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(54) **Title:** MECHANICAL COOLANT PUMP

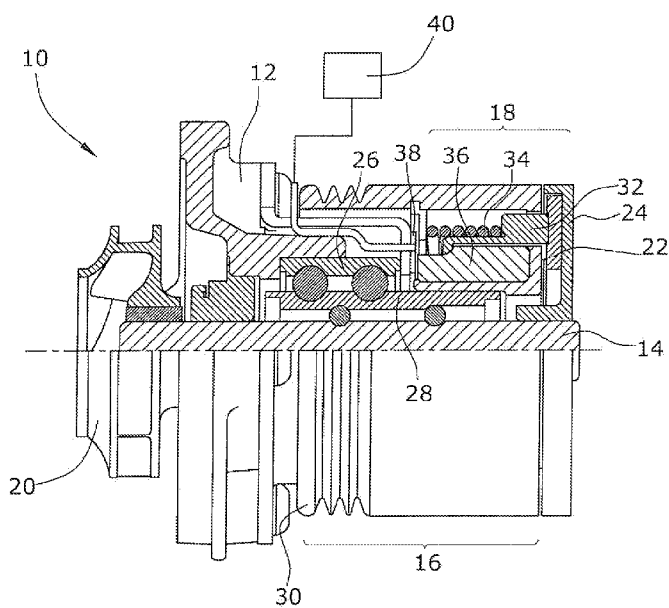


Fig. 1

its expanded state.

(57) **Abstract:** The present invention refers to a mechanical switchable coolant pump 10 for an internal combustion engine. The pump 10 comprises a stationary pump frame 12, a rotatable pump wheel shaft 14 with a pump wheel 20 arranged at a first end of the pump wheel shaft 14 and a first clutch ring 24 arranged at the second end of the pump wheel shaft 14. The pump wheel shaft 14 is rotatably supported by the pump frame 12. Further, the pump 10 comprises a rotatable pulley wheel arrangement 16 rotatably supported by the pump frame 12 and rotating independently of the pump wheel shaft 14. The pulley wheel arrangement 16 comprises a pulley wheel 30 and a second clutch ring 22, whereby the pulley wheel 30 can be driven by the combustion engine. The clutch arrangement 18 comprises the first clutch ring 24, the second clutch ring 22, a pretensioning element 34, a pushing wax element 36 and an electrical heating element 38. The pretensioning element 34 is axially pretensioning one clutch ring into an engaged position. The pushing wax element 36 pushes the pretensioned clutch ring into a disengaged position when the wax element 36 is in its expanded state. The electrical heating element 38 is provided for heating the wax element 36. The clutch is engaged when the electrical heating is not working because the wax element 36 is in its non-expanded state. The clutch is disengaged when the electrical heating is working so that the wax element 36 is in

DESCRIPTION

5 Mechanical coolant pump

The present invention refers to a mechanical switchable coolant pump for an internal combustion engine.

10 A mechanical switchable coolant pump is a coolant pump which is driven by the combustion engine itself, for example by using a driving belt driving a pulley-wheel of the coolant pump. The pulley-wheel is driving the pump wheel shaft or a pump wheel which is rotatably fixed at the pump wheel shaft. The rotational speed of such a coolant pump is proportional to the
15 rotational speed of the engine's crankshaft so that the coolant pump is running permanently even if no coolant flow is needed by the engine. This increases the fuel consumption of the combustion engine unnecessarily. Therefore switchable coolant pumps are used to optimize the energy consumption of the system. Especially, as long as the combustion engine
20 is cold and no substantial coolant flow is needed, the coolant pumps can be switched-off with the result that the combustion engine's warming-up phase is shortened, the exhaust emission decreases and the fuel consumption is reduced.

25 A mechanical coolant pump of the prior art which is switchable is known from GB 2 408 775 A. The disclosed coolant pump provides a pump wheel shaft and a driven shaft. A clutch including a first and a second clutch member is provided between both shafts. The first clutch member is axially moveable into and out of engagement to connect and disconnect

the pump wheel shaft with the drive shaft. The mechanical clutch of such a coolant pump is controlled by a pretensioning element, for example a spring, and a wax element. The spring biases the first clutch member into a disengaged position, the wax element pushes the first clutch member
5 against the biasing force into the engaged position if the temperature of the coolant is above a limiting value. The wax element is affected by the coolant temperature itself. However, such a clutch arrangement is not fail-safe, because the clutch is disengaged if the wax element is broken.

