June 30, 1942. M. P. WINTHER 2,287,953

ELECTRICAL APPARATUS

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FIG. 1.

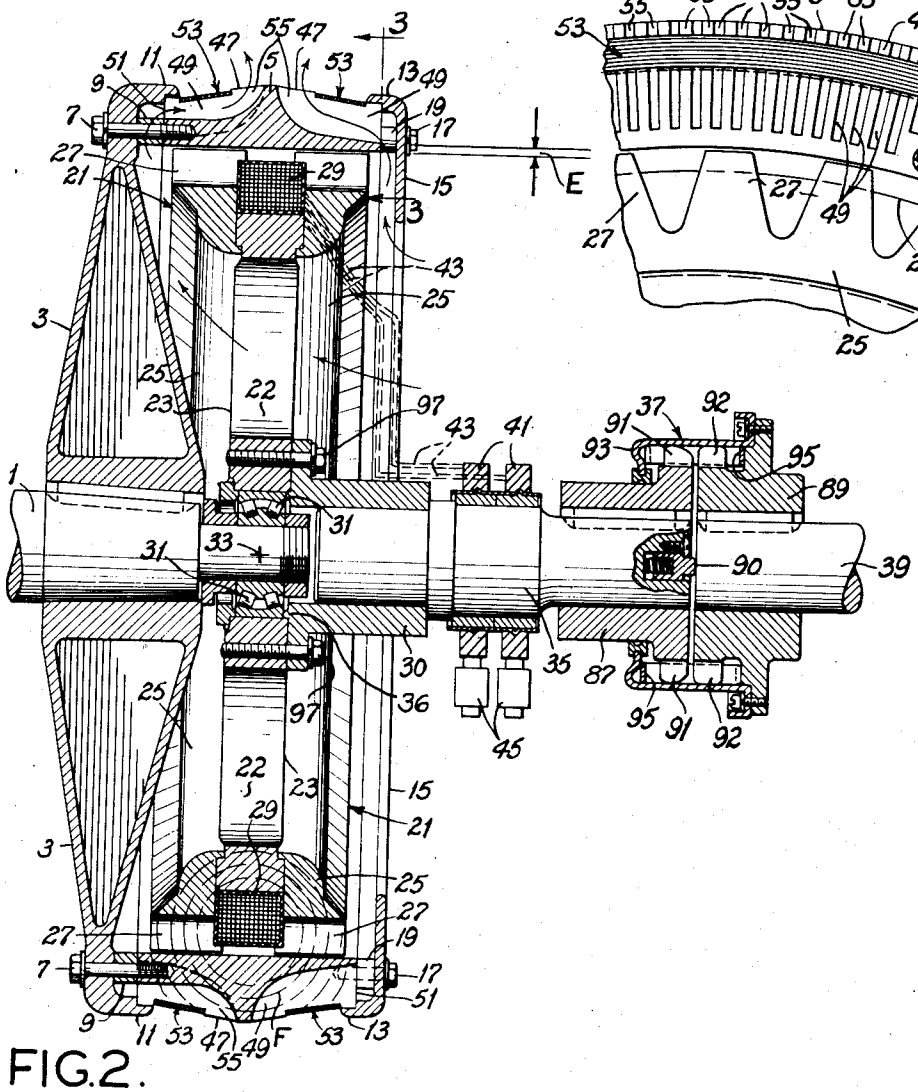
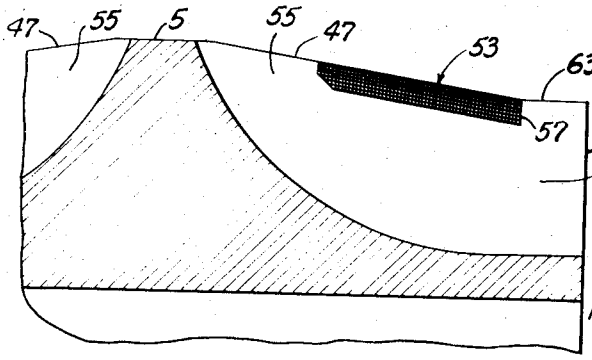


FIG. 3.

