantial flux saturation of said cross section between the overlapping areas of the tooth and pole faces.

13. A rotary inductor for an eddy current torque-producing device comprising a series of elongated teeth of magnetic material disposed side by side in closely spaced relation with their internal faces lying substantially on a cylinder of revolution and defining air inlets, and means rigidly connecting said teeth and supporting the same for rotation about the axis of said cylinder, said teeth extending longitudinally of the axis of said cylinder whereby the sides of said teeth act during rotation of the inductor as fan elements inducing the flow of air outwardly through each of said inlets and across the teeth.

14. A rotary inductor for an eddy current device comprising axially spaced rings of magnetic material, and a series of teeth of magnetic material each spanning and rigidly connecting said rings and angularly spaced around

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the latter whereby to form a fan operable during rotation of the inductor to induce an outward flow of air between the teeth, the inner surfaces of said teeth lying substantially on a common cylinder of revolution and the cross section of each tooth decreasing in width outwardly from said inner faces.

15. A rotary inductor for an eddy current device comprising axially spaced rings of magnetic material, a series of teeth of magnetic material each spanning and rigidly connecting said rings and angularly spaced around the latter whereby to form a fan operable during rotation of the inductor to induce an outward flow of air between the teeth, the inner surfaces of said teeth lying substantially on a common cylinder of revolution and the cross section of each tooth decreasing in width outwardly from said inner faces, and a layer of metal of high electrical conductivity covering said inner faces and the sides of said teeth.

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