10 Therefore, it is an object of the present invention to provide a mechanical switchable coolant pump which overcome the disadvantages of the prior art.

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

The mechanical switchable coolant pump for an internal combustion engine according to claim 1 comprises a stationary pump frame, a rotatable pump wheel shaft with a pump wheel arranged at a first end of
20 the pump wheel shaft and a first clutch ring arranged at the second end of the pump wheel shaft. The pump wheel shaft is rotatably supported by the pump frame. Preferably, the pump wheel shaft is rotatably supported by a second anti-friction bearing. Further, the pump comprises a rotatable pulley wheel arrangement rotatably supported by the pump frame and
25 rotating independently of the pump wheel shaft. Preferably, the pulley wheel arrangement is rotatably supported by a first anti-friction bearing supported by the pump frame. The pulley wheel arrangement comprises a pulley wheel and a second clutch ring, whereby the pulley wheel can be driven by the combustion engine, for example by a driving belt.

The clutch arrangement comprises the first clutch ring, the second clutch ring, a pretensioning element, a pushing wax element and an electrical heating element. The pretensioning element is axially pretensioning one clutch ring into an engaged position. The pushing wax element pushes the
5 pretensioned clutch ring into a disengaged position when the wax element is in its expanded state. The electrical heating element is provided for heating the wax element. The clutch is engaged when the electrical heating is not working because the wax element is in its non-expanded state. The clutch is disengaged when the electrical heating is working so
10 that the wax element is in its expanded state. This arrangement makes the pump fail-safe because a leaky wax element causes the clutch to be engaged. Furthermore, using a wax element for switching a coolant pump clutch is a very economic solution.

15 Preferably, the wax element is part of and rotatably fixed to the rotatable pulley wheel arrangement. The wax element pushes directly the second clutch ring axially into the disengaged position if the electrical heating is working. Such an arrangement minimizes the installation space of such a pump.

20

According to a preferred embodiment, the electrical heating element is fixed at the pump frame. The heating element is positioned adjacent and face to face to the rotatable wax element so that the heat generated by the heating element is efficiently transferred to the wax element. The wax
25 element and the heating element are not in direct contact to each other. The distance between the heating element and the rotating wax element should be as small as possible to allow a heat transfer which is almost free of losses.

Preferably, the pretensioning element is a part of the pulley wheel arrangement and is preferably an axial compression spring. The spring biases the second clutch ring axially into an engaged position, so that the pump is working even in case of an electrical power loss, so that the pump is fail-safe.

Preferably, the pulley wheel arrangement is directly rotatably supported by the pump frame via a first anti-friction bearing and the pump wheel shaft is directly rotatably supported by the pulley wheel arrangement via a second anti-friction bearing. The first anti-friction bearing is preferably connected in series with the second anti-friction bearing. The first anti-friction bearing can encircle the second anti-friction bearing. This allows a compact arrangement of the pump.

According to a preferred embodiment, the switching temperature of the wax element is higher than 120 °C, preferably between 140 and 200 °C, more preferably between 140 and 180 °C, and most preferred between 140 and 160 °C. The temperature of a coolant in a combustion engine is typically not higher than 120 °C. A wax element with a switching temperature higher than 120 °C avoids an unintentional switching of the wax element caused by a hot coolant. In addition, a switching temperature above the maximum coolant temperature enables a switching of the wax element independent of the coolant temperature in the engine.

According to a preferred embodiment, the pump comprises a pump control unit, whereby the pump control unit switches the electrical heating element on if the coolant temperature of the engine is below a limiting value and switches the electrical heating element off if the coolant temperature is above the limiting value, for example 70 to 90 °C.

One preferred embodiment of the invention is described with reference to the drawing, wherein

figure 1 shows a perspective partial-sectional view of a mechanical coolant
5 pump.

Figure 1 shows a mechanical switchable coolant pump 10 for providing a coolant to an internal combustion engine (not shown). The pump 10 comprises a stationary pump frame 12, a rotatable pump wheel shaft 14,
10 a pulley wheel arrangement 16 and a clutch arrangement 18.

The pump wheel shaft 14 is provided with a pump wheel 20 arranged at a first end of the pump wheel shaft 14 and a first clutch ring 24 positioned at the second end of the pump wheel shaft 14 adjacent to a pulley wheel
15 30. The pump wheel shaft 14 is rotatably supported by the pump frame 12 via a bearing arrangement.