FIG. 2.



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FIG 4.

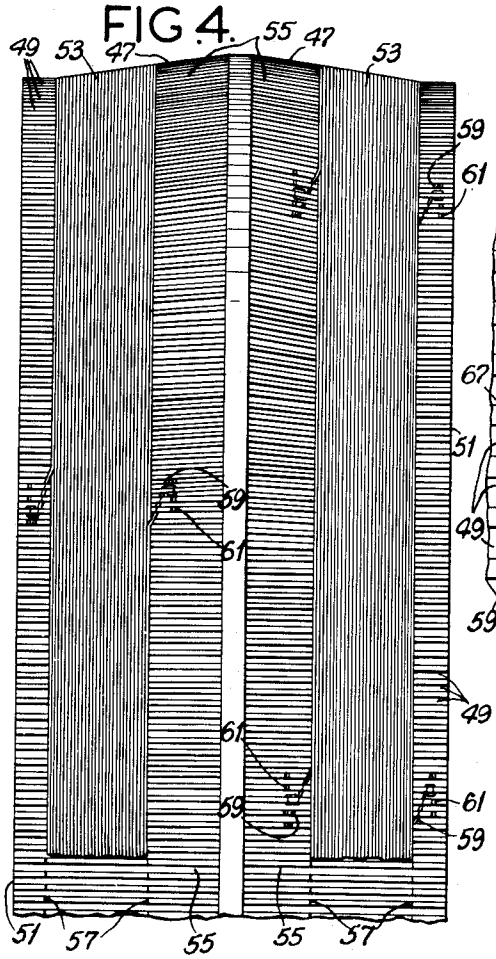


FIG.5.

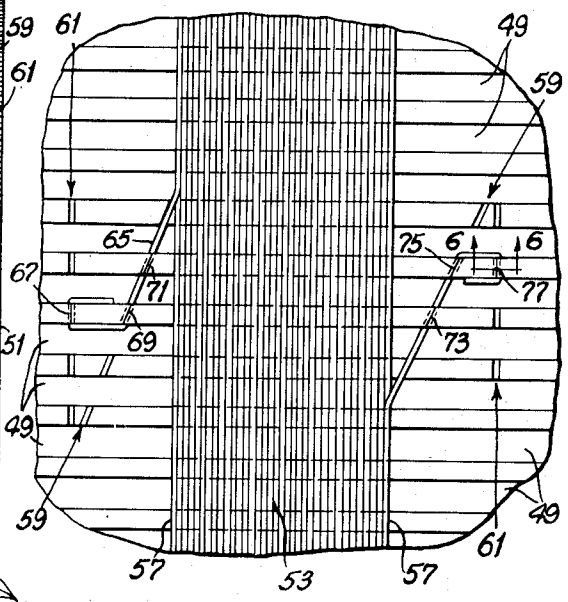


FIG.6.

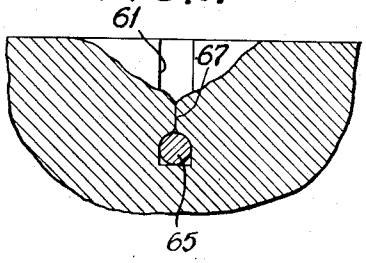
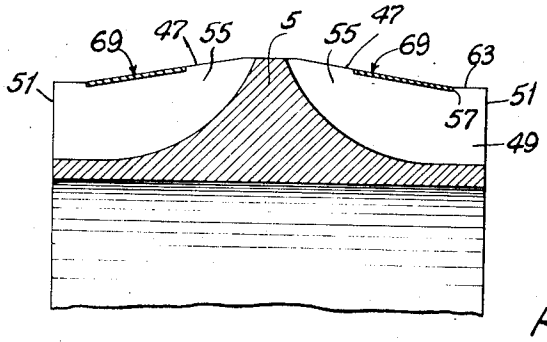


FIG.7.



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FIG.8.

