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(54) A CRANE COMPRISING A CRANE COLUMN AND A PUMP FOR LUBRICATION OF BEARINGS

(57) A crane (2) arranged to be mounted to a vehicle (4), the crane comprises:
- a crane base (6) arranged to be attached to the vehicle (4),
- a crane column (8) rotatably connected to the crane base (6) by a slewing house (10),
- an actuator (12) arranged to apply a rotating movement of the crane column (8),
- at least a first boom (14) pivotally connected to the crane column (8).

The slewing house (10) comprises at least a first bearing (16) facilitating the rotation of the crane column (8) relative to the crane base (6), and the crane (2) further comprises an oil-bath chamber (18) for lubrication of the at least one first bearing (16). The crane (2) further comprises at least one pump (20) configured to supply, when activated, oil from the oil-bath chamber (18) to the at least one first bearing (16), and that the at least one pump (20) is configured to be activated in response to the rotating movement of the crane column (8).

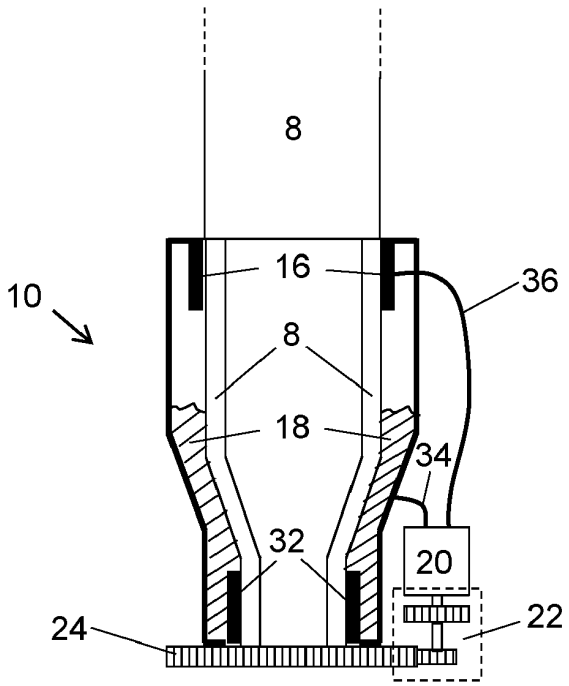

FIG. 7

EP 4 008 678 A1

Description

Technical field

[0001] The present disclosure relates to the technical field of slewing mechanisms for cranes, and in particular, lubrication solutions for the slewing bearing or slewing ring. The disclosure also relates to a method in relation to the crane.

Background

[0002] A crane mounted on a vehicle often comprises a slewing mechanism provided with an upper and lower bearing arranged to lubricate a slewing motion of a crane column. One common approach for lubricating the bearings is to lubricate the lower bearing in an oil bath and to use grease for lubrication of the upper bearing. There are also alternative solutions where the lower, upper and drive assembly of the slewing are lubricated through a common oil chamber.

[0003] Cranes with continuous slewing have normally somewhat different lubrication solutions with one bearing lubricated with grease.

[0004] Herein, by bearing is typically meant radial bearings referring to bearings that support primarily radial loads. Typical examples of radial bearings are deep groove ball bearings, and cylindrical roller bearings. However, some cranes, e.g. so-called continuous slewing-cranes, are only provided with one bearing, which then is intended to support both radial and axial loads. The present invention is thus applicable to bearings intended to support both radial and axial loads.

[0005] In the following, some patent documents in the technical field of lubrication of movable crane columns will be briefly discussed.

[0006] JP2017115898A discloses a greasing system for a construction machine such as a jib crane. The jib crane has an upper swivel body that is pivotable via a swing device on a lower traveling body. The swing device comprises an inner ring attached to the lower traveling body and an outer race attached to the upper swivel body. The swing device is rotated by a motor, which further turns the upper body with respect to the lower body. When a relative movement of rings occur, a controller outputs a greasing execution command to the lubricating device for lubrication.

[0007] KR19980062266U discloses an automatic grease supply device for driving part of an overhead crane. The crane consists of a wire drum that rotates while lifting and lowering of the hoist of the crane. A pump is installed at the periphery of the drum, such that when the drum rotates, the pump pushes grease to the bearing through the distribution valve for lubrication.

[0008] US20170022036A1 discloses a crane including a crane pillar supported rotatably about an axis. A radial bearing is present for supporting the rotatable crane pillar in a base. The radial bearings between the crane base and pillar can further be arranged in an oil bath chamber. The oil bath serves as the purpose of lubrication of the bearings. The crane further comprises a drive unit, specifically a rack-and-pinion drive unit. The crane also comprises a second bearing between the pillar and crane base. The second bearing is located in an oil bath.