The pulley wheel arrangement 16 is rotatably supported at the pump frame 12 by the bearing arrangement, but rotatably independent of the
20 pump wheel shaft 14. More specifically, the pulley wheel arrangement 16 is directly rotatably supported by the pump frame 12 via a first ball bearing 26 and the pump wheel shaft 14 is directly rotatably supported by the pulley wheel arrangement 16 via a second ball bearing 28. Both bearings 26, 28 are arranged in series. The pulley wheel arrangement 16
25 comprises the pulley wheel 30 and a second clutch ring 22. The pulley wheel 30 can be driven by the combustion engine, for example by using a driving belt (not shown).

The clutch arrangement 18 comprises the first clutch ring 24, a shifting ring 32, the second clutch ring 22, a compression spring 34, a pushing wax element 36 and an electrical heating element 38.

5 The compression spring 34 biases axially the shifting ring 32 and the second clutch ring 22 into an engaged position. Both, the shifting ring 32 and the second clutch ring 22 are directly connected to each other. Further, the second clutch ring 22 is provided with a friction layer (not shown) at the axial distal side of the clutch ring 22. The pushing wax
10 element 36 pushes the pretensioned second clutch ring 22 into a disengaged position when the wax element 36 is in its expanded state. The electrical heating element 38 is provided for heating the wax element 36 and is stationary fixed at the pump frame 12.

15 The heating element 38 is positioned adjacent and face to face to the rotatable wax element 36 so that the heat generated by the heating element 38 is transferred efficiently to the wax element 36. The wax element 36 and the heating element 38 are not in direct contact to each other. The distance between the heating element 38 and the rotating wax
20 element 36 is as small as possible to allow a heat transfer which is almost free of losses. The heating element 38 heats the wax element 36 so that the clutch is disengaged when the electrical heating is working and is engaged when the electrical heating is not working. More specifically, the wax element 36 is expanding in a temperature range of approximately of
25 140 - 200 °C so that the second clutch ring 22 is pushed against the biasing force of the compression spring 34 into the disengaged position.

The heating element 38 is controlled by a pump control unit 40, whereby the pump control unit 40 switches the electrical heating element 38 on if
30 the coolant temperature of the engine is below a limiting value, for

example 70 - 90 °C, and switches the electrical heating element 38 off if the coolant temperature is above the limiting value.