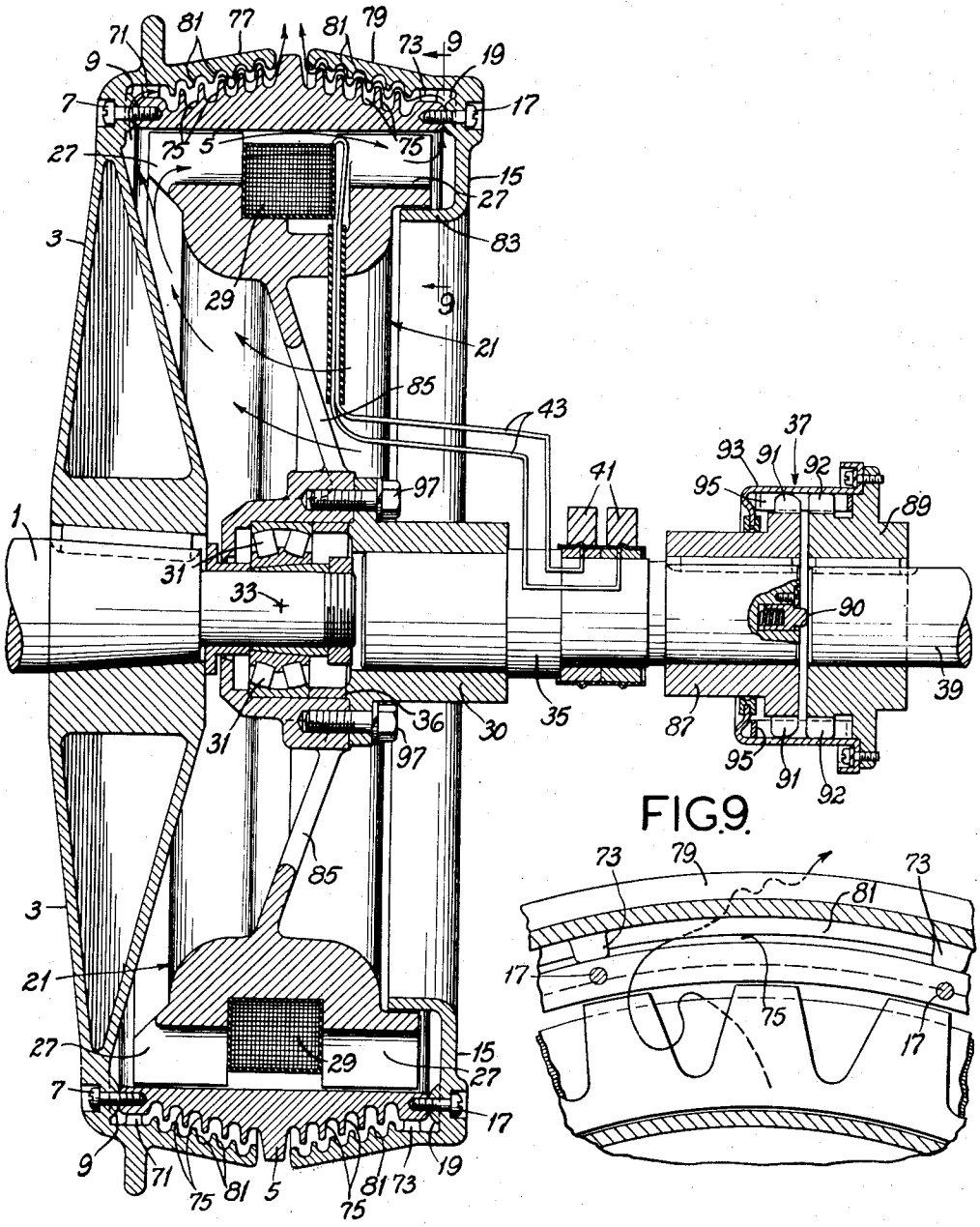


FIG.9.

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UNITED STATES PATENT OFFICE

2,287,953

ELECTRICAL APPARATUS

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Application May 4, 1940, Serial No. 333,313

17 Claims. (Cl. 172—284)

This invention relates to electrical apparatus, and with regard to certain more specific features, to structural features which are particularly useful in eddy-current machines.

