

Aug. 21, 1962

M. P. WINTHER

3,050,647

LIQUID-COOLED ELECTRICAL MACHINES

Filed Aug. 10, 1960

FIG. 1.

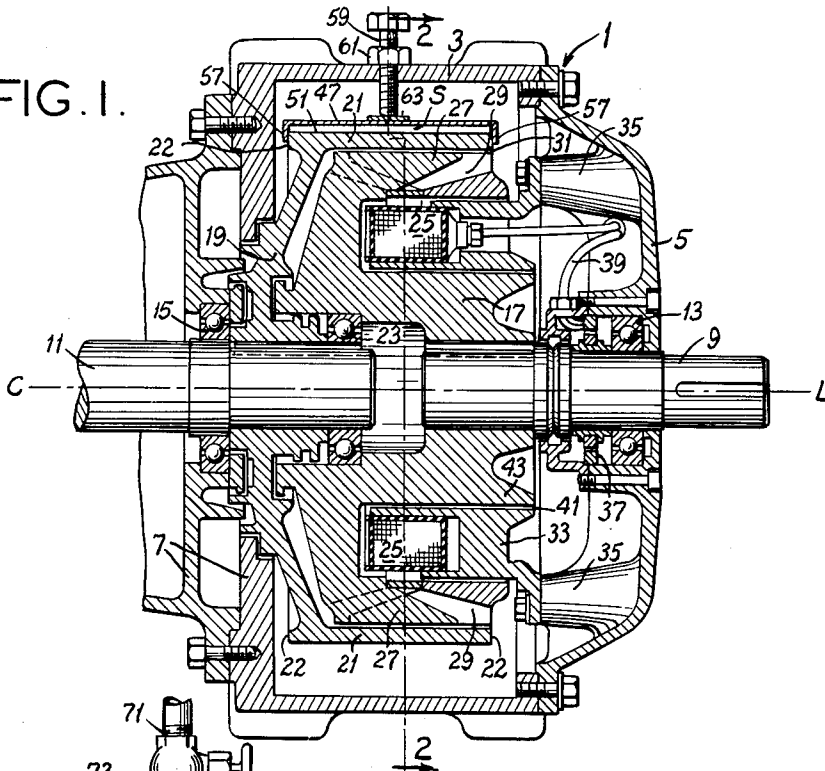
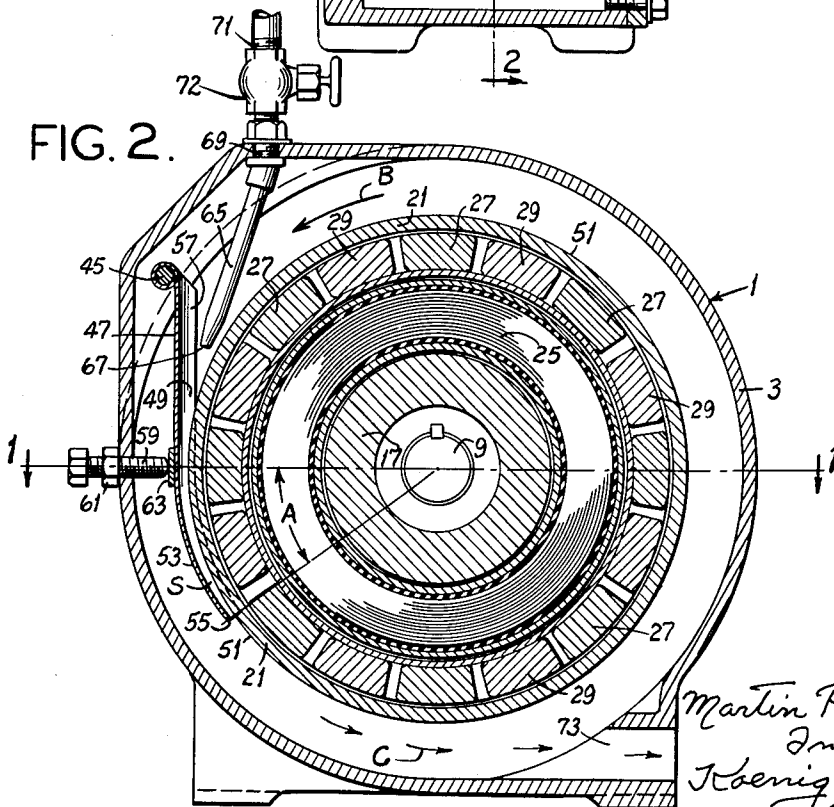


FIG. 2.