[0009] JPH10237897A discloses an automatic lubrication system for a construction machine like hydraulic crane. The construction machine comprises a lower traveling body and an upper revolving body. The machine further comprises a boom and an arm cylinder, which is operated by a pressure detecting means. The pressure detecting means is provided in the hydraulic circuit and detects the work frequency of the actuator or the load amount of the hydraulic oil. The sensor then detects the load, provides a signal to the controller that drives the grease pump to lubricate the bearings.

[0010] CN210318449U discloses a lubricating device for gear column of horizontal rotary large gear ring. The large gear ring is arranged below a rotary platform seat frame of a loading and unloading machine like a portal crane. The gear ring is installed in a bearing house. The lubricating device is driven by the driving gear meshing with the large ring gear, which then lubricates the internal oil passages in the wheel body of the wheel. A highpressure oil pump is used for pumping oil from the supply pipe to the discharge pipe. The prior art further comprises a motor for rotating the gear.

[0011] A crane bearing that is lubricated with grease needs to be checked and maintained quite frequently by the crane operator or crane owner. Solutions with oil-baths to cover both bearings require quite a large oil bath.

[0012] In cranes with a slewing mechanism provided with an upper and lower bearing, as discussed above, the most common approach is to lubricate the lower bearing in an oil bath and to use grease for lubrication of the upper bearing. One drawback with such a solution is that grease from the lubrication of the upper bearing may be mixed with the oil in the oil-bath. This may change or reduce the lubrication effect of the oil to the lower bearing.

[0013] Furthermore, one general driving force for customers and the industry as a whole is to decrease the need for maintenance such as manual greasing.

[0014] Thus, the object of the present invention is to achieve a crane provided with at least one bearing that is essentially maintenance free in the sense that no manual greasing is required, and that the lubrication with oil of the at least one bearing is accurate, predictable, and easily controlled.

Summary

[0015] The above-mentioned objects are achieved, or at least mitigated, by the present invention according to the independent claims.

[0016] Preferred embodiments are set forth in the dependent claims.

[0017] By applying the crane according to the present

invention, an essentially maintenance free lubrication with oil of bearings of the crane is achieved.

[0018] The crane, and method according to the present invention, is based on the idea that a bearing in the slewing house that is not located in an oil-bath should instead be lubricated by distributing oil from the oil-bath using a pump when the rotation of the crane column takes place.

[0019] There are several alternative solutions for harvesting energy from the rotation of the crane column to simultaneously activate and drive the pump in response to the rotational movement of the crane column. This may be achieved by providing a roller clutch, or arranging a cam on the crane column, to transfer rotational movement of the crane column to the pump. Thus, the rotating movement of the column may then be used to drive the pump, to limit the need for an additional energy source.

[0020] According to one embodiment, the drive of the pump consists of gear wheels and roller clutches placed in a combination that will convert a slewing motion into a rotational motion. The rotational motion drives the pump that distributes oil to the bearings in the slewing mechanism. By letting the pump be driven by the slewing movements, the pump does not need to be individually controlled by a control system of the vehicle. It will however still be active when it is most needed to efficiently lubricate the bearing with oil.

[0021] As an alternative, it is also possible to use an additional energy source and a sensor that could be applied to monitor the movement of the crane column in order to activate the pump in response to a rotating movement.

[0022] By applying the present invention in accordance with one embodiment, the crane operator and owner will not need to maintain the lubrication of an upper bearing that is frequently done when lubricated with grease (approximately once a week). Furthermore, by avoiding using grease as in the crane of the present disclosure, the oil will not be contaminated by the grease and there will be less grease stains and contaminations of the working area around the crane. Thus, the crane according to the present invention will hence also have an environmental aspect.

Brief description of the drawings

[0023]

Figure 1 is a schematic perspective view of a vehicle provided with a crane according to one embodiment of the present invention.

Figure 2 is a schematic perspective view of another vehicle provided with a crane according to another embodiment of the present invention.

Figure 3 is a schematic illustration of a vehicle provided with a crane according to the present invention.

Figure 4 shows a schematic illustration of one embodiment of the crane according to the present invention.

Figure 5 shows a schematic illustration of another embodiment of the crane according to the present invention.

Figure 6 shows a schematic illustration of still another embodiment of the crane according to the present invention.

Figure 7 shows a schematic illustration of a further embodiment of the crane according to the present invention.

Figure 8 shows a schematic illustration of another further embodiment of the crane according to the present invention.

