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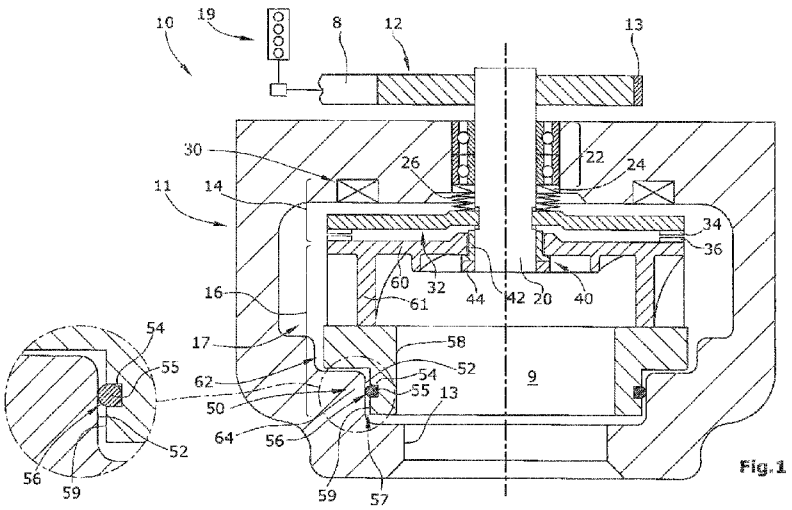

Fig.1

(57) Abstract: A switchable mechanical automotive coolant pump (10) for providing a liquid coolant for an internal combustion engine (19), comprising a static pump housing (11), a rotatable pulley wheel (12) supported by a shaft (20), a rotatable pump wheel (16) for pumping the coolant from an axial lo pump inlet opening (13) radially outwardly into an outlet volute (17), a friction clutch arrangement (14) for co-rotatably engaging or disengaging the pulley wheel (12) with the pump wheel (16), and a continuous frictional braking arrangement (50) comprising an 15 elastic friction means (56) which is continuously in frictional contact with the pump wheel (16) and the pump housing (11), wherein the friction generated by the frictional braking arrangement (50) is high enough to stop the rotation of the pump wheel (16) when the friction clutch arrangement (14) is in the disengaged state.

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Switchable mechanical automotive coolant pump

The invention refers to a switchable mechanical automotive coolant pump for providing a liquid coolant for an internal combustion engine.

A mechanical automotive coolant pump is mechanically driven by the internal combustion engine via a pump's pulley wheel so that the rotational speed of the coolant pump is proportional with the rotational speed of the combustion engine. In some situations, and in particular after starting the cold engine, it is desirable to avoid cooling of the engine by stopping the pumping action of the coolant pump. This can be realized with a switchable coolant pump which comprises a friction clutch arrangement which allows engaging or disengaging of the pulley wheel with/from the pump wheel as required. However, since there are still rotating parts in the disengaged clutch state, a rotational momentum can still be transferred to the pump wheel so that a considerable rotation of the pump wheel still can be present even if the friction clutch is completely disengaged. In particular in a wet clutch arrangement the drag torque of the disengaged wet clutch can be considerably high so that the pump wheel can still rotate with, for example, one third of the rotational speed of the pulley wheel. As a consequence, a considerable coolant flow is caused even if no cooling performance is needed.

It is an object of the invention to provide a switchable mechanical automotive coolant pump with no relevant coolant flow when the friction clutch arrangement is in the disengaged state.

This object is solved with a switchable mechanical automotive coolant pump with the features of claim 1.

The coolant pump comprises a static pump housing which rotatably supports a rotatable pulley wheel which is supported by a shaft which generally can be provided non-rotatable or rotatable. A rotatable pump wheel is provided for pumping the coolant from an axial pump inlet opening radially outwardly into an outlet volute. A friction clutch arrangement is provided for co-rotatably engaging or disengaging the pulley wheel with/from the pump wheel.

