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(54) Mechanical coolant pump for cooling an internal combustion engine

(57) The invention refers to a switchable mechanical coolant pump (10) for cooling an internal combustion engine (12).

The coolant pump (10) is provided with a rotatable drive wheel (24) driven by the engine (12),
a pump wheel (30) being directly connected with the drive wheel (24), the pump wheel (30) comprising a wheel disk (34) and pump blades (32) projecting axially from the wheel disk (34),
a separate control disk (40) being axially movable and being provided with blade slits (44), the control disk (40) being provided at the pump wheel (30) so that the pump blades (32) are received in the blade slits (44), so that the blade height of the pump blades (32) between the wheel disk (34) and the control disk (40) is axially adjustable by axially shifting the control disk (40), and
an actuation element (46; 70) for actuating the control disk (40).

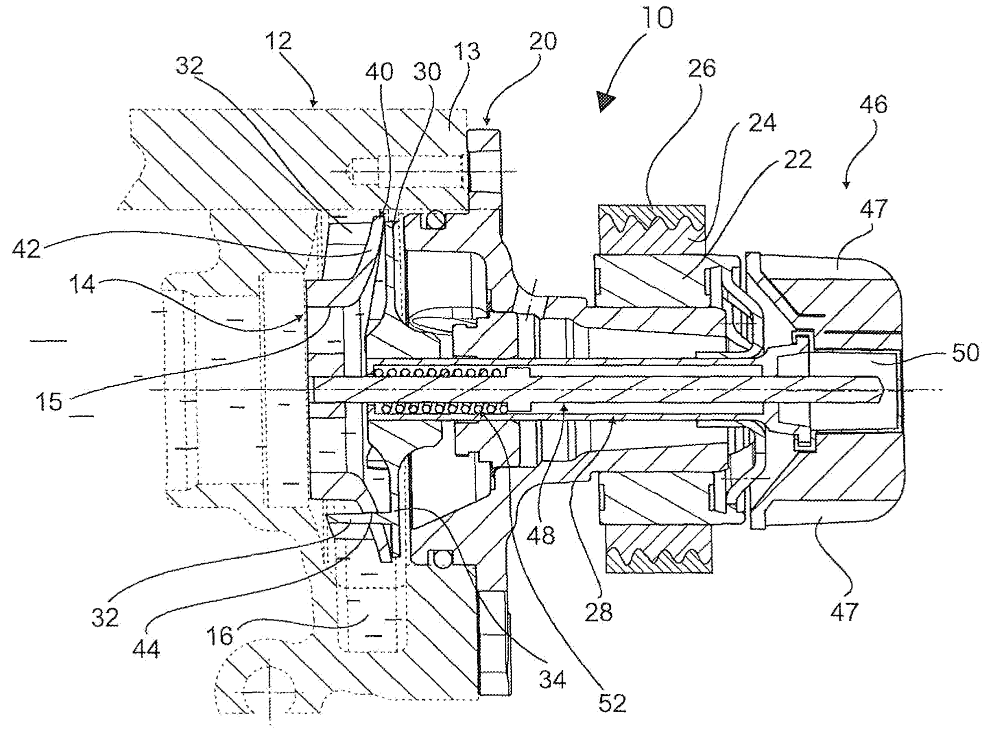

Fig. 1

EP 2 299 120 A1

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Description

[0001] The present invention refers to a mechanically driven liquid coolant pump for cooling an interval combustion engine.

[0002] A mechanical coolant pump is coupled to and driven by the engine itself. As a consequence, the coolant pump is driven as long as the engine is running, even if no or only a reduced coolant circulation is needed. This leads to unnecessary energy consumption for driving the pump while no coolant circulation is needed, and leads to a slow engine warming when the cold engine is started.

[0003] To solve this problem, coolant pumps of the state of the art can be switched off by means of a clutch between the drive wheel and the pump wheel of the coolant pump. This configuration bears the risk not to be totally failsafe because, in case of a malfunction or a jam of the clutch, a total stop of the pumping can occur when coolant circulation is needed. This can quickly lead to a serious damage of the engine.

[0004] It is an object of the invention to provide a switchable mechanical coolant pump which can be driven with a reduced circulation performance, if needed.

