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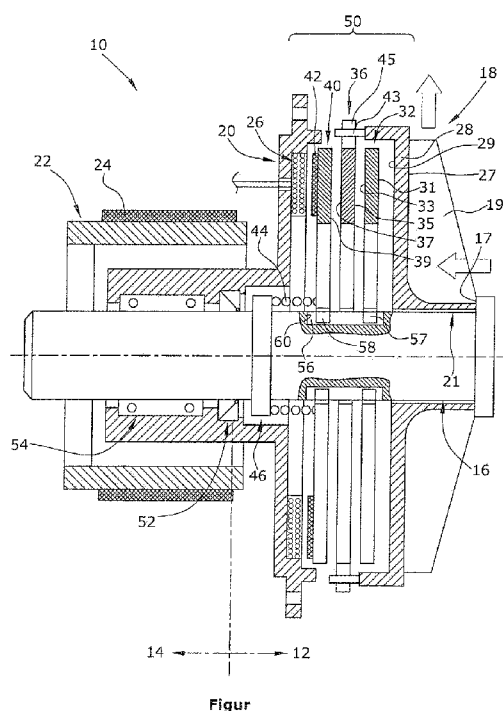
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(54) Title: MECHANICAL AUTOMOTIVE COOLANT PUMP



(57) Abstract: The invention refers to a mechanical automotive coolant pump (10) with a wet friction clutch (50) being actuated by an electromagnet (26). The pump (10) comprises a rotatable shaft (16) and a pulley wheel (22) being co-rotatably supported by the shaft (16), a pump wheel (18) being supported by the shaft (16), whereby the pump wheel (18) is rotatable with respect to the shaft (16), and a shaft sealing (52) separating a wet section (12) and a dry section (14) of the pump (10). The friction clutch (50) is arranged in the wet pump section (12) and comprises a first pump wheel-connected friction ring surface (29) and a separate second pump wheel-connected friction ring surface (35), whereby both pump wheel-connected friction ring surfaces (29, 35) are co-rotatably connected to the pump wheel (18), and a first shaft-connected friction ring surface (31) and a separate second shaft-connected friction ring surface (33), whereby both shaft-connected friction ring surfaces (31, 33) are co-rotatably connected to the shaft (16) and are arranged opposite to the first and second pump wheel-connected friction ring surfaces (29, 35), respectively. One friction ring surface (29) is axially not shiftable and the other friction ring surfaces (31, 33, 35) are axially shiftable. A last friction ring surface (39) being the closest to the dry section (14) is axially pretensioned by a spring element (44) into the engaged direction and is provided with a ferromagnetic element (42). The electromagnet (26) is arranged axially opposite to the ferromagnetic element (42) so that the energized electromagnet (26) axially attracts the last friction ring surface (39) into the disengaged position.

Mechanical automotive coolant pump

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The invention refers to a mechanical automotive coolant pump with a wet friction clutch whereby the friction clutch is actuated by an electromagnet.

Mechanical automotive coolant pumps are mechanically driven by the internal combustion engine of an automobile, so that the coolant pump's rotational speed is proportional with the engine's rotational speed. A switchable mechanical coolant pump can be adapted to the cooling demand of the engine by engaging and disengaging a friction clutch which connects or disconnects the pulley wheel with or from the pump wheel. A dry friction clutch increases the axial length of the coolant pump's dry part which projects in distal direction from the engine's block into the motor compartment. If the friction clutch is arranged in the wet section of the pump, the dry sector of the coolant pump is more compact. Since the friction forces of a wet friction clutch are decreased significantly compared with a dry friction clutch, the diameter of the friction clutch ring has to be increased to guarantee the same level of transfer torque compared to a dry friction clutch.

It is an object of the invention to provide a switchable mechanical automotive coolant pump with a wet friction clutch with high transfer torque.

This object is achieved with a mechanical automotive coolant pump with the feature of claim 1.

According to the invention, the switchable mechanical automotive coolant pump is provided with a wet friction clutch which is actuated by an electromagnet. A rotatable pump shaft is provided which supports the pulley wheel co-rotatably so that the pulley wheel always rotates with the same rotational speed as the shaft. The pulley wheel can be driven by the engine via a pulley belt or a gear arrangement. On its other axial end the shaft supports the pump wheel which is rotatable with respect to the shaft. The pump wheel is, for example, supported by a friction type bearing at the shaft. A shaft sealing is provided surrounding the shaft and separating the coolant pump into a wet section and a dry section. In the wet section all parts are in contact with the coolant which is, for example, water.