Figure 9 is a flow diagram illustrating the method according to the present invention.

Detailed description

[0024] The crane will now be described in detail with references to the appended figures. Throughout the figures, the same, or similar, items have the same reference signs. Moreover, the items and the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

[0025] Figure 1 is a perspective view of a vehicle 4 provided with a crane 2 according to one embodiment of the present invention. The vehicle 4 is e.g. a loader truck, a forestry vehicle, or any vehicle where a crane may be arranged. The crane 2 conventionally comprises a crane column 8, and a first boom 14, e.g. a telescopic boom, pivotably connected to the crane column. Further booms may naturally also be arranged, and a tool, e.g. a hook or a grapple to grab logs for a forestry application, may be attached to a tip of the final boom. The illustrated crane comprises a slewing house 10 where two bearings are arranged, e.g. in a so-called rack and pinion arrangement. A rack and pinion is a type of linear actuator that comprises a circular gear (the pinion) engaging a linear gear (the rack), which operate to translate linear motion to a rotational movement of the crane column 8. The linear motion of the rack may be controlled by a hydraulic cylinder.

[0026] Figure 2 is a perspective view of a vehicle 4 provided with a crane 2 according to another embodiment of the present invention. This crane is provided with a slewing house 10 provided with one bearing and adapted for continuous slewing. The crane comprises a crane column 8 and at least one boom 14, e.g. a telescopic boom, pivotably connected to the crane column. As with the crane in figure 1, further booms may naturally also be arranged, and a tool, e.g. a hook or a grapple to grab logs for a forestry application, may be attached to a final boom extension.

[0027] With references to the schematic illustration of figure 3, the crane comprises a crane base 6 arranged to be attached to the vehicle 4, and a crane column 8 rotatably connected to the crane base 6 by a slewing house 10. During use, the crane column 8 has an essentially vertical orientation. At least a first boom 14 is piv-

otally connected to the crane column 8, and, as mentioned above, further booms may be attached to the first boom, and a tool may be arranged at a boom tip. An actuator 12 comprising e.g. a hydraulic cylinder or a hydraulic motor, is arranged to apply a rotating movement of the crane column 8. The rotating movement may be applied by the actuator driven by a hydraulic system. The actuator may provide movement to the crane column via various cogwheels, e.g. arranged at a lower end of the crane column.

[0028] Various embodiments of the crane are illustrated in figures 4-7, and with references to those figures, the slewing house 10 comprises at least a first bearing 16 facilitating the rotation of the crane column 8 relative to the crane base 6.

[0029] The crane 2 further comprises an oil-bath chamber 18 containing oil for lubrication of the at least one first bearing 16. The oil-bath chamber 18 may either be arranged outside the slewing house 10 as shown in figures 4 and 6, or inside the slewing house 10 as shown in figures 5 and 7.

[0030] The crane 2 comprises at least one pump 20 configured to supply, when activated, oil from the oil-bath chamber 18 via an oil feeding tube 36 to the at least one first bearing 16. The pump 20 is supplied with oil from the oil-bath chamber 18 via an oil input tube 34. The at least one pump 20 is configured to be activated in response to the rotating movement of the crane column 8. The arrow from the crane column 8 to the pump illustrates the activation of the at least one pump 20.

[0031] According to an embodiment, the at least one pump 20 is configured to be directly physically activated by the rotating movement of the crane column 8. This is achieved by providing means that transfers the rotating movement of the crane column 8 to an input movement applicable to operate the pump. The nature of the input movement is dependent of the type of pump, and may e.g. be a rotating movement, or a reciprocating movement.

[0032] According to another embodiment, the at least one pump 20 is configured to be directly physically activated by the rotating movement of the crane column 8 by at least one roller clutch member 22 provided in relation to the crane column 8 to transfer rotating movement from the crane column 8 to the at least one pump 20. This is illustrated in figure 7.

[0033] According to still another embodiment, the at least one pump 20 is configured to be directly physically activated by the rotating movement of the crane column 8 by at least one cam member provided at the crane column 8 to transfer rotating movement from the crane column 8 to the at least one pump 20.

[0034] In particular, the cam member is structured to transform the rotating movement of the crane column to a back and forth motion driving a membrane pump. For non-continuous slewing cranes with upper and lower bearings, this solution may easily be adapted to presently applied cranes. The oil-bath chamber for the lower bearing may be used, adding components for activating the pump and the pump itself. The oil may be directed from the pump to the present inlet for grease to the upper bearing, and the oil is then returned to the oil-bath chamber through the slewing house.