Among the several objects of the invention may be noted the provision of simple means for noiselessly cooling the eddy-current member of an electromagnetic clutch; the provision of apparatus of the class described in which the eddy-current member has its strength increased; and the provision of means for demountably coupling the apparatus to allow for some misalignment of the driven member. Other objects will be in part obvious 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 is illustrated several of various possible embodiments of the invention,

Fig. 1 is a longitudinal section showing one form of the invention;

Fig. 2 is an enlarged fragmentary section of the edge of the rotor of the construction shown in Fig. 1;

Fig. 3 is an enlarged fragmentary vertical section taken on line 3—3 of Fig. 1;

Fig. 4 is a partial side elevation of the eddy-current member of Fig. 1;

Fig. 5 is an enlarged detail plan view of a wire fastening means of Fig. 4;

Fig. 6 is an enlarged fragmentary and detailed section taken on line 6—6 of Fig. 5;

Fig. 7 is a view similar to Fig. 2 showing another form of the invention;

Fig. 8 is a view similar to Fig. 1 showing another form of the invention; and,

Fig. 9 is an enlarged fragmentary vertical section taken on line 9—9 of Fig. 8.

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

Referring now more particularly to Fig. 1, there is shown at numeral 1 a drive shaft to which is keyed a driving head 3 for supporting an eddy-current rotor 5. The latter is made of cast iron or other suitable material in which eddy-currents may be engendered efficiently.

Studs 7 are used, with spacing pillars 9 for fastening members 3 and 5. The edge 11 of the head 3 overlaps the edge of the drum 5. On the other side of the drum 5 is a similar overlapping portion 13 forming part of a baffle or guide or deflector 15 which is attached to the drum 5 by means of studs 17 and spacing pillars 19.

At 21 is shown a driven rotor consisting of a central magnetic spider 23 (having openings 22), on opposite sides of which are clamped magnetic rings 25. On the edges of rings 25 are rows of flux-concentrating teeth 27 analogous to those shown in Anthony Winther United States Patent 2,106,542 dated January 25, 1938. Between the rows of teeth 27 and around the member 23 is located a toric field coil 29 which forms a toric flux field of the general character shown by the dotted lines at F.

The driven rotor 21 is carried upon a hub 30 and together therewith is piloted upon the end of the shaft 1 by means of a spherical bearing 31. The center of the spherical bearing 31 is indicated at 33 in a plane substantially midway between the rows of teeth 27. The hub 30 is fastened to an intermediate shaft 35 which through a coupling 37 is connected with the driven shaft 39.

If the coil 29 is electrically energized and the shaft 1 rotated, an electromagnetic driving connection is provided by the flux field F generating eddy-currents in the drum 5. Collector rings 41 with connections 43 together with brushes 45 serve for closing a circuit through the field coil 29.

The eddy-currents in the drum 5 generate heat which needs to be carried off. Heretofore cast fins and the like have been used as fan blades or paddles for engendering a circulation and carrying away heat but the resulting windage has been too noisy for exacting service such as in air conditioning. This old method of casting fins into a drum also limited the numbers of fins which could be used, because of the necessarily crude methods used for obtaining such fins.

By means of the present invention I avoid this windage but cool efficiently. This is done by truncating the outside of the drum 5, preferably in opposite directions as illustrated at 47. In the truncations 47 are finely milled slots 49 forming many fins or heat dissipating means 63, as indicated in Fig. 3.

The principal eddy-currents generated in a drum such as 5 are ordinarily within one-quarter inch to three-eighths inch or perhaps up to three-quarters inch from the inner surface (see region E in Fig. 1), but it is necessary to have a greater radial thickness of metal at as many peripheral points (fins) as possible in order to carry the flux without obtaining a bar effect such as is obtained in so-called squirrel-cage apparatus with widely spaced bars. By milling many narrow slots, more fin metal may be left at more points for carrying this flux. At the same time the slots are carried deeper into the metal of the drum to a point such that the flowing air can reach nearer to and more readily carry away heat generated in the eddy-current region, which region is at the distance above referred to.