[0005] This object is, according to the invention, solved with a mechanical coolant pump with the features of claim 1.

[0006] The mechanical coolant pump according to the invention is provided with a rotatable drive wheel driven by the engine and with a pump wheel directly connected with the drive wheel, The pump wheel comprises a wheel disk and pump blades projecting axially from the wheel disk. A separate control disk is provided with blade slits. The control disk is coaxially provided at the pump wheel and is axially movable or shiftable with respect to the pump wheel, The pump blades are received in the blade slits of the control disk, so that the control disk is rotated by and is rotating with the pump wheel, and the effective axial blade height of the blades between the wheel disk and the control disk is adjustable by axially shifting the control disk. The pump wheel and the control wheel together form an impeller with a radial outside outlet. The impeller, and in concrete the control disk, can preferably be provided with a central axial inlet opening. An actuation element for actuating the control disk, i.e. for axially shifting the control disk, is provided.

[0007] The pumping performance of the coolant pump is controlled by the axial position of the control disk. When the control disk with an axial inlet opening is adjacent to the pump wheel disk in the idle position, the effective height of the pump blades between the pump disk and the control disk is low or zero. In this idle position or idle state, the coolant pump still is pumping but with a significantly reduced low efficiency. When the control disk is spaced apart from the pump disk in its pumping position or pumping state, the effective height of the pump blades between the pump disk and the control disk is higher so that the pump is pumping with a higher or with the maximum pump efficiency.

[0008] Since even in the idle position of the control disk the pump wheel still is rotating and is pumping with a reduced efficiency, the coolant pump is absolutely failsafe.

[0009] When the control disk is closed, i.e. no axial inlet opening is provided in it, the pumping position is the position of the control disk adjacent to the pump wheel disk, while the idle control disk position is spaced apart from the pump wheel disk.

[0010] According to a preferred embodiment, the drive wheel and the pump wheel are connected by a tubular driving shaft, and the control disk is moved via the hollow space inside the driving shaft. The tubular hallow configuration of the driving shaft makes it possible to position the actuation means for actuating the control disk remote from the control disk, for example distal of the drive wheel.

[0011] According to another preferred embodiment, the control disk is axially moved by an actuation rod inside the tubular driving shaft. The actuation rod makes it possible to position the actuation element at the very distal end of the pump, so that the actuation element does not need to be inside of the water bearing part of the pump.

[0012] The axial actuation of the control disk is preferably provided by a thermal actuation element which can be provided with a wax element or with a bimetal spring. A thermal actuation element does not need any electrical control, and therefore is highly reliable. As an alternative, the actuation element can be an electromagnetic actuator which pulls or pushes the actuation rod when energized.

[0013] The following drawings show two embodiments of the invention:

figure 1: a first embodiment of a cold mechanical coolant pump with an open pump wheel or control disk in the cold idle state, actuated by a thermal actuation element, in a longitudinal section,

figure 2: the warm mechanical coolant pump of figure 1 in the pumping state, in a longitudinal section,

figure 3: the coolant pump of figure 1 in perspective view,

figure 4: a second embodiment of a warm mechanical coolant pump in the pumping state, actuated by a electromagnetic actuation element, in a longitudinal section,

figure 5: the cold mechanical coolant pump of figure 4 in the idle state, in a longitudinal section,

figure 6: the coolant pump of figure 4 in perspective view, and

figure 7: the coolant pump of fig. 5 in perspective view.

[0014] Figures 1 to 3 show a first embodiment of a mechanically driven coolant pump 10 for cooling an internal combustion engine 12. The coolant pump 10 circulates a coolant by pumping a coolant liquid from a central axial pump inlet 14 to a radial pump outlet 16. The coolant pump 10 is switchable between an idle state shown in figure 1 and 3 and a pumping state shown in figure 2.

[0015] The coolant pump 10 is provided with a hollow circular frame 20 which is mounted to an engine block 13 of the engine 12. A distal end of the pump frame 20 supports a roller bearing 22 which is provided with a drive wheel 24. The drive wheel 24 is driven by a drive belt 26 which is driven by the engine 12.