[0035] In a further embodiment shown in figures 5 and 7, the crane 2 comprises two bearings mounted in the slewing house, the first bearing 16 and a second bearing 32. The second bearing 32 is mounted below said first bearing 16, and the oil-bath chamber 18 is structured to enclose the second bearing 32 such that the second bearing 32 is immersed in oil, and wherein the pump 20 is structured to be mounted close to the second bearing 32. By the expression that the pump 20 is mounted close to the second bearing 32 is meant that the pump is mounted such that rotation movement of the crane column may be transferred to the pump by e.g. a roller clutch or a cam. Figure 7 discloses a part of the crane provided with a roller clutch member 22 including cogwheels driving the pump distributing oil from the oil-bath chamber 18, where a second bearing is arranged, to the first bearing 16 in the upper part of the slewing house.

[0036] In this embodiment, a roller clutch with a gear is placed on a shaft that is in contact with the component 24 (a cogwheel) creating the slewing motion, a second shaft (not shown) with a roller clutch working in the opposite direction is also in contact with the component creating the slewing motion. Both shafts are in contact by gears where one of the gears is equipped with a roller clutch and one of the shafts is driving the oil pump 20. Several types of pumps, such as Helm pumps, Gear wheel pumps, etc. may be applied.

[0037] According to still another embodiment, the crane comprises at least one pressure sensor arranged to sense pressure of hydraulic fluid in a hydraulic system of the actuator 12 arranged to apply a rotating movement of the crane column 8. The crane also comprises a pump control unit 28 (see figure 6) configured to determine at least one pump control parameter in dependence of the sensed hydraulic pressure, and to activate the at least one pump 20 by the determined at least one control parameter.

[0038] According to another embodiment the crane comprises a pump control unit 28 connected to the crane control unit. The crane control unit generates operation commands to the actuators of the crane in response to driving instructions input from e.g. an operator controlling the crane with a remote control unit. The pump control unit 28 may hence be activated in response to an operation command activating actuators controlling the slewing of the crane column.

[0039] The pump control unit 28 may be further configured to determine at least one pump control parameter in dependence of the at least one operation command or driving instructions, and to activate the at least one pump 20 by the determined at least one control parameter. The at least one pump control parameter comprises one or many of a time period that the pump 20 is activated,

an amount of oil that is supplied during the activation, and a variability factor of supplied oil during one activation. The variability factor may be set such that the amount of supplied oil is dependent on the expected rotational speed of the crane column. For example, a low speed may result in a low amount of supplied oil, and a high speed may result in a high amount of supplied oil, and that the amount of supplied oil is gradually increased between the low speed, up to the high speed.

[0040] According to another embodiment, the crane comprises a rotating movement measurement member 30 (see figure 6) configured to determine at least one movement parameter related to the rotating movement of the crane column 8. The measurement member 30 may e.g. be any optical, inductive or mechanical sensor capable of sensing the movement parameter (e.g. rotational speed). The crane comprises a pump control unit 28 configured to determine at least one pump control parameter in dependence of the at least one movement parameter, and to activate the at least one pump 20 by the determined at least one control parameter. The at least one pump control parameter comprises one or many of a time period that the pump 20 is activated, an amount of oil that is supplied during the activation, and a variability factor of supplied oil during one activation. The variability factor may be set such that the amount of supplied oil is dependent on the rotational speed of the crane column. For example, a low speed may result in a low amount of supplied oil, and a high speed may result in a high amount of supplied oil, and that the amount of supplied oil is gradually increased between the low speed, up to the high speed.

[0041] In another embodiment, the oil-bath chamber 18 is arranged separately from the slewing house 10. This is illustrated in figures 4 and 6. Thus, no bearing is located within the oil-bath chamber 18. The oil-bath chamber 18 may further be placed in such a way that no bearing is located within the oil-bath chamber, but the location of the oil-bath chamber still enables to collect and reuse oil that has once been used to lubricate the bearing. This way oil may be reused in the system which further mitigates the need of frequent maintenance. The oil-bath may e.g. be placed below the bearing to the lubricated. The oil-bath may as an alternative be arranged to be in connection with a recycling system that collects and returns oil to the oil-bath chamber.

[0042] Figure 8 shows a schematic illustration of a part of a continuous slewing-crane provided with a roller clutch member 22 including cogwheels driving the pump 20 distributing oil from the oil-bath chamber 18 via an oil input tube 34 and by an oil feeding tube 36 to the bearing 16. The at least one pump 20 is configured to be activated in response to the rotating movement of the crane column 8.

[0043] The present invention also relates to a method of a crane 2 arranged to be mounted to a vehicle 4. The crane has been described in detail above and it is here referred to that description.

