

May 27, 1958

F. O. LUENBERGER
SYSTEM FOR COOLING LUBRICANT

2,836,471

Filed July 16, 1954

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Fig. 1.

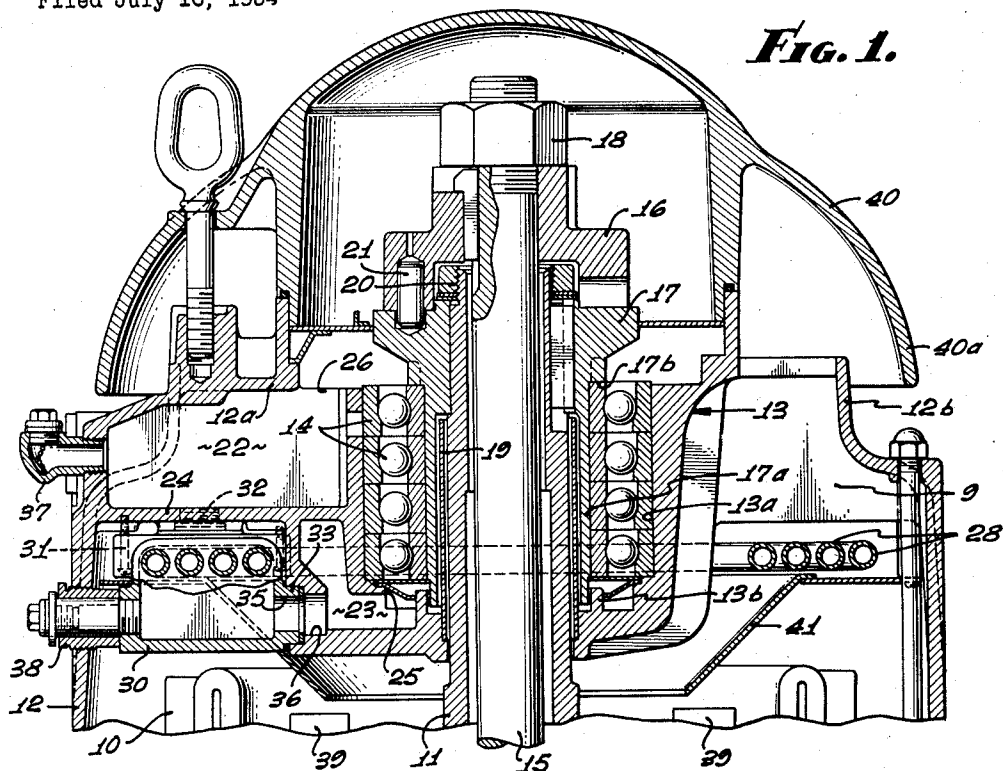
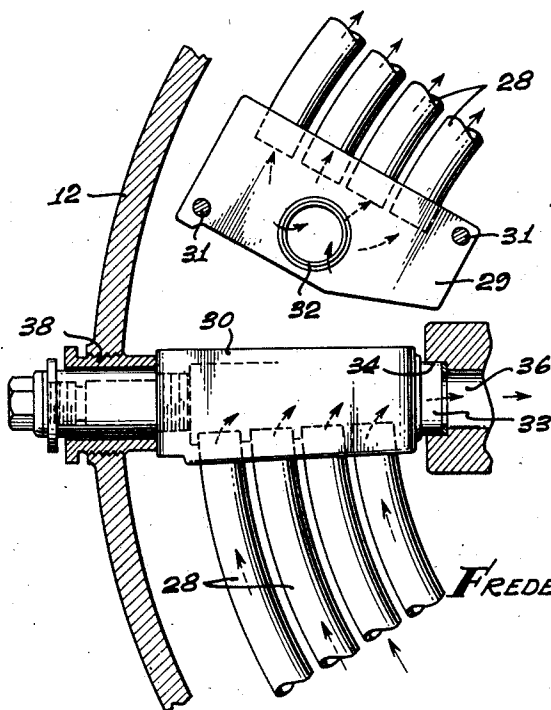


Fig. 2.



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Fig. 3.