[0016] The drive wheel 24 is directly connected to a hollow tubular driving shaft 28 which supports at its proximal end a pump wheel 30. The pump wheel 30 consists of a wheel disk 34 and several pump blades 32 projecting axially from the wheel disk 34. The drive wheel 24 is directly and without any slip connected to the pump wheel 30 so that the pump wheel 30 is rotating as long when the drive wheel 24 is rotating.

[0017] The pump wheel 30 is provided with an axially shiftable control disk 40. The control disk 40 consists of ring-like disk body 42 having a central inlet opening 15 and being provided with blade slits 44 through which the pump blades 32 protrude. The control disk 40 is rotated together with the pump wheel 30. The axial position of the control disk 40 is controlled by a thermal actuation element 46 via an actuation rod 48 which is moved axially by the thermal actuation element 46. The actuation rod 48 is pushed by a preload spring 52 into the idle position.

[0018] The thermal actuation element 46 is provided with a wax element 50, which significantly increases its volume with increasing temperature. The thermal actuation element 46 is provided with radial heat transfer fins 47 which improve the heat transfer between the wax element 50 and the environment. When the wax element 50 is cold, its volume is low so that the preload spring 52 is pushing the actuation rod 48 and the control wheel 40 into the idle position or idle state, as shown in figures 1 and 3. When the wax element 50 is warm, it pushes the actuation rod 48 and the control wheel 40 into the pumping position, as shown in figure 2.

[0019] In the idle position (Fig. 1), the control disk body 42 is adjacent or at least very close to the pump wheel disk 52 so that the effective axial height of the pump blades 32 between the control disk body 42 and the wheel disk 52 is very low. This leads to a low pumping efficiency of the pump 10 so that a low pumping rate is achieved. In the pumping position (Fig. 2), the control disk body 42 and the pump wheel disk 52 have the maximum axial distance from each other, so that the axial height of the pump blades 32 between the control disk body 42 and the wheel disk 52 is maximally. This leads to the maximum pumping efficiency of the pump 10 so that the high pumping rate is achieved.

[0020] The temperature of the wax element 50 is determined by the temperature of the engine 12 on the basis of heat conduction via the pump frame 20, and via the environment on the basis of heat exchange via the heat exchange fins 47. When the engine and the environment are relatively warm, the pump 10 is driven in the pumping state or state, as shown in figure 2. When the engine and the environment are relatively cold, the pump 10 is driven in the idle position or state, as shown in figures 1 and 3.

[0021] Figures 4 - 7 show a second embodiment of a mechanical coolant pump 10' which differs from the first embodiment shown in figures 1 and 2 only with respect to the actuation element and the control disk 40'. The actuation element 70 of the pump 10' shown in figures 4 to 7 is realized as an electromagnetic actuator 72 which interacts with the actuation rod 74. The distal end of the actuation rod 74 is provided with a permanent magnet 76 which is axially magnetized. The actuation element is hold by a mounting bracket 78 mounted at the frame 20.

[0022] The control disk 40' is not ring-like but is a closed circular disk body 42' without a central inlet opening.

[0023] When the electromagnetic actuator 72 is energized with the correct polarization, the actuation rod 74 and the control disk 40' are pushed into the idle position, or state, as shown in figures 5 and 7. When the electromagnetic actuator 72 is not energized, the actuation rod 74 and the control wheel 40 are pulled by the preload spring 52 into the pumping position or state, as shown in figures 4 and 6.

[0024] If the actuation element 70 fails, the pump 10 is always driven in the pumping state, not in the idle state. This makes the pump 10' failsafe.

Claims

1. Mechanical coolant pump (10) for cooling an internal combustion engine (12),
with
a rotatable drive wheel (24) driven by the engine (12),
a pump wheel (30) being directly connected with the drive wheel (24), the pump wheel (30) comprising a wheel disk (34) and pump blades (32) projecting axially from the wheel disk (34),
a separate control disk (40) being axially movable and being provided with blade slits (44), the control disk (40) being provided at the pump wheel (30) so that the pump blades (32) are received in the blade slits (44), so that the blade height of the pump blades (32) between the wheel disk (34) and the control disk (40) is axially adjustable by axially shifting the control disk (40), and
an actuation element (46; 70) for actuating the control disk (40).

2. The mechanical cooling pump (10) of claim 1, wherein the drive wheel (24) and the pump wheel (30) are connected by a tabular driving shaft (28) and the

control disk (40) is actuated via the hollow space inside the driving shaft (28).