[0044] Thus, the crane comprises a crane base 6 arranged to be attached to the vehicle 4, a crane column 8 rotatably connected to the crane base 6 by a slewing house 10, an actuator 12 arranged to apply a rotating movement of the crane column 8, and at least a first boom 14 pivotally connected to the crane column 8. The slewing house 10 comprises at least a first bearing 16 facilitating the rotation of the crane column 8 relative to the crane base 6, and the crane 2 further comprises an oil-bath chamber 18 for lubrication of the at least one first bearing 16.

[0045] With references to the flow diagram shown in figure 9, the method comprises activating the at least one pump in response to the rotating movement of the crane column 8, and supplying, by the at least one pump 20, when activated, oil from the oil-bath chamber 18 to the at least one first bearing 16.

[0046] According to a further embodiment, the method further comprises:

- transferring rotating movement from the crane column 8 to operating movement of the at least one pump 20, by at least one roller clutch member 22 provided in relation to the crane column 8, or by at least one cam member provided at the crane column 8, and
- directly physically activating the at least one pump 20, in response of the transferred movement.

[0047] According to still another embodiment, the method comprises:

- determining at least one movement parameter related to the rotating movement of the crane column 8 by a rotating movement measurement member 30,
- determining, by a pump control unit 28, at least one pump control parameter in dependence of said at least one movement parameter, and
- activating said at least one pump 20 by said determined at least one control parameter. The at least one pump control parameter comprises one or many of a time period that the pump 20 is activated, an amount of oil that is supplied during the activation, a variability factor of supplied oil during one activation.

[0048] The present invention also relates to a vehicle comprising a crane 2 as described above.

[0049] The present invention is not limited to the above-described preferred embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention, which is defined by the appending claims.

Claims

1. A crane (2) arranged to be mounted to a vehicle (4), the crane comprises:

   - a crane base (6) arranged to be attached to the vehicle (4),
   - a crane column (8) rotatably connected to the crane base (6) by a slewing house (10),
   - an actuator (12) arranged to apply a rotating movement of the crane column (8),
   - at least a first boom (14) pivotally connected to the crane column (8);

   wherein the slewing house (10) comprises at least a first bearing (16) facilitating the rotation of the crane column (8) relative to the crane base (6), and the crane (2) further comprises an oil-bath chamber (18) for lubrication of the at least one first bearing (16), **characterized in that** the crane (2) further comprises at least one pump (20) configured to supply, when activated, oil from the oil-bath chamber (18) to the at least one first bearing (16), and that the at least one pump (20) is configured to be activated in response to the rotating movement of the crane column (8).

2. The crane (2) according to claim 1, wherein the at least one pump (20) is configured to be directly physically activated by the rotating movement of the crane column (8).

3. The crane (2) according to claim 2, wherein the at least one pump (20) is configured to be directly physically activated by the rotating movement of the crane column (8) by at least one roller clutch member (22) provided in relation to the crane column (8) to transfer rotating movement from the crane column (8) to the at least one pump (20).

4. The crane (2) according to claim 2, wherein the at least one pump (20) is configured to be directly physically activated by the rotating movement of the crane column (8) by at least one cam member provided at the crane column (8) to transfer rotating movement from the crane column (8) to the at least one pump (20).

5. The crane (2) according to claim 1, comprising at least one pressure sensor arranged to sense pressure of hydraulic fluid in a hydraulic system of said actuator (12) arranged to apply a rotating movement of the crane column (8), and a pump control unit (28) configured to determine at least one pump control parameter in dependence of said sensed hydraulic pressure, and to activate said at least one pump (20) by said determined at least one control parameter.

6. The crane (2) according to claim 1, further comprising a rotating movement measurement member (30) configured to determine at least one movement parameter related to the rotating movement of the crane column (8), and a pump control unit (28) configured to determine at least one pump control parameter in dependence of said at least one movement parameter, and to activate said at least one pump (20) by said determined at least one control parameter.

7. The crane (2) according to claim 5 or 6, wherein said at least one pump control parameter comprises one or many of a time period that the pump (20) is activated, an amount of oil that is supplied during the activation, a variability factor of supplied oil during one activation.

8. The crane (2) according to any of claims 1-7, further comprising a second bearing (32) facilitating the rotation of the crane column (8) relative to the crane base (6), wherein the oil-bath chamber (18) is structured to enclose the second bearing (32) such that the second bearing (32) is immersed in oil.

9. The crane (2) according to any of claims 1-8, wherein said oil-bath chamber (18) is arranged within the slewing house (10).