The coolant pump is provided with a continuous frictional braking arrangement comprising an elastic friction means which is continuously in frictional contact with the pump wheel and with the pump housing. The friction generated by the frictional braking arrangement is high enough to stop the rotation of the pump wheel when the friction clutch arrangement is in the disengaged state.

The friction braking arrangement is always generating a frictional braking force, namely in the engaged clutch state as well as in the disengaged clutch state. Since the frictional braking arrangement is basically realized only by a simple elastic friction means, the effort for providing a better thermal functionality of the switchable coolant pump is little.

The braking torque generated by the friction braking arrangement is as low as possible so that the energy-loss caused by the continuous braking torque is not relevant. In the disengaged clutch state, the braking torque generated by the friction braking arrangement is higher than the drag torque of the friction clutch arrangement so that the rotation of the pump wheel is completely stopped. As a consequence, no relevant coolant flow is generated anymore when the clutch is disengaged. This allows a faster warming of the engine after a cold start which causes positive environmental and economic effects.

According to a preferred embodiment of the invention, the shaft is provided co-rotatably with the pulley wheel and the pump wheel is supported by the rotatable shaft. The pump wheel is preferably supported rotatably with respect to the rotatable shaft so that the pump wheel can

stand still when the rotor shaft is rotating. The pump wheel is supported by a frictional or a roller bearing, preferably by a frictional bearing. A frictional bearing can generate a considerable frictional drag torque so that the pump wheel can still rotate even if the friction clutch arrangement is in the disengaged state. Therefore, the frictional braking arrangement is in particular helpful if the pump wheel is supported by the rotatable shaft which is co-rotatably connected to the pulley wheel.

Preferably, the friction clutch arrangement is provided as a wet friction clutch in a wet zone of the pump. A wet friction clutch arrangement generally generates a relatively high hydraulic drag torque in the disengaged state of the clutch. Therefore, the friction braking arrangement is in particular helpful if the friction clutch arrangement is a wet friction clutch.

According to a preferred embodiment, the friction clutch arrangement comprises a pump wheel-sided friction ring at the back side of a pump wheel base disk and a pulley wheel-sided friction ring at a separate clutch wheel which is co-rotating with the pulley wheel. The pump wheel base disk therefore has a double function, namely being a fluidic part of the pump wheel and being the basis of one side of the friction clutch. This arrangement is compact, simple and economic.

Preferably, the friction clutch arrangement comprises an electromagnetic actuation coil for axially actuating the pulley wheel- sided friction ring.

According to a preferred embodiment of the invention, the pump wheel is an impeller with a base disk, numerous blades extending from the base disk and a blade covering ring defining an axial pump wheel inlet. The friction means is arranged between the blade covering ring and the corresponding housing part. The friction means has a double function, namely providing a frictional braking force and providing a sealing of the circular gap between the pump wheel blade covering ring at one side and the corresponding housing part on the other side. Since this circular gap is

significantly or completely closed by the friction means, the hydraulic efficiency of the pump is improved.

Preferably, the friction means is provided at a substantially cylindrical portion of the pump housing. Even if the pump wheel should be axially movable to some extent, the friction force generated by the friction means provided at a cylindrical portion is constant and independent of the axial position of the pump wheel.

Preferably, the friction means is an elastic closed ring body seated in a circular groove.

Alternatively, the friction means is at least one bending-flexible and non-closed ring body seated in the circular groove. The ring body is preferably made of metal and therefore is not highly abrasive and is of constant friction quality.

According to a preferred embodiment, the circular groove is a radial groove with a radial groove opening. The circular groove can be provided at the pump housing side, but is preferably provided at the radial outside of the pump wheel.

Alternatively, the friction means can be realized as a lip seal ring which is fixed to the pump wheel by being molded to the plastic pump wheel.

Two embodiments of the invention are explained with reference to the enclosed drawings, wherein:

figure 1 shows a longitudinal section of a first embodiment of a switchable mechanical automotive coolant pump with a wet friction clutch arrangement and a friction means defined by an elastic closed ring body, and

figure 2 shows a longitudinal section of a second embodiment of a switchable mechanical automotive coolant pump with a wet friction clutch arrangement and a friction means defined by numerous bending-flexible and non-closed ring bodies.