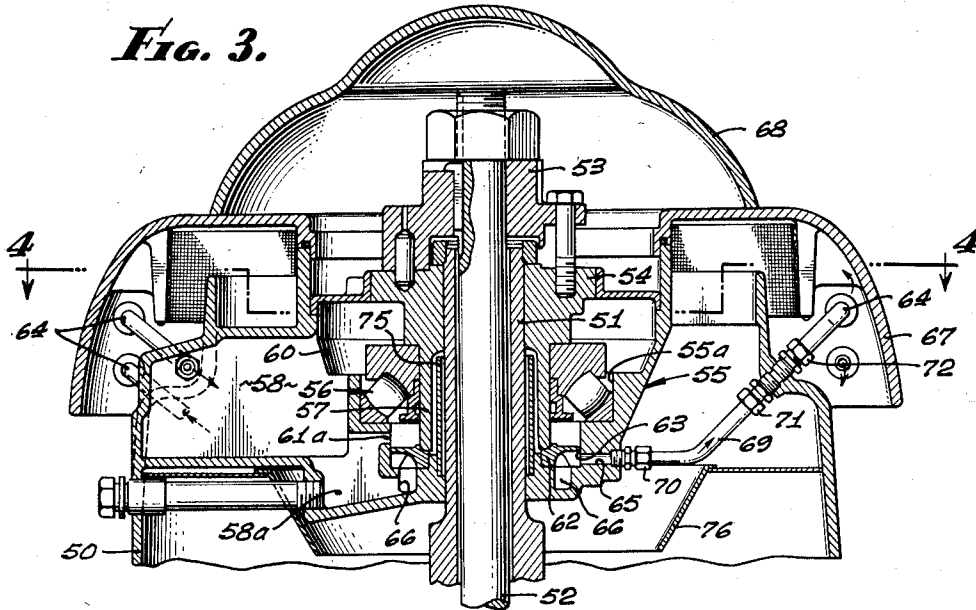
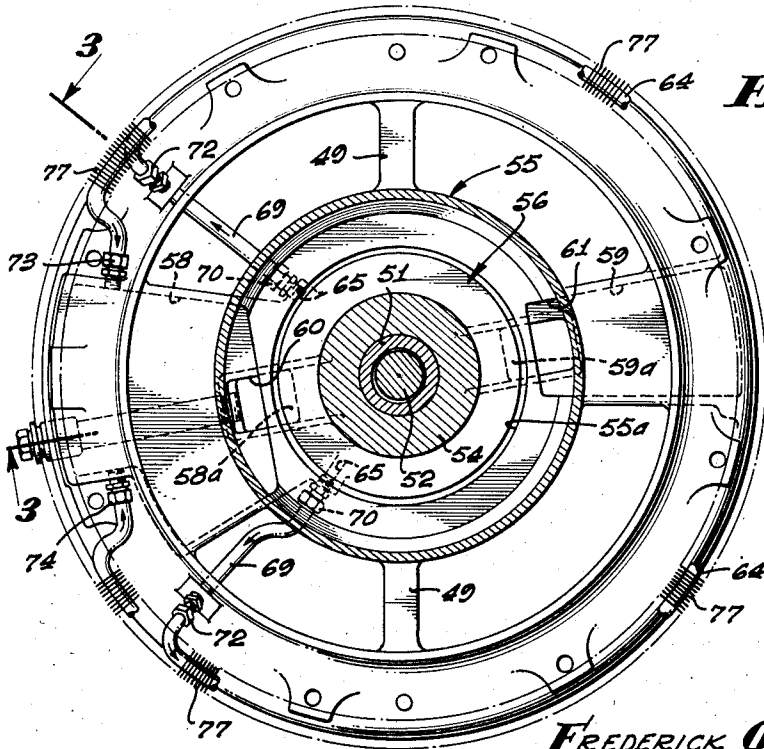


Fig. 4.



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Fig. 5.

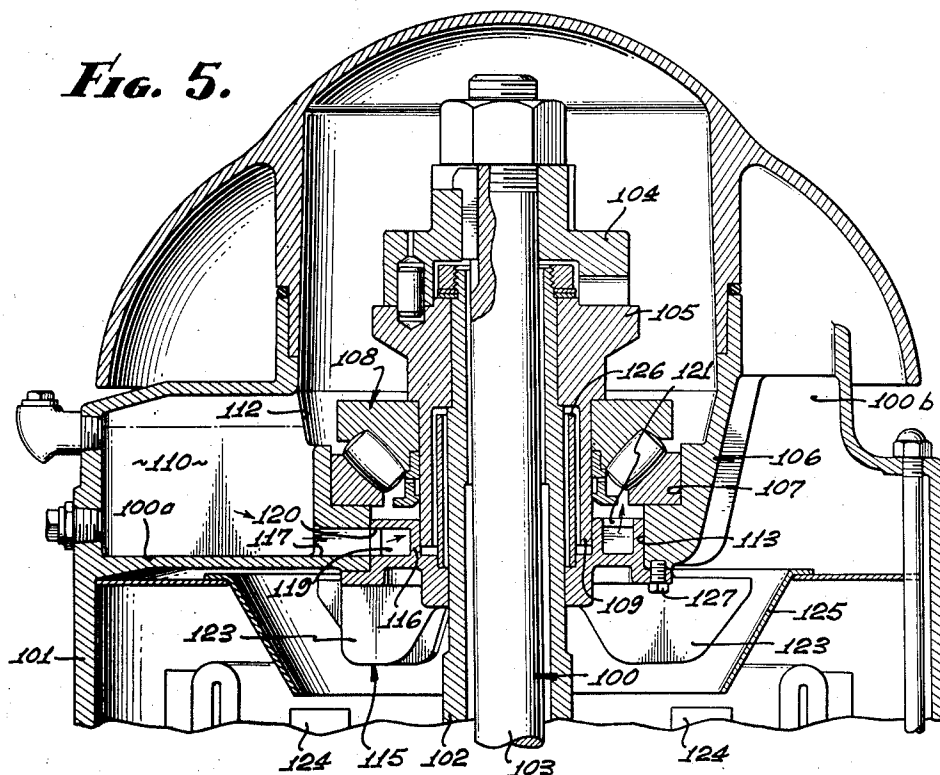
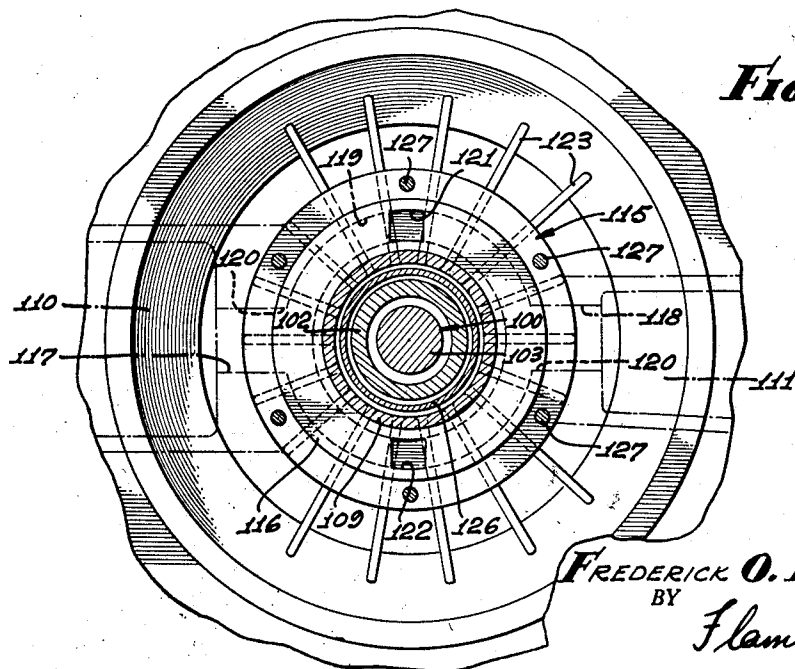


Fig. 6.



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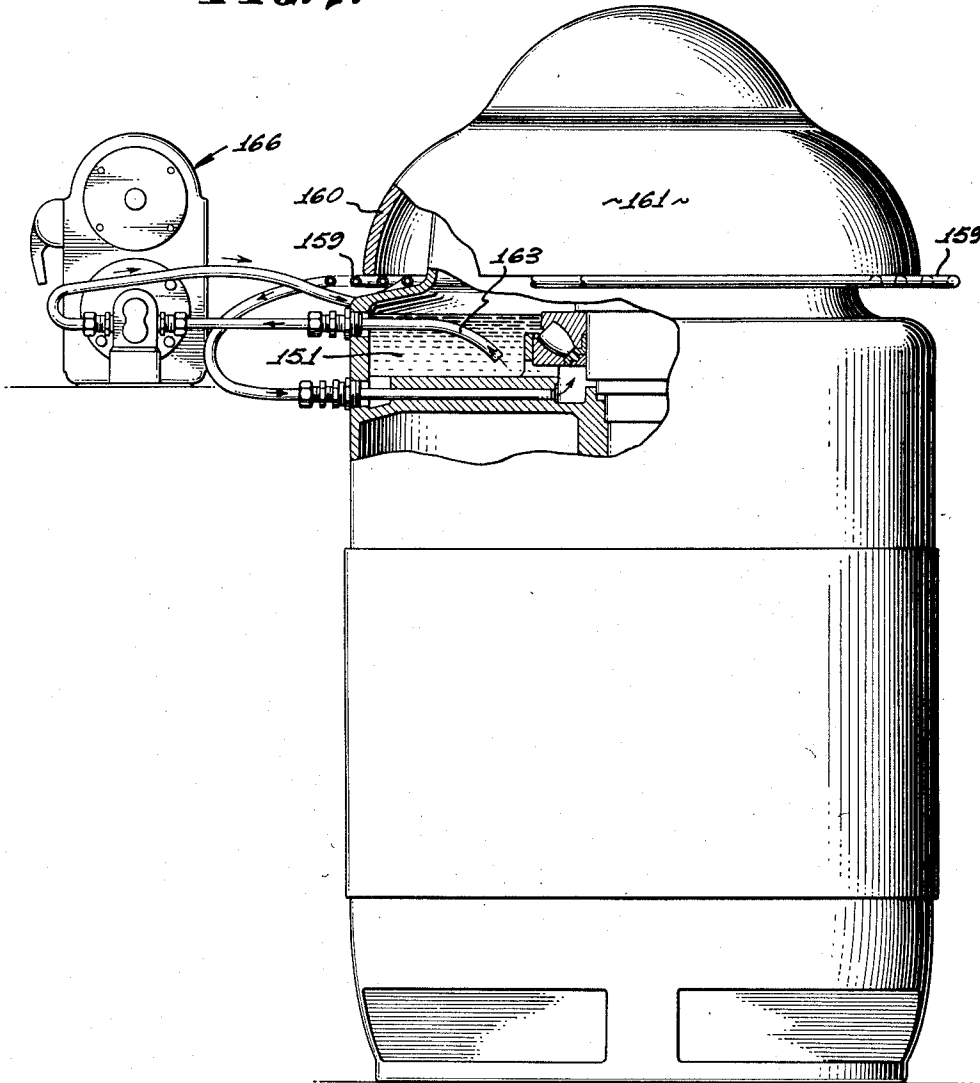
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Fig. 7.



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SYSTEM FOR COOLING LUBRICANT

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Application July 16, 1954, Serial No. 443,756

7 Claims. (Cl. 308—77)

This invention relates to a lubricating system and apparatus for bearings of rotary machines, such as electric motors, with particular application to the cooling of the lubricant.

It is an object of this invention to provide improved means for cooling lubricant, incorporating radiator coils, or a heat conducting finned reservoir member appropriately located for transfer of heat to the ambient medium.

In some embodiments of the invention, use is made of an air stream created by a rotary fan carried by the rotary device.

It is another object of this invention to provide an electric motor or the like compactly incorporating heat radiating means for a lubricant reservoir.