10. The crane (2) according to any of claims 1-7, comprising two bearings mounted in said slewing house, the first bearing (16) and a second bearing (32), wherein the second bearing (32) is mounted below said first bearing (16), the oil-bath chamber (18) is structured to enclose the second bearing (32) such that the second bearing (32) is immersed in oil, and wherein said pump (20) is structured to be mounted close to the second bearing (32).

11. The crane (2) according to any of claims 1-7, wherein said oil-bath chamber (18) is arranged separately from the slewing house (10).

12. A method of a crane (2) arranged to be mounted to a vehicle (4), the crane comprises:

    - a crane base (6) arranged to be attached to the vehicle (4),
    - a crane column (8) rotatably connected to the crane base (6) by a slewing house (10),
    - an actuator (12) arranged to apply a rotating movement of the crane column (8),
    - at least a first boom (14) pivotally connected to the crane column (8);

    wherein the slewing house (10) comprises at least a first bearing (16) facilitating the rotation of the crane column (8) relative to the crane base (6), and the

crane (2) further comprises an oil-bath chamber (18) for lubrication of the at least one first bearing (16), **characterized in that** the method comprises:

- activating said at least one pump in response to the rotating movement of the crane column (8), and
- supplying, by the at least one pump (20), when activated, oil from the oil-bath chamber (18) to the at least one first bearing (16).

13. The method according to claim 12, further comprising:

- transferring rotating movement from the crane column (8) to operating movement of the at least one pump (20), by at least one roller clutch member (22) provided in relation to the crane column (8), or by at least one cam member provided at the crane column (8), and
- directly physically activating the at least one pump (20), in response of the transferred movement.

14. The method according to claim 12, further comprising:

- determining at least one movement parameter related to the rotating movement of the crane column (8) by a rotating movement measurement member (30),
- determining, by a pump control unit (28), at least one pump control parameter in dependence of said at least one movement parameter, and
- activating said at least one pump (20) by said determined at least one control parameter, wherein said at least one pump control parameter comprises one or many of a time period that the pump (20) is activated, an amount of oil that is supplied during the activation, a variability factor of supplied oil during one activation.

