

"DYNAMOELECTRIC MACHINES"

The present invention relates in general to dynamoelectric machines, such as electric motors and generators, and in particular to an improved lubricant slinger for controlling the flow of lubricant within
5 the motor.

One type of electric motor, for example, the 51 frame fan motor manufactured by the General Electric Co., employs a self-contained lubricating system, for lubricating the rotor shaft sleeve bearing and for
10 carrying heat out of the bearing. U.S. Patent 2,522,985 to Harl C. Bradley is an example of this type of motor.

The motor includes a reservoir located coaxially with the rotor shaft comprising a lubricant saturated
15 absorbent material, such as wool felt, and a wool felt wick which transfers the lubricant, such as an appropriate oil, to a spiral groove on the rotor shaft. As the shaft rotates, lubricant is drawn from the reservoir and pumped along the shaft to establish
20 a lubricant film between the shaft and sleeve bearing which rotatably supports it. Since the lubricant flows out of the end of the bearing, motors of this type are conventionally provided with a lubricant thrower or slinger in the form of an enlarged diameter
25 ring on the shaft which throws any lubricant which reaches the slinger radially outward into an enclosing oil well cover. In some cases, an annular splash wick is positioned within the oil cover so that lubricant thrown radially outward will be absorbed by
30 it and be conveyed more readily back to the reservoir through passages in the rotor supporting structure.

Although the previously used lubricant slinger has been effective in assisting in returning the lubricant back to the reservoir, some motors of this

type have been subject to sporadic lubricant leakage problems. The oil circulation path between the reservoir and end of the bearing can be effectively sealed in the rearward portion of the motor, but the
5 inner oil well cover is open on its forward end to permit passage of the rotor shaft therethrough. Since lubricant is thrown radially outwardly against the oil well cover, on some occasions, the lubricant tends to migrate forwardly beyond the slinger and out the
10 forward end of the oil cover where it is lost into the stator compartment. This not only results in a decrease in the lubricant available for circulation through the bearing, but the lubricant can begin to leak from the motor case.

15 It has been found that prior lubricant slingers, such as the enlarged rotor shaft slingers as shown in Patent 2,522,985 or the cylindrical oil slingers comprising a cylindrical washer-like element affixed to the rotor shaft, tend to throw the lubricant off in
20 a fanned out pattern. Although most of the lubricant is slung radially outward, a portion of the lubricant slung by the forward and rear edges of the prior slingers is thrown off at angles to the shaft axis such that the lubricant has forward and rearward,
25 respectively, components of velocity. Thus, the lubricant thrown off the forward edge of the slinger has a significant component of velocity towards the open end of the inner oil well cover, thereby contributing to the aforementioned migration of
30 lubricant out into the stator housing of the motor.

Motors of the type shown in Patent 2,522,985 are designed to be operated with the shaft horizontal, with the shaft vertical and the reservoir at the bottom, or any position inbetween. If the motor
35 becomes tilted such that the forward end of the shaft

at the opening in the inner oil well cover is lower than the end of the shaft in the reservoir, however, lubricant tends to pool at the open end of the inner oil well cover. This not only prevents the lubricant from being recirculated, but can increase the possibility of its being discharged through the forward opening in the inner oil well cover and thrown outwardly by the rotor.

The problem of oil leakage described above is not necessarily limited to the type of motor described in Patent 2,522,985. Other dynamoelectric machines, such as motors and generators, may exhibit similar problems where the oil being pumped between bearing surfaces tends to migrate out of a semi-sealed oil circulation system.

The oil leakage problems with prior art motors described above is overcome by an arrangement described in the present specification in which a lubricant slinger is configured such that it imparts an axial component of velocity in a direction generally toward the reservoir to lubricant which is thrown by the slinger. Although prior slingers may throw some of the lubricant with a relatively happenstance rearward component of axially velocity, the improved slinger described in the present specification provides a substantial and intentional rearward slinging action and substantially eliminates the throwing off of lubricant at an angle in the forward direction toward the opening in the inner oil well cover, and also blocks the migration of oil through the opening. The result produced by the improved slinger is that the lubricant thrown by the slinger is thrown either radially outwardly or rearwardly, but the forward throwing and forward migration of the lubricant in the same axial direction

as the lubricant is pumped through the bearing is blocked.