Martin P. Winther,
Inventor.
Koenig and Pope
Attorneys.

1

3,050,647

LIQUID-COOLED ELECTRICAL MACHINES

Martin P. Winther, 422 Lake Shore Drive, Clermont, Fla.

Filed Aug. 10, 1960, Ser. No. 48,753

8 Claims. (Cl. 310-105)

This invention relates to liquid-cooled electrical machines, and with regard to certain more specific features, to liquid-cooled drums for electrical machines such as eddy-current couplings and the like.

Among the several objects of the invention may be noted the provision of improved apparatus for bringing about engagement between a coolant such as water and a heated drum such as, for example, an eddy-current drum of an eddy-current electrical coupling; the provision of apparatus of the class described which will bring about efficient cooling of such a drum without any substantial hydraulic drag and so-called slugging effects of the coolant; the provision of apparatus of the class described which may be regulated for most efficient operation with a minimum of coolant used; and the provision of apparatus of the class described which is simple to construct and maintain. Other objects and features 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 which will be indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is an axial section of one form of electrical machine embodying the invention, being taken on line 1-1 of FIG. 2; and

FIG. 2 is a cross section taken on line 2-2 of FIG. 1. Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

As used hereinafter, the term "coolant" includes any appropriate liquid adapted to absorb heat, such as water or the like.

There are various types of electrical machines employing drums which become heated under load such as, for example, inductor drums of eddy-current couplings and the like. Sometimes these machines are constructed with their field poles inside the inductor drums. In such event, various cooling schemes have been employed, as for example, spraying water on the outside of the drum or introducing it in the magnetic gap between the poles and the inside of the drum.

A difficulty connected with spraying water on the outside of a drum is that at any one point it bounces off the surface of the drum after remaining thereon for only a short interval. Thus the water temperature is raised only a few degrees, resulting in inefficient abstraction of heat from the drum, and requiring a comparatively large amount of cooling water applied at many points. Introduction of water into the magnetic gap, on the other hand, causes parasitic drag and also so-called slugging of the coolant by the field poles, which results in erratic transmission of power between the driving and driven members connected to the field and drum. This erratic transmission interferes with smooth control of both speed and loads. By means of the present invention, drag and slugging conditions are entirely avoided and substantial

2

amounts of heat abstracted by comparatively small amounts of water applied to the outside of the drum.

Referring now more particularly to the drawings, there is shown at numeral 1 a substantially watertight casing composed of a central circular body 3 to which are attached enclosing end assemblies 5 and 7. At numerals 9 and 11 are shown driven and driving shafts, respectively. Shaft 9 is supported in bearings 13 in the end assembly 5. Shaft 11 is supported in bearings 15 in the end assembly 7. Keyed to the shaft 9 is a magnetizable polar field member 17. Keyed to the shaft 11 is a supporting hub part 19 of a magnetizable eddy-current drum or rotor 21. A pilot bearing 23 is employed between the field member 17 and the hub member 19.

On each side of the center line CL, the field member 17 is formed with a generally C-shaped cross section, providing an annular space encompassing a fixed annular field coil 25. The outer limb of the C-shape is formed with interdigitated ferromagnetic poles 27 and 29, the outer faces of which are cylindrically machined to provide a small magnetic gap 31 between them and the inner cylindrical surface of the drum 21.

The field coil 25 is supported upon a stationary annular projection 33, bolted to supports 35 extending inward from the end assembly 5. A small cylindrical magnetic gap 41 is formed between cylindrical portions 43 and 33 of the field member 17 and stationary member 33. Exciter circuit wiring for the coil 25 and a control tachometer generator 37 are shown at 39. The stator of the generator 37 is carried on the end assembly 5. Its rotor is carried by shaft 9.

When the coil 25 is electrically excited, a polarized field extends in the known manner from the poles 27 and 29 and into the drum 21. Upon relative movements between the poles 27, 29 and the drum 21, eddy currents are generated in the latter to produce a reactive magnetic field, which causes a magnetic drive with some controlled slip between the field member 17 and the drum 21. The eddy currents generate heat in the drum 21 which increases with slip and load. In order to abstract this heat, the construction according to the invention is employed.