Figures 1 and 2 show a switchable mechanical automotive coolant pump 10 for providing pressurized liquid coolant, for example water, for an internal combustion engine 19. The coolant pump 10 is a mechanical pump which is mechanically driven by the engine 19 via a transmission belt 8. The belt 8 is driven by the engine 19 and is driving a pulley wheel 12 of the coolant pump 10.

The coolant pump 10 is provided with a static pump housing 11 which supports a rotatable pump shaft 20 and houses the wet zone 9 of the coolant pump 10. The rotor shaft 20 is rotatably supported at the static pump housing 11 by a roller bearing arrangement 22. At the wet end of the roller bearing arrangement 22 a sealing ring 24 is provided to seal the circular gap between the pump housing 11 and the rotatable rotor shaft 20 liquid-tight and to thereby separate the wet zone 9 inside the pump housing 11 from the dry zone outside the pump housing 11. The pump housing 11 also defines a circular axial pump inlet opening 13 through which the liquid coolant flows into the coolant pump 10.

The rotor shaft 20 co-rotatably supports a clutch wheel 32 which is axially shiftable within a small axial range at the rotor shaft 20.

The wet axial end of the rotor shaft 20 rotatably supports a pump wheel 16 which is rotatable with respect to the rotor shaft 20. The pump wheel 16 is supported at the rotor shaft 20 by a friction bearing 40 defined by a cylindrical friction bearing ring 42 and a stopping ring 44 which axially fixes the friction bearing ring 42 at the rotor shaft 20.

The pump wheel 16 is an impeller and substantially comprises a closed base disk 60, numerous pump blades 61 extending substantially axially from the base disk 60 and a blade covering ring 62 axially covering the pump blades 61. The blade covering ring 62 defines an axial pump wheel inlet 58, through which the liquid coolant, coming from the pump inlet opening 13, flows axially into the pump wheel 16. The liquid coolant is

pumped by the rotating blades 61 of the pump wheel 16 radially outwardly into a pump volute 17 which finally ends in a pump outlet (not shown) from where the liquid coolant flows to the engine 19.

The coolant pump 10 is provided with a friction clutch arrangement 14 within the wet pump zone 9. The clutch arrangement 14 comprises the shiftable clutch wheel 32, a static electromagnetic actuation coil 30 fixed to the pump housing 11, a friction ring 34 at the ferromagnetic clutch wheel 32 and a second friction ring 36 at the back side of the pump wheel base disk 60. The clutch wheel 32 is axially pretensioned into an engaged clutch position by an axial clutch spring 26. The two friction rings 34,36 are provided axially in-line to each other.

When the actuation coil is not energized, the clutch spring 26 axially pushes the clutch wheel 32 into the engaged position so that the friction rings 34, 36 are in frictional contact to each other so that the pump wheel 16 rotates with the rotational speed of the pulley wheel 12. When the actuation coil 30 is electrically energized, the clutch wheel 32 is attracted by the electromagnetic field generated by the actuation coil 30 so that the friction rings 34, 36 are not in direct contact with each other. The clutch is in the disengaged state.

The pump 10 is provided with a continuous frictional braking arrangement 50 in the wet zone 9 of the pump 10. The frictional braking arrangement 50 continuously generates a considerable braking force and braking torque which is high enough to completely stop the pump wheel 16 if the friction clutch arrangement 14 is in the disengaged state as shown in figures 1 and 2 so that the pump wheel 16 is not rotating anymore in the disengaged state of the clutch arrangement 14.

The continuous frictional braking arrangement 50 comprises an elastic friction means 56,56' which is in continuous frictional contact with the pump wheel 16 and the pump housing 11. A cylindrical outside surface 59 of the blade covering ring 62 is provided with a radial circular groove 54 which is open to the radial outside. The circular groove 54 is surrounded

by a static circular surface 52 of a cylindrical portion 64 of the pump housing 11 so that a circular cylindrical gap 57 is defined between the corresponding cylindrical surfaces 52,59.