The friction clutch is arranged in the wet pump section and is realized as a multi-disc clutch. The friction clutch is provided with a first pump-wheel-connected friction ring surface and a separate second pump wheel-connected friction ring surface. Both pump wheel-connected friction ring surfaces are, directly or by suitable means, co-rotatably connected with the pump wheel. Additionally, a first shaft-connected friction ring surface and a separate second shaft-connected friction ring surface are provided whereby both shaft-connected friction ring surfaces are co-rotatably connected to the shaft and are arranged opposite to the first and the second pump wheel-connected friction ring surfaces, respectively. As a consequence, the pump is provided with at least two pairs of co-operating friction ring surfaces so that the transfer torque of the wet friction clutch is increased significantly.

One friction clutch surface is axially not shiftable or is at least provided with an axial bearing which stops or limits the axial movement of the said friction ring surface. All other friction ring surfaces are axially shiftable. At least one friction ring surface is directly pretensioned by an axial spring

element into the engaged direction and is provided with a ferromagnetic element. The pretensioned friction ring surface is the friction ring surface which is the closest to the dry section. The ferromagnetic element allows to axially attract this friction ring surface with the electromagnet. The
5 electromagnet is arranged axially opposite and adjacent to the ferromagnetic element so that the energized electromagnet axially attracts the last friction ring surface into the disengaged position. The arrangement of a mechanical spring element pretensioning the last friction ring surface into **the** engaged direction and of the electromagnet to directly disengage
10 the last friction ring surface when the electromagnet is energized makes **the** coolant pump failsafe because a failure of the electromagnet always leads to an engaged friction clutch.

Preferably, the first pump wheel-connected friction ring surface is defined
15 by the backside of the pump wheel. The front side of the pump wheel is provided with pump wheel blades which are arranged at a pump wheel base disk lying within a more or less radial plane. The backside of the base disk serves as a basis for the first pump wheel-connected friction ring or defines the pump wheel-connected friction ring itself. Therefore, the pump
20 wheel body has two functions, i.e. serving as a pumping element and as a clutch element.

According to a preferred embodiment of the invention, the first and the second shaft-connected friction ring surfaces are defined by both sides of
25 the first shaft-connected clutch disk which is rotatable with respect to the pump wheel and which is co-rotating with the shaft. The first shaft-connected clutch disk is axially shiftable **with** respect to the shaft.

Preferably, the second wheel-connected friction ring surface is defined by a first wheel-connected clutch disk, whereby the first wheel-connected clutch disk is rotatable and axially shiftable with respect to the shaft.

5 According to a preferred embodiment of the invention, a second shaft-connected clutch disk is provided with a third shaft-connected friction ring surface cooperating with a third wheel-connected friction ring surface of the first wheel-connected friction clutch disk. The third shaft-connected friction ring surface and the third wheel-connected friction ring surface
10 define a third friction surface pair so that the transferable torque is increased significantly without increasing the diameter of the wet clutch.

Preferably, the shaft-connected disks are provided with drive noses orientated radially inwardly and engaging axial drive slits provided at the
15 driving shaft. As a consequence, the shaft-connected clutch disks are, with respect to rotation, form-fitted at the shaft but remain axially shiftable with respect to the shaft. The more noses-slit pairs are provided the more torque can be transferred between the shaft and of the shaft-connected clutch disks.

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According to a preferred embodiment of the invention an axial clutch disk stop is provided at the driving shaft to keep an axial clearance between the last clutch disk in its disengaged position and the electromagnet. Since the electromagnet is a stator part which is not rotating and which is
25 supported by the static pump housing, it is necessary to guarantee a clearance between the electromagnet and the adjacent clutch disk in its disengaged position. However, the axial clearance between the last clutch disk in its disengaged position as well as in an engaged position should be as small as possible to minimize the magnetic losses which are dependent
30 on the axial clearance.

Preferably, the pulley wheel is a belt pulley wheel which can be driven by a driving belt which is driven by the internal combustion engine.

5 In the following, one embodiment of the invention is described referring to the enclosed drawing, wherein

the figure shows a longitudinal cross-section of the mechanical switchable automotive coolant pump.

10 The figure shows a switchable mechanical automotive coolant pump 10 with a wet friction clutch 50 which is actuated by an electromagnet 26. The coolant pump 10 is adapted to be mounted at the engine block of an internal combustion engine for an automobile.

15 The coolant pump 10 is provided with a rotatable rotor shaft 16 supporting the pulley wheel 22 which is fixed to the shaft 16 so that the pulley wheel 22 is co-rotating with the shaft. The shaft 16 is supported by a shaft bearing 54 which is fixed to the pump housing 20. The pump housing 20 can be mounted to the engine block of the internal combustion engine.

20 The pulley wheel 22 is driven by driving belt 24 which is driven by the engine.

The coolant pump 10 is separated into a wet section 12 and a dry section 14 by the housing 20 and a shaft sealing 52 which is seated in a suitable
25 sealing seat of the housing 20. The pulley wheel 22 and the shaft bearing 54 are provided in the dry section 14, whereas a wet friction clutch 50 which is actuated by the electromagnet 26 and a pump wheel 18 are provided in the wet section 12.

The pump wheel 18 is provided at the wet axial end of the shaft 16 opposite the dry axial end of the shaft 16 where the pulley wheel 22 is provided. The pump wheel 18 is supported by a friction bearing 21 **rotatable** at and with respect to the shaft 16. The wet axial end of the
5 shaft 16 is provided with a circular axial stop 17 defining an axial bearing for the pump wheel 18. The pump wheel 18 is provided with a pump wheel base disk 28 lying in radial plane and with a number of pump wheel blades 19 projecting with an axial component from the front side 27 of the wheel base disk 28.

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The wet clutch 50 comprises a backside 29 of the **pump** wheel base disk 28, three separate **and** axially shiftable clutch disks 32, 36, 40 and the static electromagnet 26 which is fixed at the wet side of the pump housing 20. All clutch disks 32, 36, 40 are axially shiftable with respect to the shaft
is 16. The wet clutch 50 is provided with three friction surface pairs defined by respective friction surfaces 29, 31, 33, 35, 37, 39 of the backside 29 of the pump wheel base disk 28, the front side of the second shaft-connected clutch disk 40 and of the front as well of the back sides of the first shaft-connected clutch disk 32 and of the wheel-connected clutch disk 36.

20

The back side 29 of the pump wheel base disk 28 and the front side of the first shaft-connected clutch disk 32 define the first pair of friction ring surfaces 29,31 . The backside of the first shaft-connected clutch disk 32 and the front side of the wheel-connected clutch disk 36 define the second
25 pair of friction ring surfaces 33, 35. The backside of the wheel-connected clutch disk 36 and the front side of the second shaft-connected clutch disk 40 define the third pair of friction ring surfaces 37, 39. At the backside of the second shaft-connected clutch disk 40 a ferromagnetic ring element 42 is provided.

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The wheel-connected clutch disk 36 is rotatable and shiftable with respect to the shaft 16 but is co-rotating with the pump wheel 18. At the outer circumference of the pump wheel base disk 28 a ring of axial pins 43 is provided which cooperate with a ring of axial slits 45 provided at the outer
5 circumference of the wheel-connected clutch disk 36. This arrangement allows an axial movement of the wheel-connected clutch disk 36 and ensures that the wheel-connected clutch disk 36 is always co-rotating with the pump wheel 18.

10 The two shaft-connected clutch disks 32, 40 are provided with a ring of drive noses 57, 58 projecting radially inwardly into respective axial drive slits at the circumference of the shaft 16. This arrangement allows an axial shifting of the two shaft-connected clutch disks 32, 40, and ensures co-rotating of the shaft-connected clutch disks 32, 40 with each other and
15 with the shaft 16. The dry-sided axial ends of the driving slits 56 serve as an axial clutch disk stop 60 which guarantees that there remains always an axial clearance of at least 0,1 mm between the adjacent last clutch disk 40 in its disengaged position and the electromagnet 26.

20 The second and last shaft-connected clutch disk 40 is axially pretensioned into the engaged position by a spring element 44 which is axially supported by a support ring 46 provided at the shaft 16.