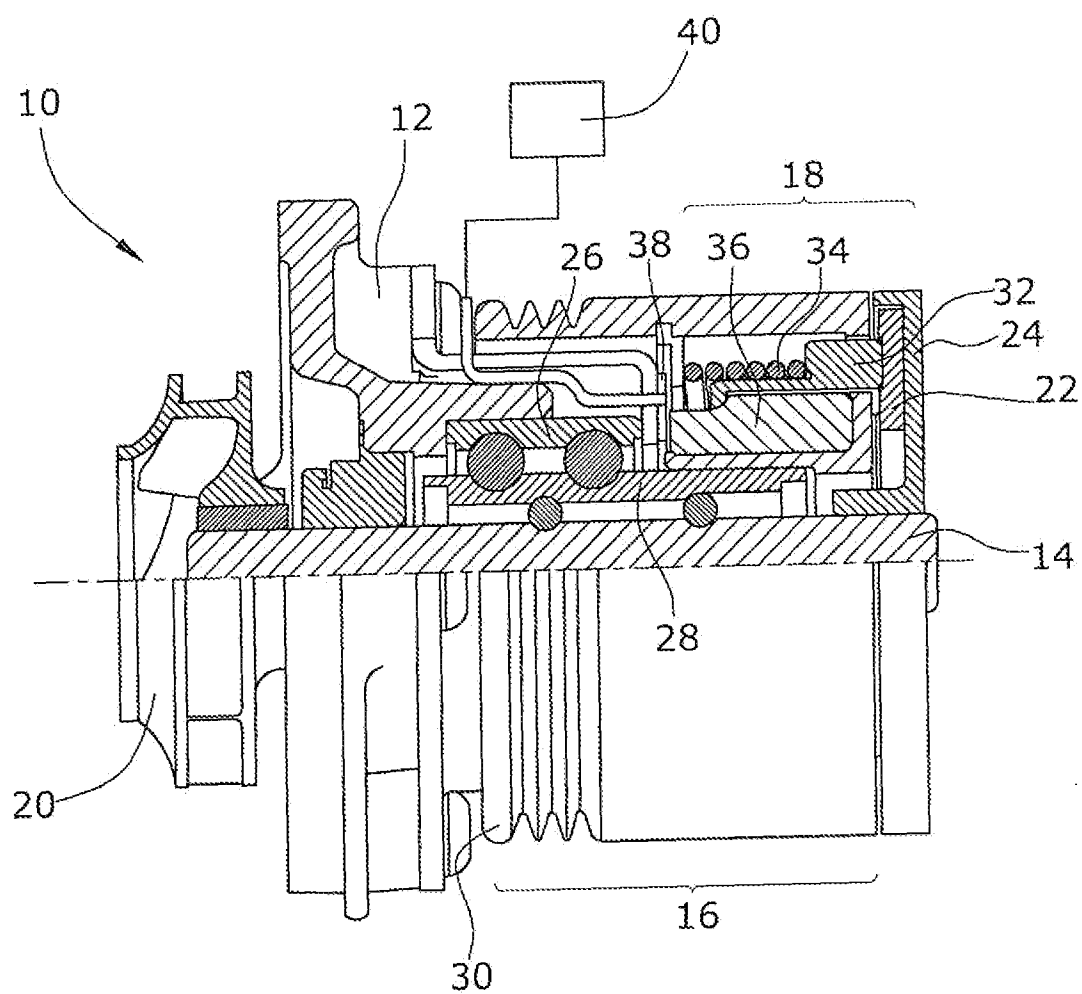
CLAIMS

- 5 1. Mechanical switchable coolant pump (10) for an internal combustion engine, comprising:
- a stationary pump frame (12),
- a rotatable pump wheel shaft (14) with a pump wheel (20) and a first clutch ring (24), whereby the pump wheel shaft (14) is rotatably supported by the pump frame(12).
- 10 a rotatable pulley wheel arrangement (16) rotatably supported by the pump frame (12) independent of the pump wheel shaft (14), the pulley wheel arrangement (16) comprising a pulley wheel (30) and a second clutch ring (22), whereby the pulley wheel (30) can be driven by the combustion engine, and
- 15 a clutch arrangement (18) comprising the first clutch ring (24), the second clutch ring (22), a pretensioning element (34) axially pretensioning one clutch ring (22) into an engaged position, a pushing wax element (36) pushing the pretensioned clutch ring into a disengaged position and an electrical heating element (38) heating the wax element (36), whereby the clutch is engaged when the electrical heating is not working and is disengaged when the electrical heating is working.
- 20
- 25 2. Mechanical switchable coolant pump (10) of claim 1, whereby the wax element (36) is part of and rotatably fixed to the pulley wheel arrangement (16).

3. Mechanical switchable coolant pump (10) of claim 1 or 2, whereby the electrical heating element (38) is fixed at the pump frame (12).
4. Mechanical switchable coolant pump (10) of one of the preceding
5 claims, whereby the pretensioning element (34) is a part of the pulley wheel arrangement (16).
5. Mechanical switchable coolant pump (10) of one of the preceding
10 claims, whereby the pulley wheel arrangement (16) is directly rotatably supported by the pump frame (12) and the pump wheel shaft (14) is directly rotatably supported by the pulley wheel arrangement (16).
6. Mechanical switchable coolant pump (10) of one of the preceding
15 claims, whereby the switching temperature of the wax element (36) is higher than 120 °C, preferably between 140 and 200 °C.
7. Mechanical switchable coolant pump (10) of claim 4, whereby the pretensioning element (34) is a compression spring.
- 20 8. Mechanical switchable coolant pump (10) of one of claims 1 to 7, comprising:

a pump control unit (40), whereby the pump control unit (40)
25 switches the electrical heating element (38) on if the coolant temperature of the engine is below a limiting value and switches the electrical heating element off if the coolant temperature is above the limiting value.

-1/1-

**Fig.1**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/070506

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01P5/12 F01P5/14
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

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 practical, 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.
A	FR 2 912 474 A1 (PIERBURG SARL [FR]) 15 August 2008 (2008-08-15) the whole document	1-8
A	GB 2 408 775 A (ECHLIN DO BRASIL IND E COM LTD [BR]) 8 June 2005 (2005-06-08) cited in the application the whole document	1-8
A	EP 0 054 896 A1 (HOECHST AG [DE]) 30 June 1982 (1982-06-30) the whole document	1-8
A	DE 21 09 341 A1 (STANDARD MAGNET AG) 4 November 1971 (1971-11-04) the whole document	1-8
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Further documents are listed in the continuation of Box C.



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"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2010/070506

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 28 34 199 A1 (DAIMLER BENZ AG) 21 February 1980 (1980-02-21) the whole document -----	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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