The tendency of the lubricant to migrate forwardly is further reduced by causing the lubricant to be thrown outwardly by the slinger at a point rearward, that is, back toward the reservoir, of the end of the bearing out of which the lubricant is pumped. Since the lubricant is initially slung at a point further back from the opening in the inner oil well cover and closer to the reservoir, the lubricant has a greater tendency to be returned to the reservoir rather than migrate out of the oil well cover opening. One way to accomplish this is to provide a cup-shaped slinger which overhangs the end of the bearing thereby providing a rearward flow path for the lubricant pumped out of the bearing until it is thrown outwardly off the rearwardly facing edge of the slinger.

In a preferred form of the slinger, the outer peripheral surface of the cup-shaped portion is provided with a vane which is pitched in a direction to impart a rearward component of velocity to the lubricant to enhance the migration of the lubricant back toward the reservoir. This vane may take the form of a single or multiple turn spiral flight, a plurality of angled blades, or other structure which provides the desired rearward impelling of the lubricant. The combination of throwing the lubricant outwardly at a point rearwardly of the end of the bearing together with the axial impeller structure on the slinger greatly reduces the tendency of the lubricant to migrate forwardly out of the oil well cover opening, thereby preventing loss of lubricant from the lubricant recirculation system of the motor.

The tendency of lubricant to collect or pool in the forward end of the inner oil well cover when the

motor is slightly tilted with its forward end lower than its rear end is overcome by providing an inner oil well cover which is tapered such that it diverges in the rearward direction toward the lubricant reservoir. When the motor is operated with its shaft horizontal, the tapered oil cover presents a lower surface which is sloped toward the reservoir so that lubricant flows by gravity back through the openings in the motor case to the reservoir. Even if the motor should be tilted slightly such that its forward end is lower than its rear end, the tapered oil cover will provide some degree of compensation for the improper orientation of the motor and avoid the pooling effect described above.

The slinger also serves as the thrust washer for the rotor. The slinger is pressed onto a brass sleeve on the rotor shaft thereby providing a seal which prevents the flow of lubricant along the shaft and through the slinger so that all the lubricant will be thrown outwardly by the slinger. The fact that the rotor sleeve is pressed within a cylindrical rim portion of the slinger results in a seal around a cylindrical surface rather than on a flat face, as is the case with prior slingers, and produces a better seal against the axial flow of lubricant along the shaft.

Automated assembly of the motor is enhanced by providing radial clearance between the cup-shaped portion of the slinger and the end of the sleeve bearing and between the central opening in the slinger and the rotor shaft. In carrying out one preferred method, the cup portion of the slinger is placed over the end of the sleeve bearing, the rotor shaft is then inserted through the slinger and into the bearing, and when the enlarged brass sleeve on the rotor shaft

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contacts the trailing edge of the slinger, it is able
center the slinger on the shaft by virtue of the
aforementioned radial clearances. Continued axial
movement of the rotor sleeve presses it into the
5 slinger thereby frictionally connecting the slinger
and rotor and providing a seal against the flow of oil
between the slinger and rotor sleeve. The edges of
the slinger and rotor sleeve are preferably tapered to
assist the centering of the slinger on the shaft and
10 bearing.

According to a first aspect of the present
invention there is provided a dynamoelectric machine
comprising: a case; a stator and rotor in the case; a
bearing connected to the case; a shaft connected to
15 the rotor and being rotatably received in said
bearing; said shaft extending out of one end of said
bearing; a lubricant reservoir; means associated with
said shaft for pumping lubricant from said reservoir
axially forward along said shaft between said shaft
20 and bearing and out said one end of said bearing; an
oil slinger connected to said shaft and rotated
thereby and including surface means circumferentially
disposed around and radially spaced from an end
portion of said bearing including said one end for
25 slinging radially outward from said shaft at a
position axially rearward of said bearing one end
lubricant pumped out of said bearing one end.

According to a second aspect of the invention
there is provided a dynamoelectric machine comprising:
30 a case; a stator and rotor in the case; a bearing
connected to said case; a shaft connected to said
rotor and being rotatably received in said bearing,
said shaft extending out of one end of said bearing; a
lubricant reservoir; means associated with said shaft
35 for pumping lubricant from said reservoir axially

forward along said shaft between said shaft and bearing and out of said one end of said bearing; and oil slinger means connected to said shaft and rotated thereby including an annular cup portion overhanging and radially spaced from an end portion of said bearing including said bearing one end and a portion of said bearing rearwardly adjacent said one end.

According to a third aspect of the invention there is provided a method of assembling a rotor assembly in a dynamoelectric machine comprising: providing a case having a sleeve bearing thereon; providing an oil slinger having a cylindrical cup portion, a central opening, and an annular rim having a trailing edge; providing a rotor including a shaft having a diameter smaller than the slinger central opening and a slinger seat coaxial with the shaft and having a leading edge; placing the cup portion of the slinger over an end portion of the sleeve bearing such that the cup portion surrounds the bearing end portion, there being radial clearance between the bearing end portion and cup portion; placing an inner oil cover over the oil slinger and connecting the oil cover to said case; inserting the rotor shaft through an opening in the oil cover, through the central opening in the oil slinger and into the sleeve bearing; continuing to insert the shaft into the bearing to cause the seat leading edge to contact the oil slinger rim trailing edge and center the oil slinger in the shaft; and then press fitting the seat into the slinger rim.

In the dynamoelectric machine embodying the invention and described herein, migration of lubricant in a direction away from the reservoir is impeded once the lubricant has been pumped out of the bearing, and a rearward axial velocity is imparted to droplets of

lubricant slung outwardly by the slinger, the droplets being impelled rearwardly through contact with a moving pitched vane or the like. The lubricant is thrown outwardly at a point rearward of the end of the bearing thereby further reducing the tendency of the lubricant to migrate out of the forward end of the semi-sealed lubricant circulation chamber.

The method for assembling the rotor and oil slinger assembly also facilitates the use of automatic assembly equipment.

In the accompanying drawings, by way of example only:

Figure 1 is a sectional view of an electric motor including one form of the present invention;

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Figure 2 is an enlarged top view of the lubricant slinger in accordance with the embodiment of the invention shown in Figure 1;

10 Figure 3 is a sectional view of Figure 2 taken along line 3-3 and viewed in the direction of the arrows;

Figure 4 is a side elevational view of the lubricant slinger of Figure 2; and

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Figure 5 is an enlarged perspective view illustrating the assembly of the rotor, oil well cover, slinger and motor case of the embodiment shown in Figure 1.

20 Referring now to the drawings, and in particular to Figure 1, rotor 10 comprises case 12 having a cast_____

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iron or cast aluminum casing 14, a steel winding cover 16 and a steel oil reservoir cover 18. Disposed within case 12 are stator laminations 20, which have molded thereon polyester ground insulation 22.

5 Stator windings 24 are wound on ground insulation 22, and winding cover 16 is sealingly connected to laminations 20 by means of a suitable adhesive. Paper-Mylar insulation 26 and 28 can be placed within case 12, if desired.

10 Oil reservoir 30 is formed between oil cover 18, which is sealingly connected to rim 32 on casing 14, and flange portion 34 of casing 14. Annular wool-felt wicks 36 and 38 are disposed within reservoir 30, and function to absorb and retain the lubricant
15 for motor 10, such as an appropriate motor oil. A finer texture wick 40, which is also annular in shape, is in contact with wick 38 and its annular surface 42 is in contact with rotor shaft 44.

Rotor 46 comprises a cast aluminum hub portion
20 48 that is cast around brass sleeve 50, the latter including longitudinal knurls 52 and ring knurls 54. Shaft 44 is press fit into brass sleeve 50, and both shaft 44 and the end of rotor 46 extend outwardly through opening 56 in winding cover 16 such that
25 shaft 44 can be connected to a suitable load, such as a fan for cooling condenser and evaporator coils in a refrigeration system. End rings 56 and 60 and rotor hub 48 are die cast around rotor laminations 64.

Casing 14 comprises sleeve bearing 66, which
30 includes an annular portion 68 integral with casing

14, and a steel backed babbitt sleeve 70 press fit within portion 68 and machined out to size. Alternatively, sleeve 70 could be a sintered iron, cast iron or aluminum sleeve. Shaft 44 is rotatably received within bearing 66 and held in place, with a degree of axial freedom of movement, by a retainer washer 77 or other suitable connector.

The rear portion 74 of shaft 44 has an outer diameter slightly less than the inner diameter of bearing 66 and is provided with a helical groove 76, and undercut relief groove 78, and has a forward portion 80, which also has a diameter slightly less than the inner diameter of bearing 66. As shown, the portion 80 of shaft 44 extends out of the forward end 82 of bearing 66. The terms "forward" and "rearward" as used herein are for the purpose of explanation and to orient the direction of oil flow when motor 10 is operating. The rearward direction is the axial direction toward reservoir 30 and the forward direction is the axial direction away from reservoir 30. As shaft 44 is rotated by rotor 46 in the counter clockwise direction as viewed from the right end of the motor in Figure 1, helical groove 76 picks up lubricant from wick 40 and carries it forwardly along shaft 44 thereby establishing a lubricant film between portions 74, 78 and 80 of shaft 44 and the inner surface 86 of bearing 66. Oil is pumped forwardly out of the forward end 82 of bearing 66 as illustrated by the arrows 87 in Figure 1, and returns to reservoir 30 through four openings 88 in casing 14, as is customary in motors of this type.

Lubricant slinger 90 is press fit on an enlarged seat portion 92 of brass sleeve 50 and is located immediately adjacent forward end 82 of bearing 66. With reference now to Figures 2, 3 and 4, lubricant
5 slinger 90 will be described in detail. Lubricant slinger 90, which may be made of a NYLATRON material, VALOX, nylon or various rubber compounds, is of one piece molded construction and comprises a generally cylindrical cup-shaped portion 94, a generally
10 cylindrical rim portion 96 and a center portion 98 having an opening 100 therethrough. Rim portion 96 has a diameter which is just slightly less than the diameter of seat portion 92 (Figure 1) to enable seat portion 92 to be press fit against the cylindrical
15 inner surface 102 thereof, and includes an inwardly tapered surface 104 on its trailing edge 106, which cooperates with the tapered leading edge 108 on seat 92 to assist in centering lubricant slinger 90 on shaft 44 and 66 as will be described hereinafter.
20 Opening 100 has an inner diameter that is larger than the outer diameter of shaft 44, again for the purpose of alignment and automatic assembly.

The outer peripheral surface 110 of cup portion 94 has upstanding therefrom a single helical vane 112
25 that is just slightly less than 360° in length, thereby enabling easier molding of the part. Vane 112 includes a rearwardly facing throwing surface 114 which is pitched with a lead of approximately five turns per inch, although the pitch is not particu-
30 larly critical as long as it is pitched in a direction such that lubricant is thrown rearwardly when rotor 46 is rotated in its normal direction.

Obviously, oppositely pitched vanes would be used for motors having a reverse direction of rotation. Cup portion 94 includes a tapered inner surface 116 to assist in the rearward travel of lubricant, as will be described hereinafter. Furthermore, since slinger 90 also functions as a thrust washer against the end 82 of bearing 66, it is provided with a plurality of oil relief grooves 118 in its rearwardly facing surface 120, as is the case with prior art slingers.

As lubricant slinger 90 is rotated by shaft 44, oil which is pumped out of the end 82 of bearing 66 contacts surface 120 of slinger 190, and due to the centrifugal forces caused by rotating slinger 90, the lubricant is forced radially outwardly against tapered inner cylindrical surface 116 where it is caused to flow rearwardly until it reaches edge 122 of cup portion 94. At this point, it is thrown radially outward as indicated by arrows 124 against the inner surface 126 of tapered inner oil well cover 128, which is sealingly connected to shoulder 68 on casing 14. Many of the oil droplets which are thrown against inner surface 126 are caused to splash back where they will be contacted by rotating pitched vane 112 which, due to the angle of its pitch, will impel the droplets rearwardly toward reservoir 30. Additionally, any oil which travels along the outer peripheral surface 110 of slinger 90 will likewise be contacted by vane 112 and impelled rearwardly.

The effect of the impeller comprising vane 112 is to prevent the lubricant from migrating forwardly and out of the opening 132 in the forward end 134 of inner oil well cover 128 through which rotor shaft 44

and brass sleeve 50 extend. If lubricant were permitted to migrate out of opening 132, it would be thrown outwardly by rotor 46 and be lost within the stator chamber.

5 Because inner oil well cover 128 is tapered, oil which settles in the lower portion thereof will be caused to flow by gravity back toward reservoir 30, and this will occur even if motor 10 should be tilted slightly forwardly, thereby preventing pooling of
10 lubricant within the forward portion of oil well cover 128.

 The droplets of oil which are contacted by rotating vane 112 will typically be impelled rearwardly in a direction which has both a rearward axial
15 component of velocity as well as a radial component of velocity, the latter due to centrifugal forces produced by rotating slinger 90. The net result is that oil is thrown in a direction generally opposite opening 132 such that it has an axial component of
20 velocity which is in a direction opposite the axial flow of pumping along shaft 44. The oil seal between seat 92 pressed within the rim portion 96 of slinger 90 prevents oil from migrating forwardly past this point.

25 Inner oil well cover 128 extends forwardly past the forward end of oil slinger 90 and includes an inwardly extending flange 135. Due to the tapered shape of oil cover 128 which diverges in the rearward direction, no splash oil wick is necessary in the
30 forward portion of inner oil well cover 128, as is typically used in many prior art motors of this type.

The height of vane 112 is not critical, although it has been found that the higher vane 112 is, the better will be the rearward impelling action.

Clearance between vane 112 and the inner surface 126 of cover 128 is the limiting constraint, however. As was indicated earlier, vane 112 could be of multiple turns, although a single turn slightly less than 360° is preferred because of the ease in molding. Alternatively, a plurality of pitched impeller blades or other structure which produces a rearward impelling action when rotated could be utilized.

With reference to Figures 1 and 8, a method for assembling the preferred embodiment illustrated in Figure 1 is illustrated. This assembly can be accomplished by automatic machinery (not shown), thereby reducing the cost and time of manufacture.

Motor casing 14 is oriented such that bearing 66 is vertical and lubricant slinger 90 is placed on the forward end 82 of bearing 66 such that cup portion 94 surrounds the forward end portion 140 of bearing 66. Since the inner diameter of slinger cup portion 94 is larger than the outer diameter of bearing forward end portion 40, there is clearance between oil slinger 90 and bearing forward portion 140 thereby enabling slinger 90 to "float" thereon. Next, inner oil well cover 128 is lowered over slinger 90 and bearing 66 and seated against shoulder 68 on casing 14. A suitable adhesive, such as a silicon compound, can be used to provide a fluid-tight seal between oil well cover 128 and shoulder 68.

Next, rotor 124 is lowered over inner oil well cover 128 and shaft 44 is inserted into opening 86 in

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bearing 66. As the tapered leading edge 108 of rotor seat 92 contacts tapered trailing edge 92 of slinger rim portion 96, slinger 90 will be centered on bearing 66 and shaft 44 because the outer diameter of shaft 44 is smaller than the inner diameter of slinger opening 100, as is apparent from Figure 1. Once slinger 90 has been centered due to the camming action between tapered surfaces 104 and 108, continued downward movement of rotor 46 will press seat 92 into frictional engagement with the inner cylindrical wall 102 of slinger 90, thereby frictionally connecting slinger 90 to rotor 46. Attachment of push fastener 72 (Figure 1) on the rear end 144 of shaft 44 locks the rotor assembly to casing 14. Axial movement of shaft 44 in the rearward direction is limited by the abutment of the thrust face 120 of slinger 90 against end 82 of bearing 66. When stator windings 24 are activated, magnetic forces align rotor laminations 64 with stator laminations 20 to the position shown in Figure 1.