15. A vehicle comprising a crane (2) according to any of claims 1-11.

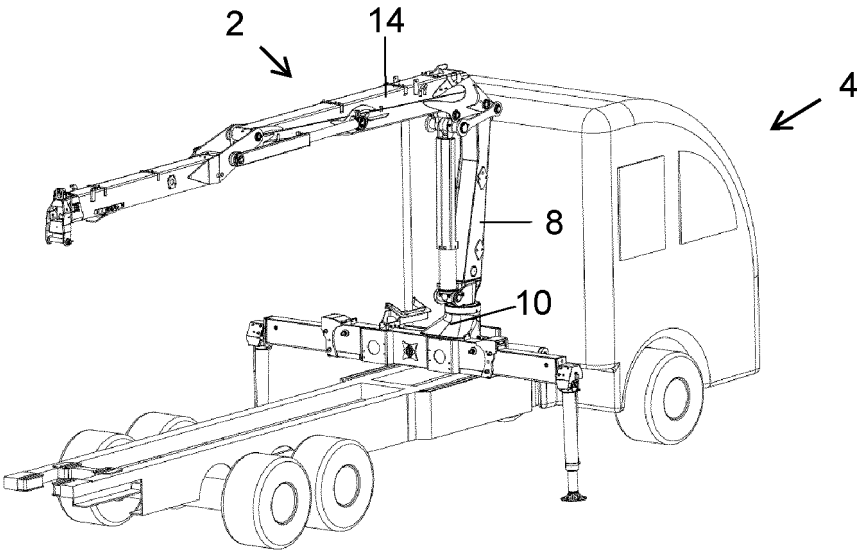

FIG. 1

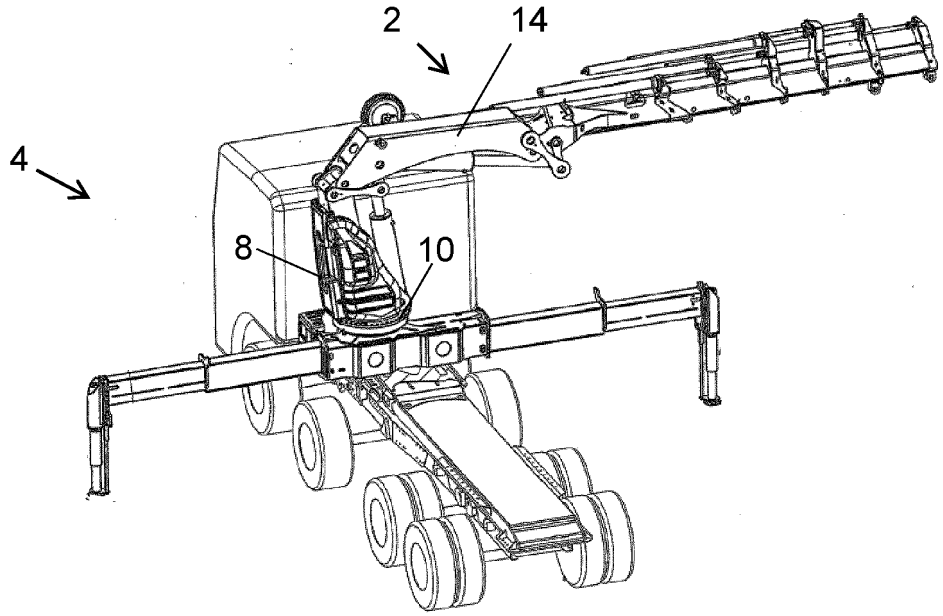

FIG. 2

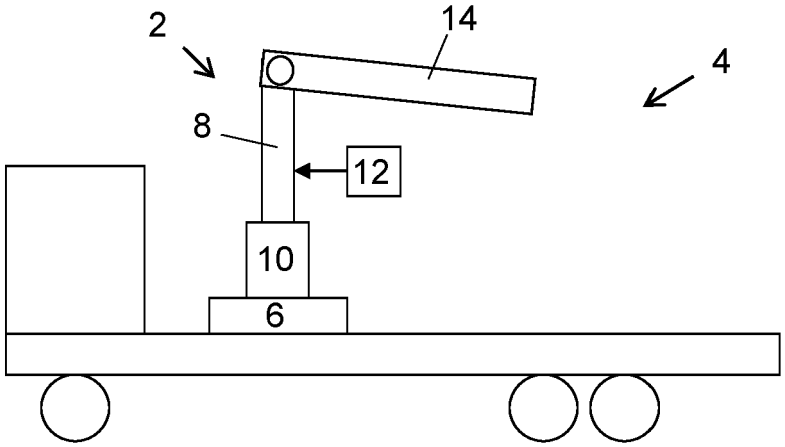

FIG. 3

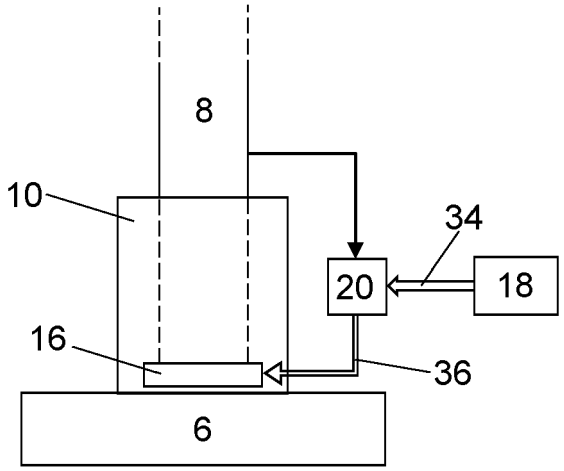

FIG. 4

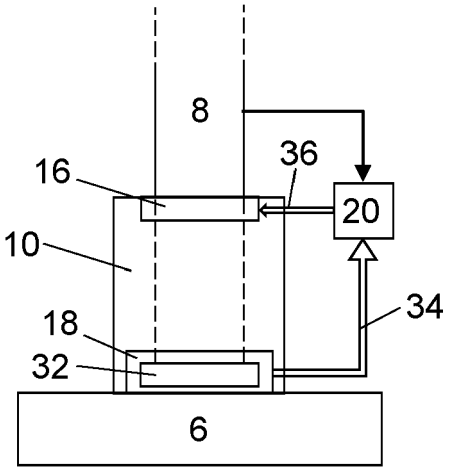

FIG. 5

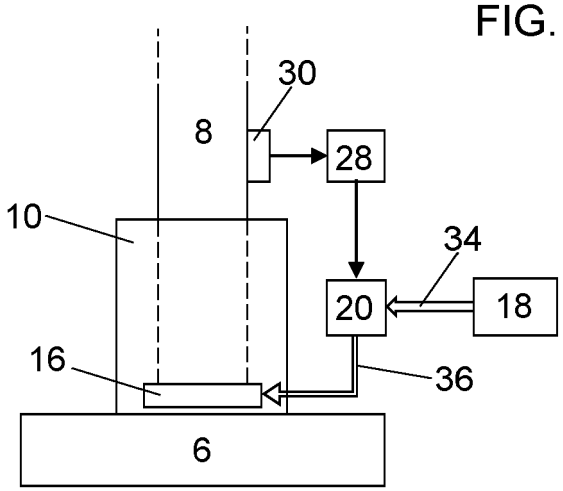

FIG. 6

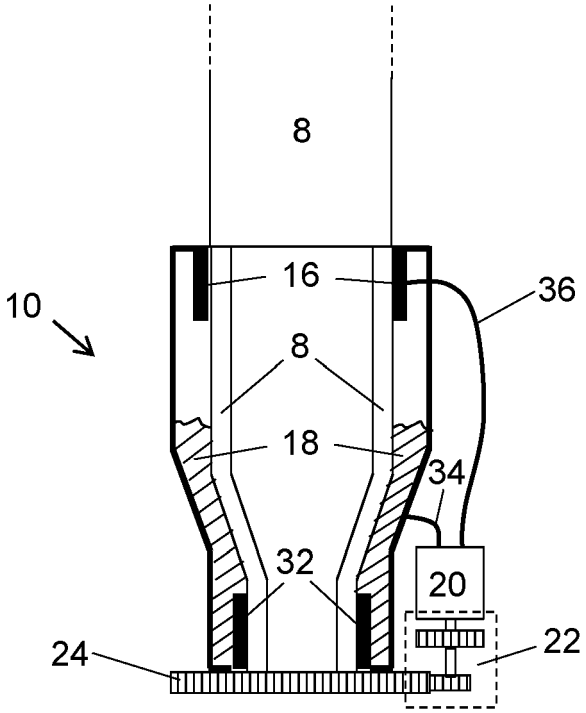

FIG. 7

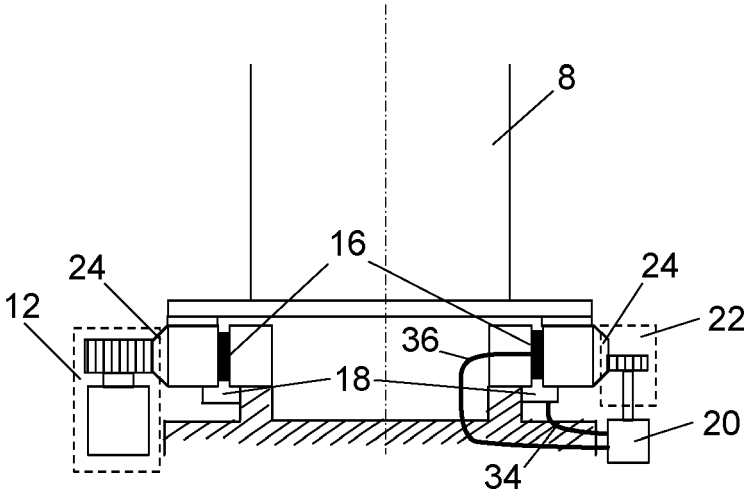