The friction means 56,56' is provided in and hold by the circular groove 54. In the first embodiment of the pump 10 shown in figure 1, the friction means 56 is an elastic closed ring body 55 seated in the circular groove 54. The closed ring body 54 is a so-called o-ring made out of an elastic material, as for example rubber or plastics. The nominal radial diameter of the ring body 55 is a bit larger than the radial groove depth and the radial gap width so that the ring body 55 fluidically closes the radial gap 57.

In the second embodiment of the pump 10 shown in figure 2, the friction means 56' is defined by four separate non-closed ring bodies 55' seated in the circular groove 54. The ring bodies 55' a made out of metal, are bending-flexible and pretensioned radially outwardly.

The friction means 56, 56' of the frictional braking arrangement 50 continuously generate a frictional force which is sufficient to completely stop rotation of the pump wheel 16 if the friction clutch arrangement 14 is in the disengaged state.

CLAIMS

1. A switchable mechanical automotive coolant pump (10) for providing a liquid coolant for an internal combustion engine (19), comprising

a static pump housing (11),

a rotatable pulley wheel (12) supported by a shaft (20),

a rotatable pump wheel (16) for pumping the coolant from an axial pump inlet opening (13) radially outwardly into an outlet volute (17),

a friction clutch arrangement (14) for co-rotatably engaging or disengaging the pulley wheel (12) with the pump wheel (16), and

a continuous frictional braking arrangement (50) comprising an elastic friction means (56) which is continuously in frictional contact with the pump wheel (16) and the pump housing (11), wherein the friction generated by the frictional braking arrangement (50) is high enough to stop the rotation of the pump wheel (16) when the friction clutch arrangement (14) is in the disengaged state.

2. The switchable mechanical automotive coolant pump (10) of claim 1, wherein the shaft (20) is provided co-rotatably with the pulley wheel (12) and the pump wheel (16) is supported by the rotatable shaft (20).

3. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction clutch arrangement (14) is provided as a wet clutch within a wet zone (9) of the pump (10).

4. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction clutch arrangement (14) comprises a pump wheel-sided friction ring (36) at the back side of a pump wheel base disk (60) and a pulley wheel-sided friction ring (34) at a clutch wheel (32) co-rotating with the pulley wheel (12).

5. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction clutch arrangement (14) comprises an electromagnetic actuation coil (30) for axially actuating the pulley wheel-sided friction ring (34).

6. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the pump wheel (16) is an impeller with a base disk (60), numerous blades (61) extending from the base disk (60) and a blade covering ring (62) defining an axial pump wheel inlet (58), the friction means (56) being arranged between the blade covering ring (62) and a corresponding housing portion (64).

7. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction means (56; 56') is provided at a substantially cylindrical portion (64) of the pump housing (11).

8. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction means (56) is an elastic closed ring body (55) seated in a circular groove (54).

9. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the friction means (56') is at least one bending-flexible and non-closed ring body (55') seated in a circular groove (54).

10. The switchable mechanical automotive coolant pump (10) of one of the preceding claims, wherein the circular groove (54) is a radial groove with a radial groove opening.