A shaft 45 is supported crosswise in the member 3. A coolant chute or scoop 47 is pivoted on this shaft 45, having an inlet portion 49 which is arranged more or less tangentially to the outer cylindrical surface 51 of the drum 21. The chute also includes an eccentric curved portion 53 enveloping the drum 21. Its curvature is in the same general direction as that of the surface 51, except that from the tangential portion 49 to its lower lip 55 it gradually approaches the drum surface, as illustrated in FIG. 2. In any event, the concave side of the chute faces the convex side of the drum.

Marginally the chute 47 is provided with radial side flanges 57, which have a fairly close-running fit with respect to the radially faced ends 22 of the drum 21. Thus it will be seen that between the curved portion 53 of the chute 47, its marginal portions 57 and the outside 51 of the drum, there is formed an adjustable tapered funnel having rectangular cross sections which decrease in area in a downward direction. The funnel shape is subtended by an angle A, as illustrated in FIG. 2, the size of which is made appropriate to any given design. In general, the more heat to be abstracted, the greater should be the of the voltage-dropping resistor 9. The other end of the angle A. The inner side of the funnel as constituted by

the drum surface 51 moves downward, assuming drum rotation as shown by the arrow B in FIG. 2.

The chute 47 is backed by an adjusting screw 59, threaded through the member 3 and adapted to be held in any given adjusted position by a lock nut 61. This screw 59 engages a wear plate 63 on the back of the chute 47. By adjusting the screw 59, the areas of the cross sections of the curved portion of the chute may be adjusted. In general, the greater the amount of heat to be abstracted, the more the screw 59 is backed off to permit the chute to retract from the drum surface 51. On the other hand, it is not backed off sufficiently to allow coolant to bounce from the drum but to maintain a continuous interfacial contact therewith throughout angle A approximately.

At numeral 65 is shown a coolant inlet nozzle having an outlet 67 which is above the point of tangency of the chute 47 with respect to the drum surface 51. The nozzle is mounted on the casing 3, as shown at 69, and is connected with a coolant supply such as, for example, a water pipe 71. A control valve therefor is shown at 72.

Operation is as follows:

Assume that the drum 21 is rotating in the anticlockwise direction indicated by the arrow B in FIG. 2, and that sufficient water is flowing from the nozzle outlet 67. The water enters the tangential portion 49 of the chute and is directed along by the downward motion of the drum surface 51, being just maintained in contact therewith over angle A by the curved portion 53 of the chute. The chute 47 is so set by the screw 59 and the amount of water flowing from the nozzle 65 is so controlled at valve 72, that under prevailing load conditions a minimum amount of water is employed to transfer the amount of heat to the water abstract from the drum as is required to maintain the desired drum temperature. The adjustments are made so that an adequate amount of water is employed without building up an excessive head of water above the point of chute tangency 49. Thus the curved portion 53 of the chute 47 maintains the water for a substantial time just in contact with the drum surface 51 as it passes through angle A, without being bounced off from the drum surface. The water leaves the lower lip 55, as shown by the short darts C, being projected tangentially through an appropriately placed lower outlet 73 in the casing 1.

The curved tapered funnel-forming chute arrangement brings about a smooth contact action between the water and the outer surface of the drum, avoiding any slugging and concomitant drag or unsteadiness. Slugging and drag do not occur between the field member 17 and drum 51 because gaps 31 and 41 are substantially dry.

While a single nozzle 65 is illustrated, it will be apparent that a bank of such may be employed across the tangent inlet 49, the number depending upon the width of the drum 21, or a single transverse flat nozzle outlet may be employed. In general, the greater the amount of heat to be abstracted, the greater individually or in combination will be the flow of water, the angle A, and the adjusted cross sections of the curved throat of chute part 53. It is contemplated that adjustments will be of a range accommodating conditions corresponding to maximum allowable temperatures under full-load conditions.

It will be seen that the lower lip 55 is arranged just to clear the drum sufficiently that there is no undue water constriction during water movement through the wedging chute space.