Thus solid circular metal is confined to and carries current at the eddy-current region, while at the same time many deep laminations of metal (fins) are left for flux carriage. The many machined fins 63 avoid the stated bar effect which would provide an undesirable condition analogous to a squirrel-cage machine and which would cause undesirable conditions at high speeds.

The slots being machined, may be closely spaced and many closely spaced thin fins obtained. In fact, the fins are so closely spaced that they do not function as did the old cast vanes. They form, along with bands 53, to be mentioned, closely contiguous air carrier passages or conduits for axial flow of air, which is forced by centrifugal action due to the rotation of the drum 5, as will be seen. The many fins also provide a large number of radiation surfaces between which the air sweeps axially.

In order that the air may be directed into the axial ends 51 of the passages, with minimum windage, the head 3 is shaped radially to cover the passage ends as shown, and the deflector 15 is also shaped radially to cover the opposite passage ends. The air flow is then around the pillars 9 and 19 as shown by the arrows in Fig. 1. Openings 22 through the member 23 accommodate flow interiorly for entrance adjacent to the head 3.

In order that the flow may be axial through the passages 49, covering bands are provided at 53, which are arranged to provide outlets 55 for the passages 49. These outlets are on the maximum diameter of the truncation, so that the centrifugal action above referred to will induce circulation from the ends 51 of the passages and out of the outlets 55. The truncated forms of the bands 53 help properly to direct circulation.

The bands 53 are also made to strengthen the drum 5, which it may be seen is weakened by the substantial number of milled slots cut deeply into its periphery. The strengthening is accomplished by making the covers 53 from bands of tightly wrapped piano wire as indicated in Figs. 4 to 6. For example, several layers of piano wire may be used.

In order to apply the layers of piano wire, two recesses 57 are machined around the drum 5 in the mid-portions of the fins 63 to form seats for the wire. Adjacent to the machined recesses 57 are arranged saw cuts 59 and 61. These are cut into the adjacent ribs.

To start off a layer of wire such as 65 (Fig. 5), it is laid into a portion of the saw cut 61 in one of the ribs 63 and then the adjacent parts of the rib peened down as indicated at 67 in Fig. 6. The wire is then brought over through the sloping saw cut 59 and led back toward the machined groove 57 being peened at points 69 and 71. Then it is wrapped around in adjacent loops in the groove 57 until on the other side it is led off through the other sloping cut 59, being peened at 73 and 75. It is then turned over and sent through the cut 61 and peened at 77. Thus one layer is laid and held in tension.

The next and overlaying band of wire is started off at another pair of saw cuts 61 and 59 spaced from the first-named group and the process is continuous until as many bands of wire have been applied as desired. For example, if seven bands are used, then the groups of saw cuts 59 and 61 therefor will be spaced at seven equally spaced positions about the rotor 5. In Fig. 4 is indicated at the right the spacing between two of the fastenings for two of seven layers of wire used.

The layers of wire not only function as means for directing the air circulations properly, but to strengthen the drum 5 against berakage under centrifugal force at high speeds, the wires resisting breakage in tension.

As shown in Fig. 1, the outer edges of the head 3 and of the deflector 15 are arranged to enclose the slots 49 up to a point adjacent to the wire wrappings so that air does not escape before the outlets 55 are reached.

An advantage of using many closely and deeply milled slots, instead of a few cast vanes or the like is that they do not whip the air, and therefore noise and windage are substantially reduced. The purpose of the deflector 15 is to avoid a direct rushing stream of air toward the ends of the end 51 of the slots, which rush if it occurred would be slashed by the edges of the fins or ribs 63. For the same reason, the edge of the head 3 admits air radially and acts as a similar deflector.

The invention is particularly useful for driving apparatus for air-conditioning machinery and the like where silence is of great importance.

From the above it will be seen that the multiplicity of fins employed on the drum 5 is enough to accommodate all of the flux needed for engendering substantially all the eddy-currents and to prevent the fins from beating the air. They are also deep enough to cause the circulated air to pass closely to the hot eddy-current region. Thus the pitch of the fins is less than their maximum depth (see Fig. 3).