It is still another object of this invention to make use of the normal thermal circulation of lubricant, the lubricant circulating through an appropriate heat radiating member prior to passing to the bearings. Effective cooling is thereby provided by forming a definite circulating path for the lubricant.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of the upper portion of a vertical electric motor incorporating the present invention;

Fig. 2 is an enlarged fragmentary sectional view, taken along a plane transverse to the motor;

Fig. 3 is a sectional view similar to Fig. 1, taken along a plane corresponding to line 3—3 of Fig. 4, and showing a modified form of the present invention;

Fig. 4 is a sectional view of the embodiment of Fig. 3, the cap of the housing being omitted, the view being taken along a plane indicated by line 4—4 of Fig. 3;

Figs. 5 and 6 are views respectively similar to Figs. 3 and 4, showing a further modified form of the present invention, Fig. 6 being reduced; and

Fig. 7 is a diagrammatic view showing a further modified form of the present invention.

In Figs. 1 and 2 there is shown the upper portion of a vertical electric motor. Supported within the motor casing frame 12 is a stator structure 10, and a rotor mounted upon a hollow shaft 11.

The shaft 11 extends upwardly beyond the upper opening of the casing 12. It also extends axially through the bearing cup 13. This bearing cup 13 is supported by a plurality of ribs or spokes 9 extending inwardly from the casing. The ribs 9 together provide a web located near the top of the casing 12, the web having openings.

The bottom of the cup 13 provides a reduced annular recess 13a for the accommodation of a plurality of vertically arranged ball bearing structures 14.

Juxtaposed coupling members 16 and 17 serve to interconnect a load shaft 15 with the hollow rotor shaft 11. This load shaft 15 is telescopically received in and extends upwardly beyond the hollow rotor shaft 11; it may extend downwardly in a well for operating a pump or other load. The upper coupling members 16 and 17 are respectively spline connected to the load shaft 15 and rotor shaft 11.

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The bearing structures 14 are interposed between the member 17 and cup 13.

The coupling members 16 and 17, in turn, are rotatably coupled by pins 21.

Nuts 18 and 20, respectively carried by the load shaft 15 and rotor shaft 11, engage the upper and lower coupling members 16 and 17 to limit downward movement of the shafts.

The lower coupling member 17, rotary with the shafts 11 and 15, has an annular extension 17a piloted at its lower end by an annular wall 13b at the bottom of the cup recess 13a. A shoulder 17b defining the extension 17a rests upon the inner race of the uppermost bearing structure 14.

A wall 24 of the casing 12 forms the lower wall of an upper lubricant well or reservoir 22 adjoining the cup 13. The well 22 is protected by an overhanging wall 12a of the casing 12. This well extends for a substantial angle around the cup 13.

The wall 24 also forms a lower chamber 23 beneath the well 22 adjoining the lower portion of the cup 13. These wells are separated by the wall 24. The chamber 23 communicated with an annular groove 25 at the bottom of the cup recess 13a, the annular groove 25 extending immediately beneath the lowermost bearing 14. Lubricant from the chamber 23 may pass upwardly through the stacked bearing structures 14. Lubricant is also intended to pass over the upper edge of the cup recess 13a through an opening 26 connecting the upper well 22 with the cup 13.

Since heated lubricant rises, a natural circulation of lubricant is established from the lower chamber 23 to the upper lubricant well 22 via the opening 26.

The lower chamber 23 receives lubricant from the upper well 22 via a series of concentric cooling coils 28. These cooling coils 28 extend beneath the web, and substantially encircle, with substantial clearance, the lower portion of the cup 13. The clockwise end of each of the coils, as viewed in Fig. 2, communicates with and is supported by an inlet manifold structure 29. The counter-clockwisemost end of each coil communicates with and is supported by an outlet manifold structure 30.

These manifolds 29 and 30 are quite closely spaced angularly from each other. The manifold 29 is secured in place beneath the wall 24 as by the aid of machine screws 31. This manifold 29 is in communication with the upper lubricant well 22 via appropriately aligned ports in the wall 24 and the manifold 29. An appropriate fitting 32 establishes a fluid-tight connection.

The manifold 30 is secured in place immediately radially outwardly of the lower chamber 23. The manifold 30 has a cylindrical extension 33 fitting a corresponding recess 34 in the outer wall bounding the chamber 23. Ports 35 and 36 in the extension 33 and the chamber wall establish communication between the manifold 30 and the chamber 23.

The circulation path for lubricant is thus completed from the well 22, through the fitting 32, into intake manifold 29, thence through the substantially circularly extending cooling coils 28, to the outlet manifold 30, extension 33, port 36, and well 23. Thence the oil, as heretofore stated, is discharged through the bearing structures 14 into well 22.

A normally capped fitting 37, carried by the casing 12, serves as a means whereby lubricant may be introduced into the system. The fitting 37 registers with the well 22. A normally capped drain fitting 38 cooperates with the outlet manifold 30 in order to drain lubricant from the system.

Cooling air passes upwardly and about the coils 28, thereby maintaining the lubricant cool. To create an

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appropriate current of air, the rotor carries a plurality of fan blades 39 that urge air upwardly through the open spaces of the web. A bell cap cover 40, secured in place upon the casing 12, has a flange 40a extending, with substantial clearance, about the inwardly flared upper end 12b of the casing 12. The cover 40 deflects the air downwardly as it issues from the casing. A conical deflector 41 within the casing 12 guides the air past the cooling coils 23.

A sleeve 19, extending upwardly from the bottom of the cup 13, and between the rotor shaft 11 and extension 17a, ensures against passage of lubricant axially downwardly along the rotor shaft 11.

An efficient self-contained cooling system for the lubricant is provided, ensuring proper operation of the rotary structure.

In the form shown in Figs. 3 and 4, the same general arrangement is provided. A rotor (not shown), supported within a casing 50, has a hollow shaft 51 projecting upwardly through a cup structure 55 supported by ribs 49 at the top of the casing 50. A load shaft 52 is rotatably coupled to the rotor shaft 51 by the aid of coupling members 53 and 54. The cup 55 provides near its lower end a bearing recess 55a in which a bearing structure 56 may be seated. The lower coupling member 54, as in the previous form, has an extension 57 upon which the inner race of bearing structure 56 is mounted.

Two diametrically oppositely disposed lubricant wells 58 and 59 are formed between the cup structure 55 and the casing 50. These wells are protected by overhanging walls of the casing 50. These wells communicate with the interior of the cup 55 beneath the top of the cup 55 through openings 60 and 61 (see also Fig. 4) located at the upper edge of the cylindrical recess 55a that accommodates the outer race of bearing structure 56.

Lubricant from the wells 58 and 59 can flow into the upper portion of a reduced recess 63 in the cup 53 located immediately beneath the bearing recess 55a. Passage of lubricant from the wells 58 and 59 to the reduced recess 63 is provided through sunken portions 58a and 59a of the wells. Ports, such as 61a, connect the sunken portions 58a and 59a with the reduced recess 63. Lubricant from the reduced recess 63 may pass upwardly through the bearing 56.

The lower terminal portion of the coupling member extension 57 mounts an impeller 62 accommodated in the lower portion of the reduced recess 63. The impeller 62 urges lubricant into parallel cooling coils 64 (two in this instance) via transverse passages 65 forming outlets from the impeller pump structure. Lubricant passes to the impeller 62 through passages 66 communicating with the sunken portions 58a and 59a of the recesses.

The passage 61a to the bearing structure 56 opens above the impeller 62 for direct passage of lubricant to the bearing structure 56. Lubricant from the passages such as 66, paralleling the bearing supply passage 61, provides inlets for the impeller.

The cooling coils 64 are supported by webs within the flange 67 of a bell cover 68 and extend circularly thereabout. Conduits 69 connect the impeller outlet passages 65 with the cooling coils 64. Appropriate fittings 70, 71 and 72 are provided for making these connections. Radiating fins 77 are provided over the entire length of the coils 64.

Lubricant, after passing through the coils 64, re-enters the lubricant well 58 through fittings 73 and 74. These fittings 73 and 74 cooperate with transverse openings in the walls of the web defining the lubricant well 58.

Lubricant circulates from the wells 58 and 59 through the bearing structure 56 and thence back to the wells. Lubricant also is circulated by the pump or impeller 62 from the well 58, through the cooling coils 64, back to the well 58.

A sleeve 75, projecting upwardly from the bottom of the cup, extends, with clearance, between the coupling

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member extension 57 and the rotor shaft 51 to prevent passage of oil axially downwardly of the shaft 51. The normal level of lubricant is slightly above the top of the bearing recess 55a.

As in the previous form, air is urged upwardly through the ported web by the aid of a fan structure (not shown) carried by the rotor. A deflector 76 appropriately guides the air upwardly through the upper end of casing 50. Air passes between the bell cover flange 67 and the upper portion of the exterior of the casing 50, past the cooling coils 64. The current of air thus created serves to transfer heat from the lubricant to the air passing about the cooling coils 64. The radiating fins 77 increase the efficiency of heat transfer.

In the form shown in Figs. 5 and 6, a rotary structure 100 supported within a casing 101 has a shaft 102 projecting upwardly beyond a wall 100a of an oil well 110 formed in the casing 101. A load shaft 103 is connected to the hollow rotor shaft 102 by the aid of coupling members 104 and 105 as in the previous forms. Ribs 100b support a cup 106 having an intermediate reduced recess 107 in which a bearing structure 108 is seated. The lower coupling member 105 has an extension 109 mounting the bearing structure 108.

There are two lubricant wells 110 and 111 on diametrically opposite portions of the cup. The wells communicate with the interior of the cup 106 via openings such as 112 immediately above the cup bearing recess 107 that are below the upper edge of the cup 106.

The bottom of the cup in the present instance opens downwardly through a reduced cylindrical opening 113 adjoining the bearing recess 107.

A heat radiating cap 115 has a substantially annular hollow hub portion 116 fitting into the annular space defined by the cup opening 113 and the extension 109. This hub portion forms an annular space 119.

Lubricant from the wells 110 and 111 passes into the space 119 and thence upwardly into the cup 106 for passage through the bearing structure 108.

Passages 117 and 118 establish communication from the wells 110 and 111 to the space 119. Ports such as 120, provided in the outer portion of the hollow wall 116, register with the passages 117 and 118 for this purpose. Lubricant passes upwardly into the bearing recess through a pair of diametrically oppositely disposed ports 121 and 122 provided in the hollow wall 116.

A normal circulation path of lubricant is produced from the wells 110 and 111 through the annular space 119, upwardly through the bearing structure 108, back to the wells 110 and 111. The lubricant, in passing from the wells 110 and 111 to the bearing recess 107, must travel a substantial distance in the hollow wall 116 before entering the bearing structure 108. The outlet ports 121 and 122 are spaced a quarter revolution from the inlet ports such as 120 for this purpose.

The radiating cap 115 carries a plurality of integrally formed depending radiating fins 123 that extend radially of the cap 115 beneath the cup 116. These fins 123 are in the path of air urged upwardly by a fan 124 carried by the rotor. A deflector 125 extending about the fins 123 appropriately directs the air past the radiating fins 123.

The radiating cap 115 is made of high heat transfer material, such as a cast aluminum alloy. Since the fins 123 are integral with the hollow hub 116, and since lubricant is in heat transfer relation to the cap 115 for a substantial time prior to entrance into the bearing recess 107, heat is effectively conducted from the lubricant to the passing air stream via the radiating cap 116 and its fins 123.

A sleeve 126, as in the previous forms, prevents passage of lubricant from the wells 110 and 111 axially downwardly of the rotor shaft 102. In the present instance, the sleeve 126 is carried in an annular recess in the upper side of the radiating cap 115 and extends, with

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clearance, between the rotor shaft 102 and the coupling member extension 109 extending thereabout.

The radiating cap 115 is held in place by appropriate screws 127 engaging the lower portion of the cup 106.

In the form shown in Fig. 7, an arrangement is provided that is similar to that shown in Figs. 3 and 4, but in which the pump is located exteriorly of the motor.

One well 151 is shown adjacent a bearing cup.

In order to cool lubricants in the system, a spiral cooling coil 159 is provided. The coil 159 is located below the flange 160 of the bell cover 161 in a manner similar to the coils 64 of the form shown in Figs. 3 and 4.