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

As various 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 draw-

ings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Eddy-current electrical apparatus comprising an inner rotary polar field member, an outer rotary eddy-current drum surrounding said field member, said drum and field member being also relatively rotary, a coolant-confining chute adjacent the outside surface of said rotary drum, said chute having a tangential coolant inlet portion adjacent said outside drum surface and a curved portion extending from said tangential portion to a lip thereof adjacent the drum surface, said curved portion having a concave portion adjacent a convex portion of said drum surface, an a coolant inlet at said tangential inlet portion, said concave portion extending around the drum over a substantial angle but substantially less than 360°, whereby coolant is held by the chute against the drum over a substantial angular extent thereof without entirely surrounding the same while in contact.

2. Eddy-current electrical apparatus comprising an inner rotary polar field member, an outer relatively rotary eddy-current drum surrounding said field member, said drum having an exterior cylindrical surface, a pivoted coolant-confining chute adjacent the outside surface of said drum, the pivot axis being substantially parallel to the axis of rotation of the drum, said chute having a tangential coolant inlet portion adjacent said outside drum surface and a curved portion extending from said tangential portion to a lip thereof adjacent the drum surface, radial running fit means between the sides of the chute and the end portions of the drum, said curved portion of the chute having a concave extent adjacent and eccentric to a convex extent of said drum surface and forming therewith and with said running fit means a coolant path of diminishing substantially rectangular cross sections from the inlet portion to the lip, and a coolant inlet at said tangential inlet portion.

3. Eddy-current electrical apparatus according to claim 2, including adjusting means for changing the pivoted position of the chute relative to the drum, said running fit means accommodating adjustments by said adjusting means.

4. Eddy-current electrical apparatus comprising an inner rotary polar field member, an outer relatively rotary eddy-current drum surrounding said field member, a coolant-confining chute adjacent the outside surface of said drum, said chute having a tangential coolant inlet portion adjacent said outside drum surface and a curved portion extending from said tangential portion to a lip thereof adjacent the drum surface, said curved portion having a concave extent adjacent a convex extent of said drum surface, and a coolant inlet at said tangential inlet portion, said curved portion of the chute with the curved surface of the drum forming a wedge-shaped space gradually tapering from said tangential inlet portion to said lip, and a pivotal support for the chute located on the side of said tangential inlet portion which is opposite to the side of said tangential inlet portion from which extends the curved portion of the chute.

5. Eddy-current electrical apparatus comprising an inner rotary polar field member, an outer relatively rotary eddy-current drum surrounding said field member, a coolant-confining chute adjacent the outside surface of said drum, said chute having a tangential coolant inlet portion adjacent said outside drum surface and a curved portion extending from said tangential portion to a lip thereof adjacent the drum surface, said curved portion having a concave extent adjacent a convex extent of said drum surface, and a coolant inlet at said tangential inlet portion, said curved portion of the chute with the curved surface of the drum forming a wedge-shaped space gradually tapering from said tangential inlet portion to said lip, a pivotal support for the chute on one side of said tangential inlet portion, said side being opposite to the side of said tangential inlet portion from which extends

5

the curved portion of the chute, and means for adjusting the position of the chute around said pivotal support and relative to the drum surface.

6. Eddy-current electrical apparatus according to claim 5, including lateral enclosing means between the ends of the drum and the sides of the chute providing a small running fit therebetween in any adjusted chute position. 5

7. Eddy-current electrical apparatus according to claim 6, including valve control means for said coolant inlet.

8. Eddy-current electrical apparatus according to claim 10

6

7, including a substantially liquid-tight casing surrounding the drum and having an outlet adapted tangentially to receive water from the drum as it leaves the lip of the chute.

References Cited in the file of this patent

UNITED STATES PATENTS

2,100,716	Lipman	Nov. 30, 1937
2,541,227	Findley	Feb. 13, 1951

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,050,647

August 21, 1962

Martin P. Winther

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 64, strike out "of the voltage-dropping resistor 9. The other end of the"; column 4, line 14, for "an" read -- and --.

Signed and sealed this 11th day of December 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,050,647

August 21, 1962

Martin P. Winther

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 64, strike out "of the voltage-dropping resistor 9. The other end of the"; column 4, line 14, for "an" read -- and --.

Signed and sealed this 11th day of December 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents