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5 BEARING CARRIER WITH MULTIPLE LUBRICATION SLOTS

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The present invention relates generally to pumps, and more particularly to a bearing carrier for such pumps that use multiple lubrication access locations for bearings located within the pump.

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Chemical process pumps are often used to move petroleum products, industrial chemicals, solvents and related fluids. Such pumps are especially well-suited for use with low-viscosity and relatively non-abrasive fluids. In one particular form, chemical process pumps employ rotating vanes that are placed relative to complementary stator or related housing surfaces to ensure tight tolerances and precise degrees of adjustment. One form of such pump, which is manufactured by the assignee of the present invention, is a centrifugal pump with a rotating impeller; such pump is referred to commercially as the Flowserve Durco® Mark 3™ ISO Pump.

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For optimum capability for handling chemical products, the impellers of such pumps are of a semi front-open type, or a reverse vane type. To ensure continued proper operation over time, the pump impeller may need to be periodically adjusted. In such case (as with the pump model discussed above), the pump may include a device to permit fine-tuned adjustment of the impeller. Such a device involves rotating a bearing carrier that is disposed within a bearing housing; such a process is referred to by the Assignee of the present invention as "micrometer adjustment". While this ability to quickly and precisely adjust impeller clearances significantly contributes to overall pump operability and efficiency, it increases the complexity of the mechanism used to contain the pump's thrust bearings. This is especially true in situations involving bearing lubrication, where the connection for grease lubrication or oil mist is traditionally situated in the end face of the bearing

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5 carrier to give a simple direct passage into the chamber behind the bearing. This connection position has two disadvantages. Firstly (in situations where the connection is configured to receive grease), the connection is inside a coupling guard which therefore has to be removed every time re-greasing is required. Secondly (in situations where the lubrication system is oil mist), because the bearing
10 carrier is rotatable, then the piping carrying the oil mist to the connection on the bearing carrier has to be remade each time the micrometer adjustment is used. In either form, this undesirably increases maintenance time and complexity.

According to one aspect of the present invention, a bearing carrier for a chemical pump has multiple apertures, slots, ports or related access holes that
15 define passages to allow grease or oil mist entry to the bearing (including the region behind the bearing), irrespective of the bearing carrier orientation. More particularly, the connections for grease, oil mist and related lubricants are situated in the body of the bearing housing, allowing them to be in a fixed position relative thereto. In this way the multiple apertures mean that an adjacent aperture is available regardless of
20 the angular position of the bearing carrier. The multiple apertures or holes in the bearing carrier also ensure that there is no buildup of oil on the outside of the bearing that could otherwise leak along the rotating shaft. Such oil is drained back into an oil reservoir through the adjacent hole or holes.

According to another aspect of the present invention, a pump is disclosed that
25 includes a fluid inlet, a fluid outlet and a rotatable shaft-mounted impeller to deliver a fluid between the inlet and outlet. The pump also includes structural members to promote the rotational movement of the shaft and impeller. These structural members include a bearing assembly that is made up of at least a bearing housing and a bearing carrier that are rotatably moveable relative to one another. The
30 bearing housing includes a connection formed through its outer surface such that such that a fluid link may be formed between a remote lubricant supply and one or more bearings being supported in the bearing housing. Upon coupling of the bearing carrier to the bearing housing, the relative placement of the two is such that lubricant

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5 may flow into numerous apertures formed in the channel such that passages defined by the apertures allow delivery of the lubricant to bearings mounted or otherwise supported by the assembly. Importantly, the fluid communication formed by the connection, channel, apertures and passages ensures that lubricant is delivered to the bearing regardless of a relative rotational alignment between the housing and the carrier. In this way, periodic adjustments made to (for example) the pump's impeller to control a gap or related spacing between it and a portion of the flowpath into which the impeller is disposed will not necessitate disassembly or other maintenance-intensive actions to ensure continued lubricant delivery to the bearings contained within the assembly. In one particular form, the connection in the housing is placed adjacent the channel in the carrier so that direct fluid coupling is established between them. In such a direct coupling configuration, there is no intervening structure to interfere with the relatively free flow of lubricant from the connection to the apertures that form or otherwise feed the passages.

According to yet another aspect of the present invention, a method of lubricating a pump bearing compartment is disclosed. The method includes introducing a lubricant to one or more bearings in the bearing compartment, the introducing taking place through a bearing assembly that includes a bearing housing configured to support the bearing, and bearing carrier that is rotatably engageable with the bearing housing. A connection formed in the housing cooperates with a channel formed in the bearing carrier such that numerous lubricant passages formed in the channel receive the lubricant from the connection through the channel regardless of a relative rotational alignment between the bearing housing and the bearing carrier. This is important in that periodic adjustments to pump impeller spacings - as well as uncertain rotational positions between the housing and carrier in the assembly - do not contribute to either (a) a reduction in lubricant delivery due to lubricant flowpath misalignment or (b) increased maintenance time needed to ensure proper alignment of the carrier and housing.

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5 The following detailed description of the present invention can be best understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

FIG. 1 is a cutaway view of a pump highlighting the location of various components therein, including the bearing carrier;

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FIG. 2 is a section of an assembled bearing housing that makes up a portion of the pump of FIG. 1, the housing showing the location of a lubricant connection and an oil drain passage;

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FIG. 3 is a perspective view of the bearing carrier disassembled from the bearing housing of FIG. 2; and

FIG. 4 is a side cutaway view of the bearing carrier of FIG. 3.

Referring first to FIG. 1, a cutaway view of a centrifugal pump **1** according to the present invention is shown. Pump **1** includes a pump housing (or casing) **10**, inlet **20** and outlet **30** along with a fluid flowpath (or pumping chamber) **40** defined between them. In the present context, while pump housing **10** may be associated predominantly with the casing formed around the inlet **20**, outlet **30** and flowpath **40**, as well as defining integral or connectable footers and other structural hardware, it will be understood that additional covers, casing or related containment structure may also be included. Inlet flange **25** and outlet flange **35** form mounting locations to fluidly connect the respective inlet **20** and outlet **30** of pump housing **10** to corresponding conduit (not shown), and may include apertures formed therein to receive screws, bolts or related fasteners that can be used to facilitate such connection. An impeller **50** is mounted to an axle or shaft **60** that is rotated by the operation of a separate motor (not shown). In a preferred form, the shaft **60** may be made from a stiff, corrosion-resistant material, such as 316 stainless steel or the like. As is well-understood by those skilled in centrifugal pump art, fluid is received from a separate conduit through input **20** and operated upon by rotating impeller **50** so that

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5 it exits the outlet **30** with an increased pressure, velocity or related indicia of energy. A seal chamber **55** is integrally-formed in a cover **56** which is disposed within pump housing **10** behind impeller **50**. Due to the small nature of the clearances between impeller **50** and casing **10** and impeller **50** and cover **56**, they don't show up in the present drawing. In particular, the clearance of the reverse vane impeller **50** with
10 cover **56** is only about 0.3 mm; with such a clearance, the impeller **50** front face runs about 2 mm axially from the casing **10**. A sealing device (not shown) in chamber **55** prevents leakage of pumped fluid to atmosphere. The reliability of the seal is dependent on the pressure in the seal chamber **55**, which in turn is affected by the clearance between the reverse open impeller **50** and the cover **56**; this clearance
15 may be set and adjusted by the micrometer adjustment mentioned above. Seals **65** are placed at various axial locations along shaft **60** in order to provide fluid isolation; such seals may be of any suitable static or dynamic configuration (depending on the use), including brush seals, lip seals, labyrinth seals, packing or the like. The potential for high rotational speeds of shaft **60** and impeller **50** means that structural
20 members within pump housing **10** may be exposed to significant loads, often over the relatively long service life of pump **1**. Axially-mounted bearings, such as journal bearings **80**, provide radial load-transferring from the rotating impeller **50** and shaft **60** to structure within pump housing **10** and bearing housing **100**, while thrust bearings **90** provide axial and radial load-transferring. Together, bearings **80** and **90**
25 constitute a group of bearing members.

Referring next to FIG. 2 in conjunction with FIG. 1, a bearing carrier **110** is situated within bearing housing **100** at a distal end thereof such that is axially-spaced from impeller **50** within pump housing **10**. The bearing carrier **110** includes the ability to vary axial clearances of impeller **50** relative to cover **56** through an
30 externally adjusted mechanism (such as the aforementioned micrometer adjustment). The thrust bearing **90**, which may be any type of anti-friction bearing capable of taking both an axial and radial load, is retained against axial movement in the bearing carrier **110**. Thrust bearing **90**, which in one preferred embodiment is a double row bearing, is retained by a circlip **66**. Other locking mechanisms, such as

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5 nut **67**, are used to help keep thrust bearing **90** locked to the shaft **60**. The shaft **60**, bearing carrier **110**, bearings **80**, **90** and impeller **50** become an axially fixed assembly. The bearing carrier **110** connects to the bearing housing **100** through threads **68** on their respective surfaces to produce a threaded and rotatable connection therebetween, where the axial position of bearing carrier **110** is
10 determined by how far the threads **68** have been engaged. Thus, by rotating the bearing carrier **110**, the axial clearance between the impeller **50** and the cover **56** may be adjusted. Once the desired position is reached, one or more screws **71** (shown with particularity in FIG. 1) are screwed and tightened through complementary holes **69** formed in the end face of the bearing carrier **110**. For
15 periodic adjustment, the screws **71** are slackened and the bearing carrier **110** is rotated by hand or by tool on one or more bosses (that project rearwardly from the bearing carrier **110**) until a new desired position of the impeller **50** is achieved, after which the screws **71** are re-tightened to lock the angular position between the bearing carrier **110** and the bearing housing **100** in place. This action improves
20 pump head and efficiency and restores the pressure in seal chamber **55** to that preferred for seal reliability. Other features useful for relating the adjusting clearances to the angular rotation of the bearing carrier **110** may also be used; for example, a scale (not shown) may be included on the end of the bearing carrier **110** as a way to help set clearances without the need for measuring devices. In a pump
25 which has a previously mentioned semi front-open type of impeller (not shown), instead of reverse vane type of impeller **50**, the impeller is set to have a controlled axial clearance with casing **10** instead of cover **56**. The same mechanism is used to make the axial adjustment.

As stated above in conjunction with the prior art, a connection for feeding
30 lubricant to the bearings is traditionally located on the rear portion of the bearing carrier. Referring next to FIGS. 2 through 4, the grease or oil mist connection **77** of the present invention is relocated onto a circumferential outer surface of the bearing housing **100** such that it is in an accessible and fixed position. This continued accessibility (irrespective of the relative angular position of the bearing carrier **110** to

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5 the bearing housing **100**) is made possible by the bearing carrier **110** having multiple apertures that define passages **72** which convey the lubricant from the connection **77** in the bearing housing **100** to the chamber **78** behind the bearing **90**. A circumferential channel (or groove) **73** is formed in the bearing housing **110** and permits fluid communication among all of the apertures **72** so that the lubricant being
10 introduced through connection **77** can pass through to the bearing **90** even if the lubricant inlet connection **77** and one of the apertures **72** do not exactly line up.

If the lubrication is by oil bath, the apertures **72** and circumferential channel **73** connect the chamber **78** at the back of the bearing **90** through grooves **74** to an oil sump **101** in the bearing housing **100**. Such a configuration allows any excess oil
15 behind the bearing **90** to drain back into the sump **101**. In this way, any excess lubricant buildup against bearing **90** has a substantially unimpeded flowpath to the sump **101**, and as with the delivery of the lubricant to the bearing **90** through the connection **77**, channel **73** and apertures **72**, may take place irrespective of the rotational orientation between the bearing carrier **110** and the bearing housing **100**.
20 Significantly, this avoids having lubricant connections (in a manner generally similar to those of connections **77**) be formed in the bearing carrier **110**, as well as the concomitant need for removing the coupling guard to get access to such connections for re-greasing or related operations. Grooves **74** in the bearing housing **100** fluidly connects to the circumferential channel **73** to make a continuous passage, thereby
25 allowing oil to have access to the rear row of balls (or rollers in some designs) in a double row or pair of bearings that make up bearing **90**, to ensure lubrication.

Referring with particularity to FIGS. 3 and 4, while the number of lubricant apertures **72** may be varied, (potentially up to a hundred or more) one preferred embodiment includes between twelve and twenty spaced in substantially equal
30 increments about the periphery of the circumferential channel **73**. Likewise, threaded holes **69** may be formed in the outer flange of bearing carrier **110** to serve as a way to securely couple it to the bearing housing **100** through the use of complementary screws **71** or the like.

5 While the remainder of the present disclosure focuses on centrifugal (also known as kinetic or dynamic) variants of pump **1**, it will be appreciated by those skilled in the bearing design art that the bearing carrier **110** of the present invention may be applicable to other pump configurations (such as positive displacement pumps) that may require axial adjustment of the fluid-pumping components.

10 While certain representative embodiments and details have been shown for purposes of illustrating the invention, it will be apparent to those skilled in the art that various changes may be made without departing from the scope of the invention, which is defined in the appended claims.

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CLAIMS

1. A bearing assembly for a pump, said bearing assembly comprising:
a bearing housing configured to support at least one bearing therein, said bearing housing comprising a connection that is configured to form fluid
10 communication between a lubricant supply and said at least one bearing; and
a bearing carrier disposed between said at least one bearing and said bearing housing and rotatably engageable therewith, said bearing carrier defining a channel with a plurality of lubricant passages formed therein such that a lubricant delivered through said connection is placed in fluid communication with said at least one
15 bearing through said channel and at least one of said plurality of lubricant passages irrespective of a relative rotational alignment between said bearing housing and said bearing carrier.
2. The bearing assembly of claim 1, wherein said connection is formed through a
20 substantially radial outward surface of said bearing housing.
3. The bearing assembly of claim 1, wherein said channel defines a substantially circumferential profile about said bearing carrier.
- 25 4. The bearing assembly of claim 3, wherein said plurality of lubricant passages are spaced about said circumferential profile defined by said channel.
5. The bearing assembly of claim 4, wherein said plurality of lubricant passages are substantially evenly-spaced about said circumference.
- 30 6. The bearing assembly of claim 1, wherein said rotatably engageable disposal between said bearing carrier and said bearing housing is through a threaded fitting therebetween.

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5 7. The bearing assembly of claim 1, wherein said bearing carrier further comprises an adjustment device that permits variable axial spacing of an impeller that defines a fluid-moving portion of said pump.

8. A pump comprising:

10 a pump housing defining a fluid inlet and a fluid outlet therein;

a pumping mechanism fluidly coupled to said inlet and said outlet and configured to deliver fluid therebetween;

a plurality of bearing members configured to transfer loads from said pumping mechanism to said pump housing; and

15 a bearing assembly for a pump, said bearing assembly comprising:

a bearing housing configured to support at least one of said plurality of bearings therein, said bearing housing comprising a connection that is configured to form fluid communication between a lubricant supply and said at least one bearing; and

20 a bearing carrier disposed between said at least one bearing and said bearing housing and rotatably engageable therewith, said bearing carrier defining a channel with a plurality of lubricant passages formed therein such that a lubricant delivered from said lubricant supply through said connection is placed in fluid communication with said at least one bearing through said channel and at least one of said plurality of lubricant passages irrespective of a relative rotational alignment between said bearing housing and said bearing carrier.

30 9. The pump of claim 8, wherein said pump is a chemical process pump.

10. The pump of claim 8, wherein said connection is formed through generally radial outward surfaces of said bearing housing, and further wherein said channel defines a substantially circumferential profile about said bearing carrier such that
35 upon assembly of said bearing carrier and said bearing housing, said connection is

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5 in direct fluid coupling with said channel, and further wherein said plurality of lubricant passages are spaced about said circumferential profile defined by said channel.

11. The pump of claim 10, wherein said plurality of lubricant passages are
10 substantially evenly-spaced about said circumferential profile.

12. The pump of claim 8, further comprising an adjustment device that permits variable axial spacing of said impeller relative to said pump housing.

15 13. The pump of claim 8, further comprising a sump placed in fluid communication with said at least one bearing such that excess amounts of said lubricant may be conveyed away from said at least one bearing.

14. A method of lubricating a pump bearing, said method comprising introducing a
20 lubricant to said bearing through a bearing assembly, said bearing assembly comprising:

a bearing housing configured to support said bearing therein, said bearing housing comprising a connection that is configured to form fluid communication between a lubricant supply and said bearing; and

25 a bearing carrier disposed between said bearing and said bearing housing and rotatably engageable therewith, said bearing carrier defining a channel with a plurality of lubricant passages formed therein such that upon receipt of said lubricant from said lubricant supply through said connection, said lubricant is delivered to said bearing through said channel and at least one of said plurality of lubricant passages
30 irrespective of a relative rotational alignment between said bearing housing and said bearing carrier.

15. The method of claim 14, wherein said pump is a centrifugal pump.

35 16. The method of claim 15, wherein said pump is a chemical process pump.

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17. The method of claim 14, wherein said introducing a lubricant takes place after said bearing carrier has been rotated relative to said pump such that bearing access to said lubricant after said rotation is substantially uninhibited relative to bearing access to said lubricant prior to said rotation.

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18. The method of claim 17, wherein no realignment of said bearing carrier relative to said bearing housing is performed in order to retain said substantially uninhibited access of said lubricant to said bearing through said connection, said channel and said plurality of lubricant passages.

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19. The method of claim 14, further comprising adjusting a spacing between a pump impeller and a pump housing such that bearing access to said lubricant after said adjustment is substantially unchanged relative to bearing access to said lubricant prior to said adjustment, said adjustment taking place without need for
20 disassembling said bearing assembly.

20. The method of claim 14, further comprising draining any excess buildup of said lubricant that occurs adjacent said bearing to an oil sump, said draining taking place irrespective of a rotational orientation of said bearing carrier to said bearing housing.

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