Oil is withdrawn from the well 151 through a tube 163 by a pump 166. The pump 166 urges the lubricant through the spiral cooling coil 159, lubricant thereupon discharging into the well 151.

Air passes upwardly through the ported web and thence past the coil 159 in a manner similar to that described in connection with the form shown in Figs. 3 and 4. The lubricant is accordingly cooled. Radiating fins may be provided for the cooling coil 159.

The inventor claims:

1. In apparatus of the character described: a casing for rotary apparatus; a cup supported in the casing and having means for supporting a bearing structure intermediate its length; means forming a lubricant well communicating with the cup for receiving lubricant passing upwardly through a bearing structure mounted therein; and a heat conducting member received in the cup and forming the bottom wall thereof; said heat conducting member having means forming a passage communicating at opposite ends with the well and the cup beneath said bearing structure, the member having integrally formed fins for enhancing the transfer of heat from the member to a medium to which the fins are exposed.

2. In apparatus of the character described: a casing for rotary apparatus; a cup supported in the casing and having means for supporting a bearing structure intermediate its length; means forming a lubricant well communicating with the cup for receiving lubricant passing upwardly through a bearing structure mounted therein; a heat conducting member received in the cup and forming the bottom wall thereof; said heat conducting member having means forming a passage communicating at opposite ends with the well and the cup beneath said bearing structure, the member having integrally formed fins for enhancing the transfer of heat from the member to a medium to which the fins are exposed; and means for causing air to pass the fins.

3. In apparatus of the character described: a casing for rotary apparatus; a cup supported in the casing and having means for supporting a bearing structure intermediate its length; a web supporting the cup and having openings; means forming a lubricant well adjacent the cup and communicating with the cup above the shoulder; cant passing upwardly through a bearing structure mounted therein; a heat conducting member forming the bottom wall of said cup, and having a passage communicating at opposite ends with the well and the cup beneath the said bearing structure, said member having integrally formed fins projecting beneath said cup and said web; and means carried by the rotary apparatus for passing air through the web and past said fins.

4. In apparatus of the character described: a casing for rotary apparatus; a cup supported in the casing and

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having an intermediate shoulder for supporting a bearing structure; means forming a lubricant well adjacent the cup and communicating with the cup above the shoulder; a heat conducting member having a hollow substantially annular wall extending into the bottom of the cup; means for admitting lubricant from the well into said annular wall; said annular wall having an opening for passage of lubricant into the cup; said member having a plurality of integral fins extending about the cup; and means for passing air through the fins.

5. In apparatus of the character described: a casing for rotary apparatus; a cup supported in the casing and having an intermediate shoulder for supporting a bearing structure; a web supporting the cup, said web having openings; means forming a lubricant well adjacent the cup and communicating with the cup for receiving lubricant; a heat conducting member having a hollow substantially annular wall extending into the bottom of the cup; means for admitting lubricant from the well into said annular wall; said annular wall having an opening for passage of lubricant into the cup; said member having a plurality of integral fins extending about the cup and beneath said web; and means for passing air through the web and past said fins.

6. In a lubrication system for rotary apparatus of the vertical type: a casing having air ventilation openings at the top; a hollow vertically extending open-ended bearing support in the casing and located beneath said openings; wall means forming a lubricant reservoir adjoining one side of the support; a bearing structure in the support and located above the lower end thereof; a heat conducting member closing the lower end of the support and having a surface exposed in the support beneath the bearing structure; said member having a plurality of fins, at least some of which project radially beyond the support at places located angularly on opposite sides of the wall means for exposure within the casing; means establishing communication between the reservoir and the interior of the support beneath the bearing structure; and means for creating a vertical current of air past the fins and the openings.

7. In rotary apparatus: a casing; means forming a ventilation opening into the casing; a hollow open-ended bearing support in the casing; a heat conducting member cooperating with one end of the hollow support, and having a plurality of integrally formed fins exposed in the casing outwardly of the hollow support; means carried by the rotary apparatus in the casing for creating a current of air in the casing for passage through the ventilation opening; the fins projecting in said current of air; and means forming a lubricant well communicating with the other end of said hollow support; said heat conducting member having passage forming means establishing communication between said well and said one end of said hollow support.

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