In Fig. 7 is shown a modification in which like numerals designate like parts. In this case there are substituted for the piano wires 65 flat covering bands 69, for example, of sheet metal. These may be used in cases where the rotative speeds are low and the strengthening effect of the wires is not required. They simply define passages.

In Figs. 8 and 9 is shown another method for reducing noise without appreciably reducing the strength of the drum. Like numerals designate like parts. In this case, the head 3 is again bolted to the drum 5 by means of bolts 7, spacers 9 being used. The deflector 15 is bolted to the heads 5 by means of bolts 17 with spacers 19 again used. Spacing pads 71 are used radially between the inside of the head 3 and the outer edge of the drum 5. Similar spacing pads 73 are used between the inside of the deflector 15 and the other outer edge of the drum 5.

The outside of the drum 5 is again truncated but is in this case provided with peripheral grooves 75. These may be cast or machined. The grooves 75 are overlaid, in the case of the head 3, by an extending cover 77, and in the case of the deflector 15, by an extending cover 79. The covers 77 and 79 are provided with internal grooves 81 which are correlated to the grooves 75 so that tortuous truncated passages are determined as shown.

The air flow is as shown by the arrows in Fig. 8. Air entering around the spacers 9, 19, 71 and 73 flows as two, truncated, waved sheets between the adjacent grooves in the drum 5 and the covers 77 and 79. The direction of flow is normal to the ribs and grooves (or heat dissipating means) so that the air in effect cascades in ripples in its progress between the confining parts. The flares of the truncations provide for increased volume due to expansion upon heating.

In order to assemble the covers 77 and 79 over

the drum 5, adjacent fins between grooves must clear, as shown. Thus the truncated construction has a double function in providing the necessary clearance and the tortuous and outwardly directed flow of increasing volume.

The inner edge of the deflector 15 is turned in as shown at 83 more or less to seal off the entrance of air so that all air is required to pass through openings 85 in the driven rotor 21 and to pass partially through the teeth 27 and over the coil 29. Both the head 3 and deflector 15 enforce radial flow at the entrance to the tortuous cooling passages. Thus in this form of the invention, windage is again reduced because of the prevention of slashing or cutting action of any fins through a mass of inrushing air. There is no relative motion between the members 77, 79 and 5.

Both in Figs. 1 and 8 the deflectors 15 and head 3 serve to accelerate by friction the radially flowing air so that it has a tangential component before entering the cooling regions.

In both forms of the invention, so far as air circulation is concerned, a labyrinth is provided so that the entering air is prevented from rushing into a cutting relationship with respect to the air flow passages. The passages simply act as centrifugal pumps. Air flow convects heat which radiates from the projections or ribs.

Another feature of the construction shown in both Figs. 1 and 8 is the supporting means for the driven member 21. It is upon the spherical bearing 31 having the center at 33. Thus under slight conditions of misalignment, the intermediate shaft 35 may angle. This is not intended to be enough to cause any of the teeth 27 to interfere with the drum 5 and the fact that the center 33 is in a plane midway between the teeth 27 insures minimum interfering motion for either tooth row.

At the other end of the intermediate shaft 35 is a flange 87 of a coupling having also a spaced flange 89 on the driven shaft 39. Teeth 91 on the flange 87 are rounded at their ends so that they may angle with respect to a cover 93 which is provided on flange 89. Between the teeth 91, and 92 (on 89), are convolutions of leaf spring material 95 which provides the angling driving coupling. A spring pressed plug 90 tends to separate the flanges 87 and 89 to force the teeth 91 and 92 into solid engagement with the convolutions 95 to reduce noise.

The advantage of the coupling construction is, first, that the intermediate shaft 75, by means of the spherical bearing 31, may angle slightly if the shaft 39 is out of line with respect to the shaft 1, the coupling 87—89 permitting such angling. Second, even in cramped quarters, it is a simple matter to remove the intermediate shaft 35 from between the coupling and the member 21, simply by unbolting the hub 29 at the bolts 97 and slipping it back to clear at the centering shoulder 36. The relative movement between flanges 87 and 89 permits this, along with the angling permitted by the spherical bearing 31. Thus, besides the couplings 87, 89, there is provided the intermediate shaft 35 together with the spherical support of the driven member 21 on the pilot end of the drive shaft 1, to make a very desirable demountable flexible coupling.

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. Eddy-current apparatus comprising a rotary hollow drum having a continuous peripheral portion for flux passage and eddy-currents, ribs on the other side of the drum forming intermediate passages of a depth extending close to the limits of the eddy-current region, said ribs carrying substantially all of the flux passing through the continuous portion, covering means around the ribs to direct air axially through said passages, said passages having inlet openings edgewise of the drum and radially directed outlets.

2. Eddy-current apparatus comprising a rotary hollow drum having a continuous peripheral portion for flux passage and eddy-currents, ribs on the other side of the drum forming intermediate passages of a depth extending close to the limits of the eddy-current region, said ribs carrying substantially all of the flux passing through the continuous portion, covering means around the ribs to direct air axially, said passages having openings edgewise of the drum and radially directed outlets, and deflecting means adjacent the inlets which guide incoming air to advance in a radial direction prior to entering the ends of the axial passages.

3. Eddy-current apparatus comprising a magnetic inductor drum having a solid eddy-current region which is of the order of one-eighth to three-quarters of an inch deep, the opposite surface of said drum being recessed to provide many closely spaced radial fins and reaching to a depth close to said eddy-current region, the recesses having axial inlets and radially directed outlets, the fins being such as to accommodate substantially all flux necessary to produce the eddy-currents and being so closely spaced as substantially to cause the fins to function as air carrier passages, and a band around and carried on the fins between the outlets and the inlets and enclosing said passages to form air flow conduits movable with the drum.

4. Eddy-current apparatus comprising a magnetic inductor drum having a solid eddy-current region, the opposite surface of said drum being recessed to provide many closely spaced radial fins and reaching to a depth close to the eddy-current region, the recesses having axial inlets and radially directed outlets, the fins being such as to accommodate substantially all flux necessary to produce the eddy-currents and being so closely spaced as substantially to cause the fins to function as air carrier passages, a band around and carried on the fins between the outlets and the inlets and enclosing said passages to form substantially axially disposed air flow conduits movable with the drum, and deflector means adjacent the ends of the recesses to direct air radially toward the inlets.

5. Eddy-current apparatus comprising an inductor drum having a continuous flux-carrying and eddy-current region; the opposite surface of said drum being recessed to provide radial fins of a depth close to the eddy-current region and accommodating substantially all of the flux passing through the eddy-current region, the pitch of the fins being less than their maximum depth, each recess having an axial inlet and a radially directed outlet, a band around the fins between the outlets and the inlets, and deflecting means covering the inlets and arranged to cause

air which enters said inlets to be inrtoduced from a radial direction.

6. Eddy-current apparatus comprising a rotary inductor drum having an eddy-current region on the inside, the outside of said drum being recessed to provide many thin radial fins to a depth close to the eddy-current region whereby the drum is incidentally weakened, each recess having an axial inlet and a radially directed outlet, and a band around the fins between the outlets and the inlets, said band comprising a wire wrapped about the fins thus providing strength and directing air flow axially between the inlets and the outlets.

7. Eddy-current apparatus comprising an inductor drum of hollow form having an inner eddy-current region, the outer surface of the drum being truncated from its edges toward a mid-portion, separate sets of many thin ribs on the truncations providing spaces therebetween reaching to a point adjacent the eddy-current region and sloping outwardly to form outlets at the widest part of the truncation, the inlets of said spaces being respectively adjacent to the edges of the drum, and bands around the ribs between the inlets and said outlets.

8. Eddy-current apparatus comprising an inductor drum of hollow form having an inner eddy-current region, the outer surface of the drum being truncated from its edges towards a mid-portion, separate sets of many thin ribs on the truncations providing spaces therebetween reaching to a point adjacent the eddy-current region of the drum and sloping outwardly to form outlets at said mid-portion, the inlets of said sets of spaces being respectively adjacent to the edges of the drum, and bands around the ribs between the inlets and said outlets, said bands comprising wire wrapped to reinforce the drum.