When the electromagnet 26 is not energized, the clutch disks 40, 36, 32
25 are pushed against each other and against the base disk 28 of the pump wheel 18, so that the corresponding pairs of friction ring surfaces 39, 37, 35, 33, 31, 29 are pushed against each other so that the friction clutch 50 is engaged. When the friction clutch 50 is engaged, the pump wheel 18 is co-rotating with the pulley wheel 22. When the electromagnet 26 is
30 energized, the ferromagnetic ring element 42 is axially attracted by the

electromagnet 26 thereby axially pulling the second shaft-connected clutch disk 40 into its disengaged position. This allows also the two other clutch disks 36, 32 to axially disengage from each other so that the friction clutch 50 is completely disengaged.

CLAIMS

- 5 1. Mechanical automotive coolant pump (10) with a wet friction clutch (50) being actuated by an electromagnet (26), with
a rotatable shaft (16) and a pulley wheel (22) being co-rotatably supported by the shaft (16),
a pump wheel (18) being supported by the shaft (16), whereby the
10 pump wheel (18) is rotatable with respect to the shaft (16), and
a shaft sealing (52) separating a wet section (12) and a dry section (14) of the pump (10),
the friction clutch (50) being arranged in the wet pump section (12) and comprising
15 a first pump wheel-connected friction ring surface (29) and a separate second pump wheel-connected friction ring surface (35), whereby both pump wheel-connected friction ring surfaces (29,35) are co-rotatably connected to the pump wheel (18) , and
20 a first shaft-connected friction ring surface (31) and a separate second shaft-connected friction ring surface (33), whereby both shaft-connected friction ring surfaces (31,33) are co-rotatably connected to the shaft (16) and are arranged opposite to the first and second pump wheel-connected friction
25 ring surfaces (29, 35), respectively,
whereby one friction ring surface (29) is axially not shiftable and the other friction ring surfaces (31, 33, 35) are axially shiftable,
whereby a last friction ring surface (39) being the closest to the dry section (14) is axially pretensioned by a spring element (44) into the

engaged direction and is provided with a ferromagnetic element (42), and

whereby the electromagnet (26) is arranged axially opposite to the ferromagnetic element (42) so that the energized electromagnet (26) axially attracts the last friction ring surface (39) into the disengaged position.

2. Mechanical automotive coolant pump (10) of **claim 1**, whereby the first pump wheel-connected friction ring surface (29) is defined by the backside of a base disk (28) of the pump wheel (18).

3. Mechanical automotive coolant pump (10) of one of **the** preceding claims, whereby the first and **the** second shaft-connected friction ring surfaces (31, 33) are defined by both sides of a first shaft-connected clutch disk (32) which is co-rotating with the shaft (16) and is rotatable with respect to the pump wheel (18).