The automatic centering of slinger 90 enables the use a automatic machinery rotatably difficult to consistently align rotor shaft 44 with the center of opening 100 in slinger 90. Because of the radial clearance between slinger 90 and bearing 66 and shaft 44, even though shaft 44 enters opening 100 in slinger 90 off the true center, the camming action will radially align slinger 90 and enable the press fit between seat 92 and rim portion 96.

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Having regard to the provisions of Rule 24(2) of the Patent Rules, reference is hereby directed to our copending application 8504247 (2,155,119A).



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CLAIMS

1. A dynamoelectric machine comprising: a case; a stator and rotor in the case; a bearing connected to the case; a shaft connected to the rotor and being rotatably received in said bearing, said shaft
5 extending out of one end of said bearing; a lubricant reservoir; means associated with said shaft for pumping lubricant from said reservoir axially forward along said shaft between said shaft and bearing and out said one end of said bearing; an oil slinger
10 connected to said shaft and rotated thereby and including surface means circumferentially disposed around and radially spaced from an end portion of said bearing including said one end for slinging radially outward from said shaft at a position axially rearward
15 of said bearing one end lubricant pumped out of said bearing one end.
2. A machine according to claim 1 wherein said surface means comprises an annular portion of said slinger concentric with and radially spaced from said
20 bearing end portion, said annular portion being open in a rearward facing direction.
3. A machine according to claim 1 wherein said surface means comprises a rearwardly facing cylindrical cup portion having a rim spaced rearwardly
25 of said bearing one end.
4. A dynamoelectric machine comprising: a case; a stator and rotor in the case; a bearing connected to said case; a shaft connected to said rotor and being rotatably received in said bearing, said shaft
30 extending out of one end of said bearing; a lubricant reservoir; means associated with said shaft for pumping lubricant from said reservoir axially forward along said shaft between said shaft and bearing and

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out of said one end of said bearing; and oil slinger means connected to said shaft and rotated thereby including an annular cup portion overhanging and radially spaced from an end portion of said bearing including said bearing one end and a portion of said bearing rearwardly adjacent said one end.

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5. A machine according to claim 4 wherein said slinger means includes a forward end portion sealingly connected to said shaft, and said cup portion is a rear portion of said slinger means and terminates in a rim disposed rearwardly of said bearing one end.

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6. A method of assembling a rotor assembly in a dynamoelectric machine comprising: providing a case having a sleeve bearing thereon; providing an oil slinger having a cylindrical cup portion, a central opening, and an annular rim having a trailing edge; providing a rotor including a shaft having a diameter smaller than the slinger central opening and a slinger seat coaxial with the shaft and having a leading edge; placing the cup portion of the slinger over an end portion of the sleeve bearing such that the cup portion surrounds the bearing end portion, there being radial clearance between the bearing end portion and cup portion; placing an inner oil cover over the oil slinger and connecting the oil cover to said case; inserting the rotor shaft through an opening in the oil cover, through the central opening in the oil slinger and into the sleeve bearing; continuing to insert the shaft into the bearing to cause the seat leading edge to contact the oil slinger rim trailing edge and center the oil slinger in the shaft; and then press fitting the seat into the slinger rim.

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7. A method according to claim 6 wherein the annular rim trailing edge includes an inwardly tapered inner surface and the seat leading edge is tapered,



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and wherein the step of centering the oil slinger includes camming the seat leading edge against the slinger tapered inner surface.

- 5 8. A method according to claim 6 wherein the seat seals against a cylindrical inner surface of the slinger rim.
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