9. Eddy-current apparatus comprising an inductor drum of hollow form having an inner eddy-current region, the outer surface of the drum being truncated from its edges towards its mid-portion, separate sets of ribs on the truncation providing spaces therebetween reaching to a point adjacent the eddy-current region of the drum and sloping outwardly to the mid-portion, the sets of inlets of said spaces being adjacent to the edges of the drum, bands around the ribs between the inlets and said outlets, said bands comprising wire wrapped to reinforce the drum, and means covering the edges of the drum to direct flow of air toward the ends of the passages from a radial direction.

10. Eddy-current apparatus comprising a double truncated inductor drum, said drum being hollow and having an inside eddy-current surface, heat radiating ribs on the outside of the drum providing spaces having mid-outlets and edgewise inlets, covering means forcing air flow adjacent to the ribs from the inlets to the outlets, and spaced guide means at the edges of the drum adapted to bring air toward the ribs from a radial direction.

11. Eddy-current apparatus comprising a truncated inductor drum, ribs forming peripheral grooves on the truncation, a cover member adjacent to the outside of the truncation and having inner ribs forming grooves which are adjacent to the first-named ribs, said cover member providing an air inlet and an air outlet on opposite sides of the grooves, whereby air ripples laterally over said ribs.

12. Eddy-current apparatus comprising an inductor drum, said drum having an inner surface for eddy-currents and having an external surfact of truncated form, peripheral ribs in the truncated form providing peripheral grooves, a deflector member attached to the drum edgewise and providing an inlet for air to the grooves, said deflector having a truncated portion extending adjacent to the truncation of the drum, said truncated portion of the deflector carrying ribs providing grooves adjacent to the ribs on the drum.

13. Eddy-current apparatus comprising an inductor drum, said drum having a double truncated portion on its exterior surface with the peripheral ribs on the truncations providing two sets of peripheral grooves, separate covering members attached to the edges of the drum and providing inlets at the edges and an outlet adjacent to the central region of the drum, said covering members having peripheral ribs providing grooves adjacent to ribs on the drum.

14. Eddy-current apparatus comprising an inductor drum, said drum having a double truncated portion on its exterior surface with the peripheral ribs on the truncations providing two sets of peripheral grooves, separate covering members attached to the edges of the drum and providing inlets at the edges and an outlet adjacent to the central region of the drum, said covering members having peripheral ribs providing grooves adjacent to ribs on the drum and radial deflecting portions adjacent the edges of the drum to enforce radial direction of air at the inlets of the grooves.

15. Eddy-current apparatus comprising an inductor drum, said drum having a double truncated portion on its exterior surface, peripheral ribs on the truncation providing peripheral grooves, covering members attached to the edges of the drum and providing inlets at the edges and an outlet adjacent to its central region, said covering members having peripheral ribs providing grooves adjacent to ribs on the drum, said members having radial portions adjacent the edges of the drum to enforce radial entrance of air toward the inlets of the grooves, one of said deflecting members comprising the support for the drum.

16. In electrical machines and the like, a heated rotor, many closely spaced thin fins on the rotor providing narrow passages having axial inlets and radial outlets, covering means over the fins defining said inlets and outlets, and relatively smooth radial guide means extending from said covering means and spaced from the inlets to determine a radial flow of air in approaching the inlets and adapted frictionally to accelerate the air in a peripheral direction as the inlets are entered.

17. Eddy-current apparatus comprising an inductor drum of hollow form having an inner eddy-current region, the outer surfaces of the drum being truncated from its edges toward a mid portion, separate sets of ribs on the truncations, covers outside of the ribs and movable therewith, said covers being arranged to leave air inlets near said edges and outlets near said mid portion and enforcing air flow in such a way as to convect heat which is radiated from the ribs, the covers being attached to the drum and movable therewith, and extensions from the covers directed radially to enforce radial flow of air as it enters the inlets.

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