FIG. 8

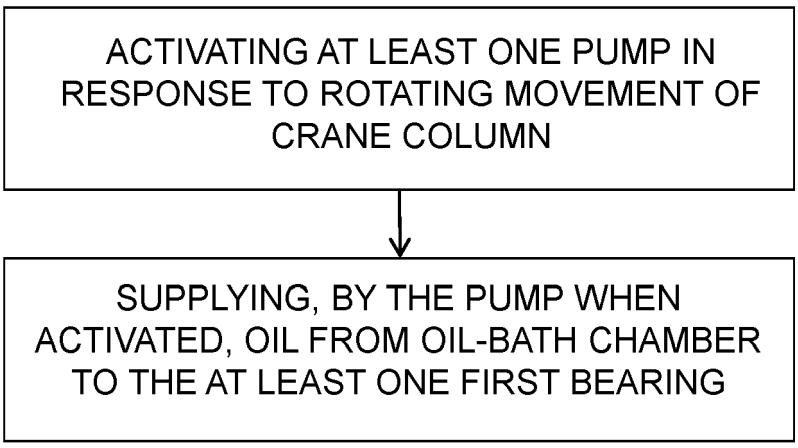
ACTIVATING AT LEAST ONE PUMP IN RESPONSE TO ROTATING MOVEMENT OF CRANE COLUMN
SUPPLYING, BY THE PUMP WHEN ACTIVATED, OIL FROM OIL-BATH CHAMBER TO THE AT LEAST ONE FIRST BEARING

FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 20 21 2119

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 May 2021	Verheul, Omiros

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