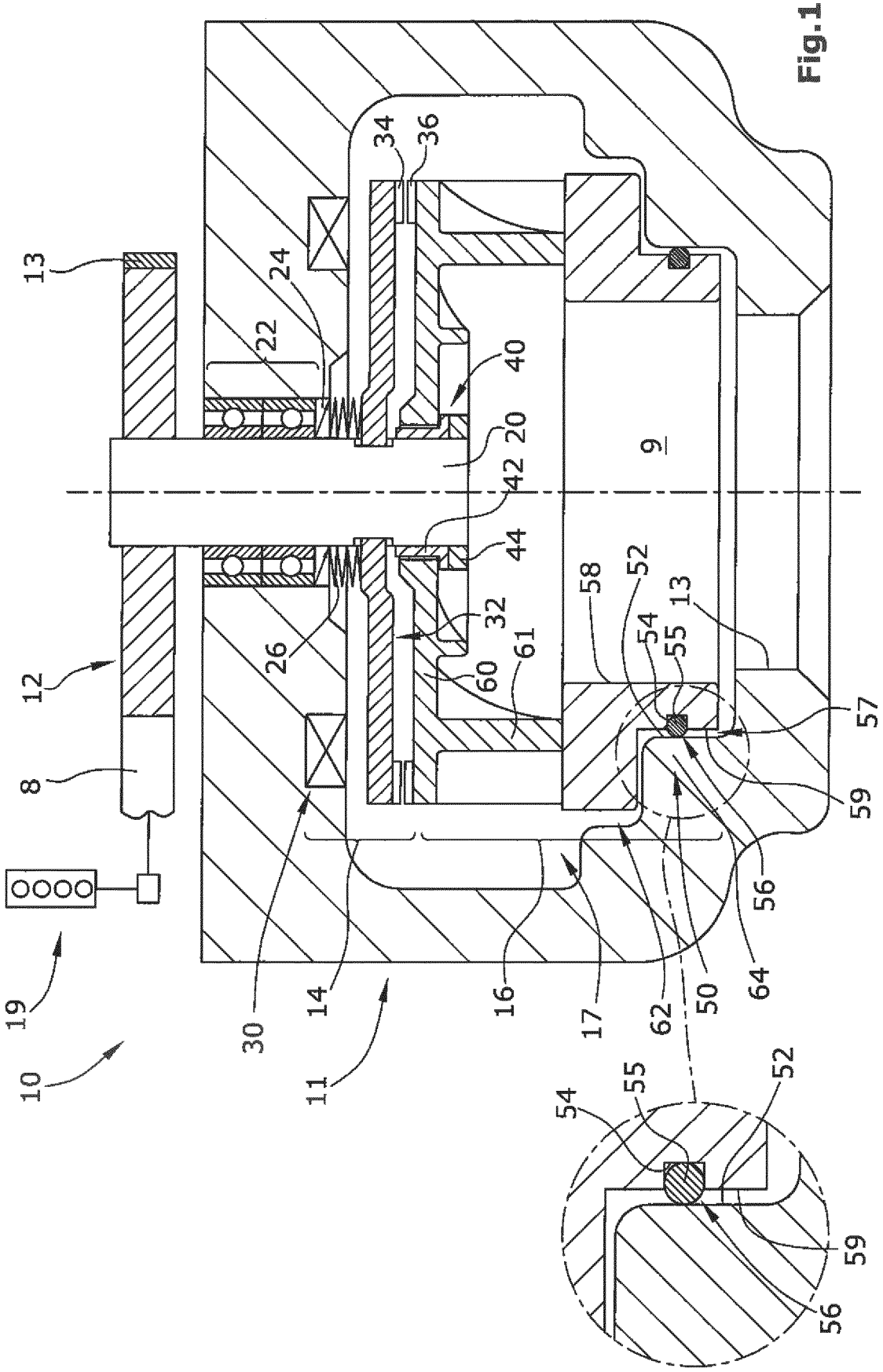
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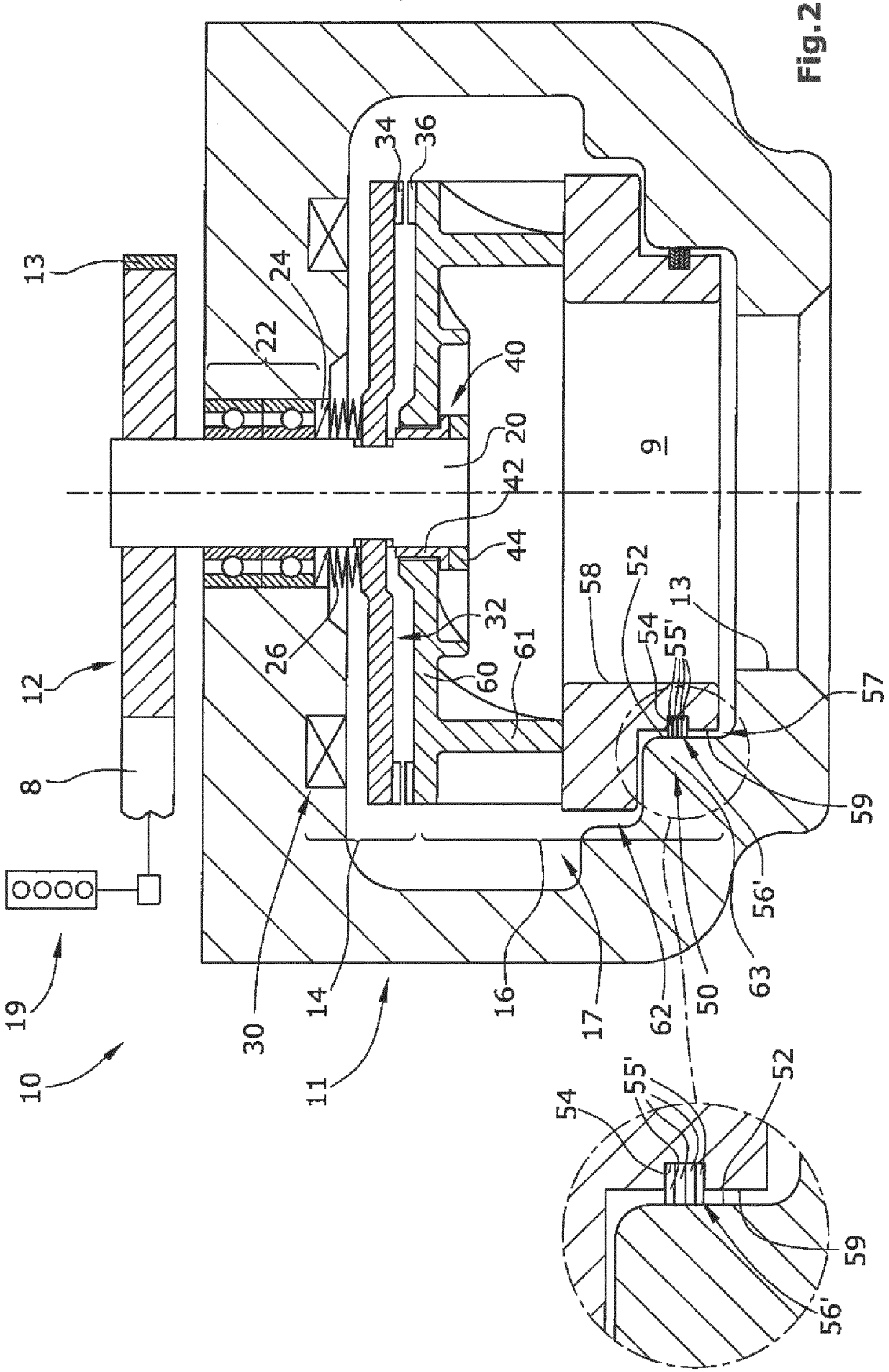
Fig.1

Fig.2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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/066076

A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01P F04D F16J F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2013/079103 A1 (PIERBURG PUMP TECHNOLOGY GMBH [DE]; DURAND JEAN-MICHEL [FR]; SCHNEIDER) 6 June 2013 (2013-06-06) pages 1-2 pages 5-7 figure 1	1-10
Y	US 3 741 679 A (JOHNSTON D) 26 June 1973 (1973-06-26) figures 1-2	1-8,10
Y	WO 2013/092144 A1 (SULZER PUMPEN AG [CH]) 27 June 2013 (2013-06-27) figure 3	1-10
A	US 3 173 696 A (REINHARDT WILLIAM J ET AL) 16 March 1965 (1965-03-16) figure 3	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/066076

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