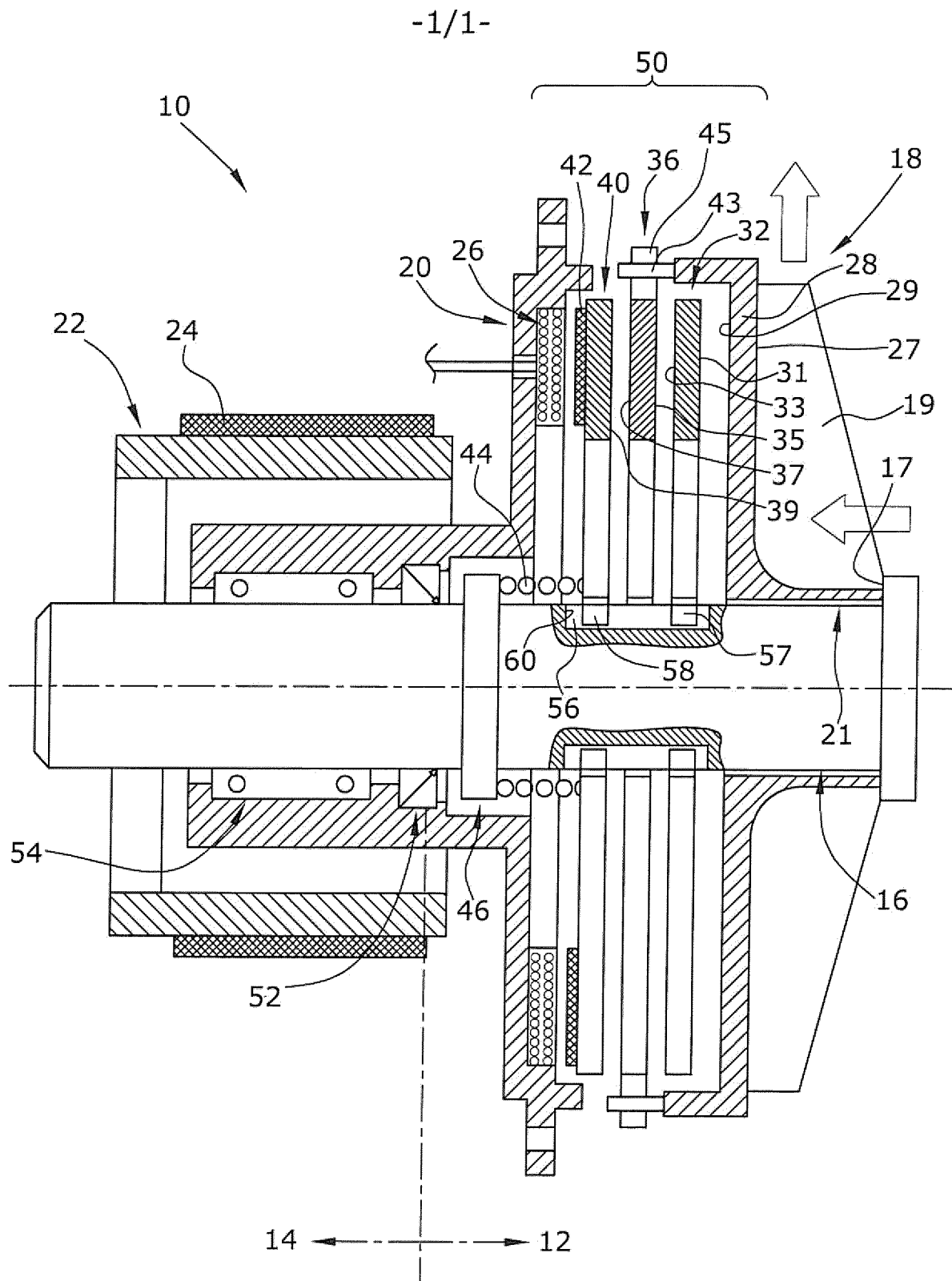
4. Mechanical automotive coolant pump (10) of one of the preceding claims, whereby the second wheel-connected friction ring surface (35) is defined by a first wheel-connected clutch disk (36).

5. Mechanical automotive coolant pump (10) of one of the preceding claims, whereby a second shaft-connected clutch disk (40) is provided which is provided with a third shaft-connected friction ring surface (39) cooperating with a third wheel-connected friction ring surface (37) of the first wheel-connected clutch disk (36).

6. Mechanical automotive coolant pump (10) of one of the preceding claims, whereby the shaft-connected clutch disks (32, 40) are

provided with drive noses (57, 56) orientated radially inwardly and engaging axial driving slits (56) provided at the driving shaft (16).

7. Mechanical automotive coolant pump (10) of one of the preceding
5 claims, whereby an axial clutch disk stop (60) is provided at the
driving shaft (16) to keep an axial clearance between the last clutch
disk (40) in its attracted disengaged position and the electromagnet
(26).
- 10 8. Mechanical automotive coolant pump (10) of one of the preceding
claims, whereby the pulley wheel (22) is a belt pulley wheel drivable
by a driving belt (24).



Figur

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/071379

A. CLASSIFICATION OF SUBJECT MATTER INV. F01P7/12 F16D27/115 F04D13/02 F01P5/12 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 F16D F04D		
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		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 100 57 098 CI (GERAETE & PUMPENBAU GMBH [DE]) 28 March 2002 (2002-03-28) abstract figures	1,4-8
Y	DE 197 52 372 AI (BEEZ GUENTHER DI PL ING [DE]) 27 May 1999 (1999-05-27) abstract column 4, lines 25-52 figures 1, 4	1,4-8
Y	GB 2 391 048 A (VISTEON GLOBAL TECH INC [US]) 28 January 2004 (2004-01-28) abstract figure 2	1,4-6,8
☐ 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

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 10057098	C I	28-03-2002	NONE	

DE 19752372	A l	27-05-1999	NONE	

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