3. The mechanical cooling pump (10) of one of the preceding claims, wherein the control disk (40) is moved by an actuation rod (48) inside the driving shaft (28).

4. The mechanical cooling pump (10) of one of the preceding claims, wherein the actuation rod (48) is axially preloaded by a preload spring (52), preferably into a failsafe position.

5. The mechanical cooling pump (10) of one of the preceding claims, wherein the axial actuation of the control disk (40) is provided by a thermal actuation element (46).

6. The mechanical cooling pump (10) of claim 5, wherein the thermal actuation element (46) comprises a wax element (50).

7. The mechanical cooling pump (10) of claim 5, wherein the thermal actuation element is a bimetal spring.

8. The mechanical cooling pump (10) of one of the preceding claims 1 to 4, wherein the axial actuation of the control disk (40) is provided by an electromagnetic actuation element (70) which pulls or pushes the actuation rod (74) when energized.

9. The mechanical cooling pump (10) of one of the preceding claims, wherein the actuation element (46; 70) is provided distal of the drive wheel (24).

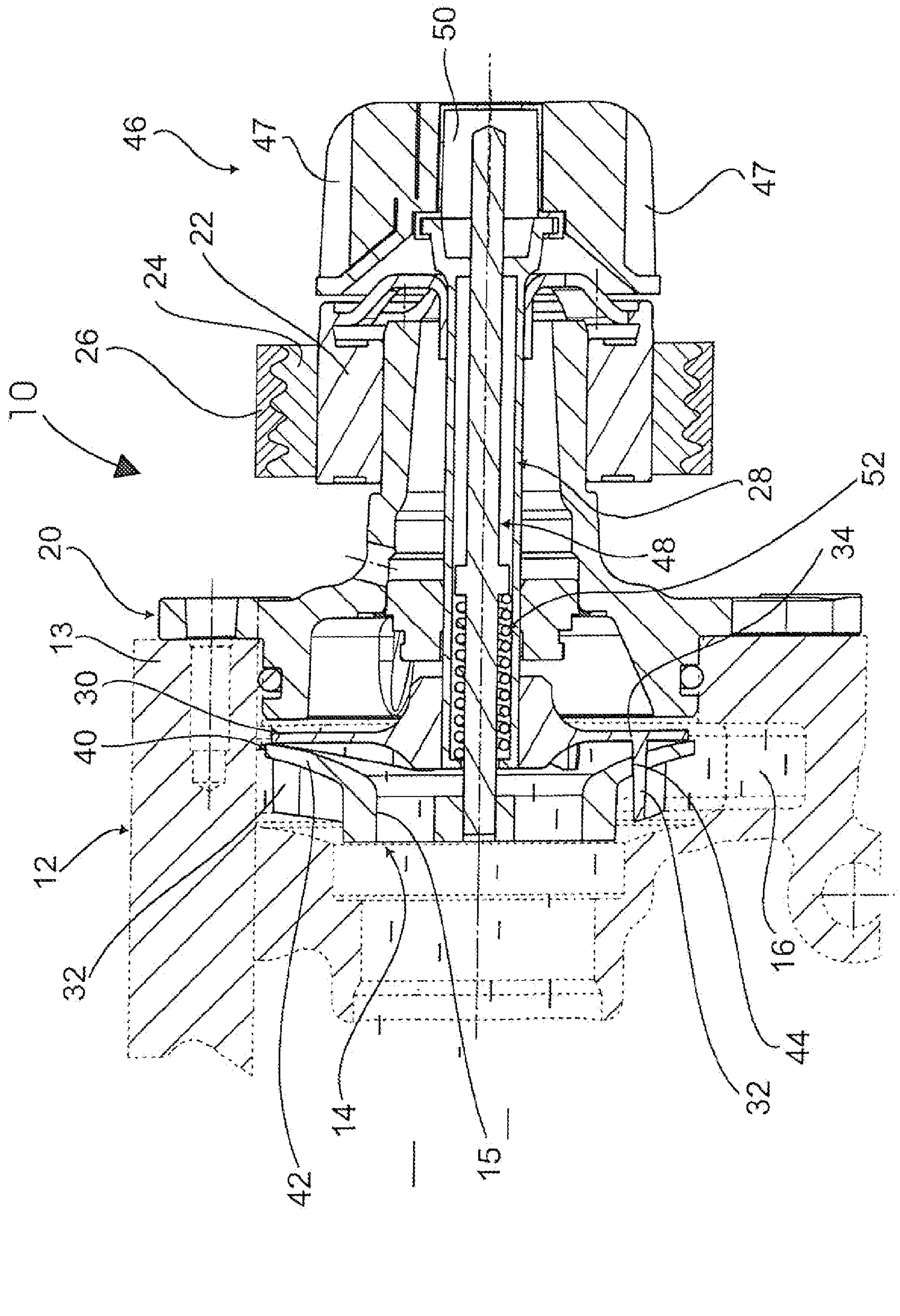

Fig. 1

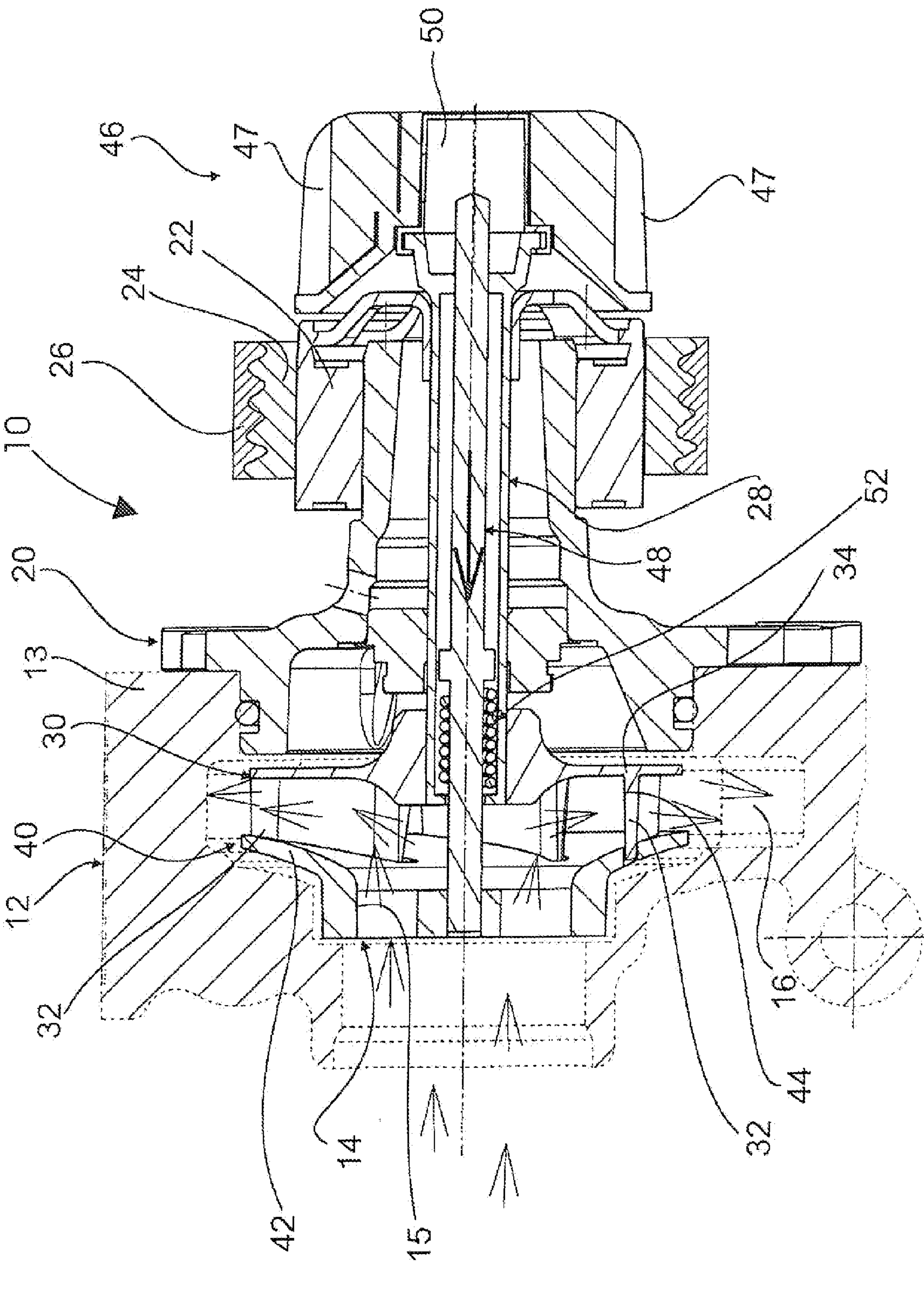

Fig. 2

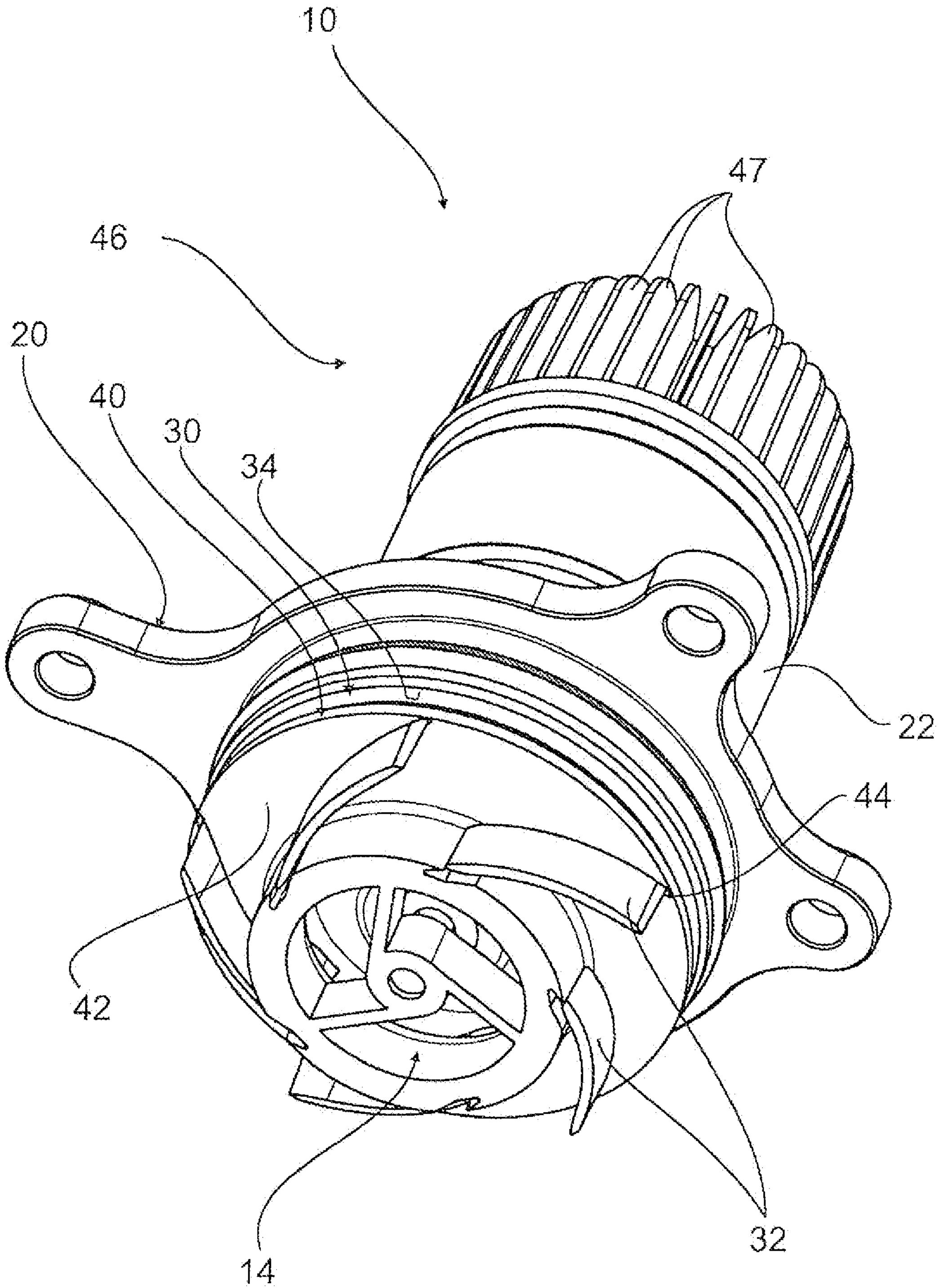

Fig. 3

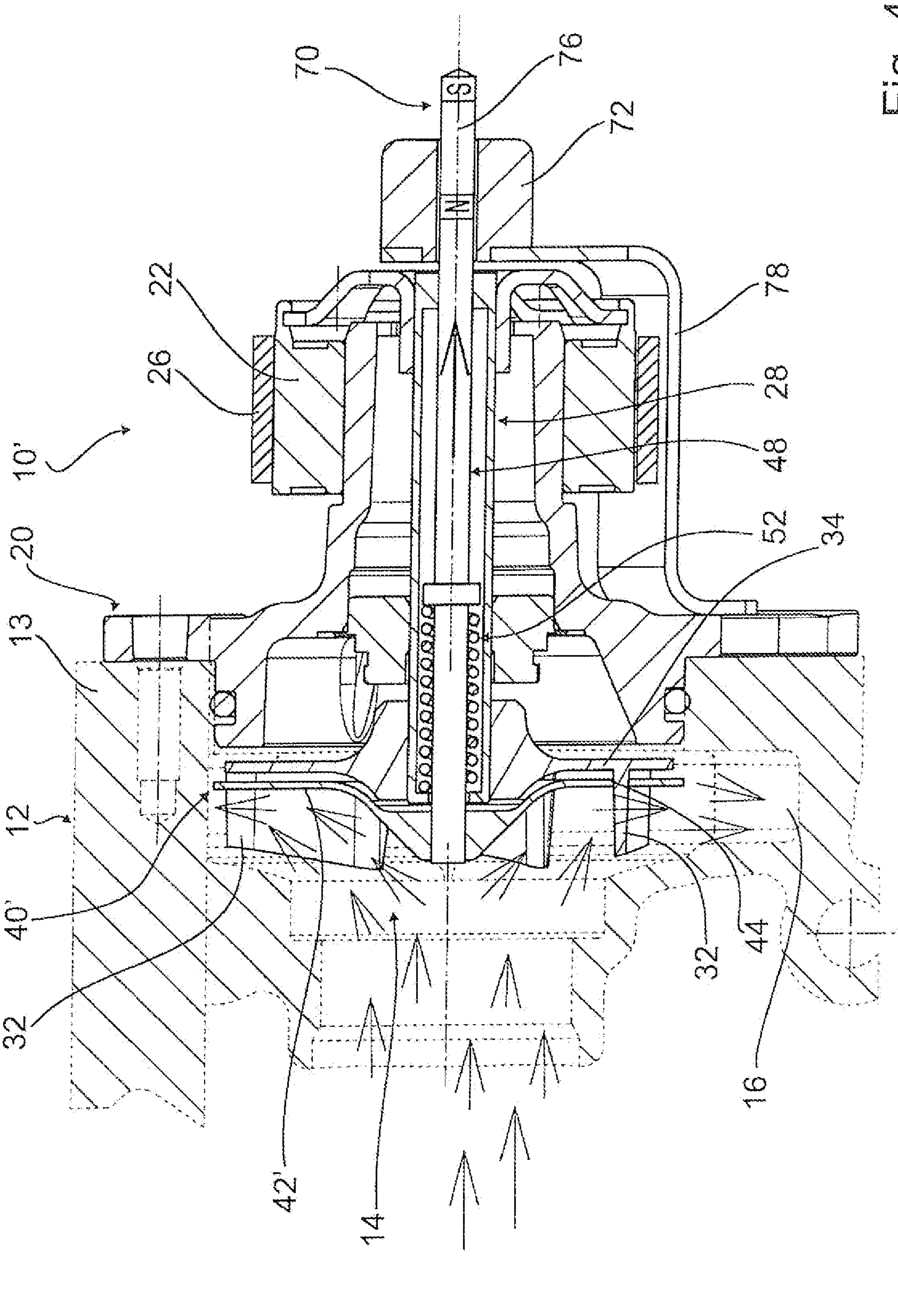

Fig. 4

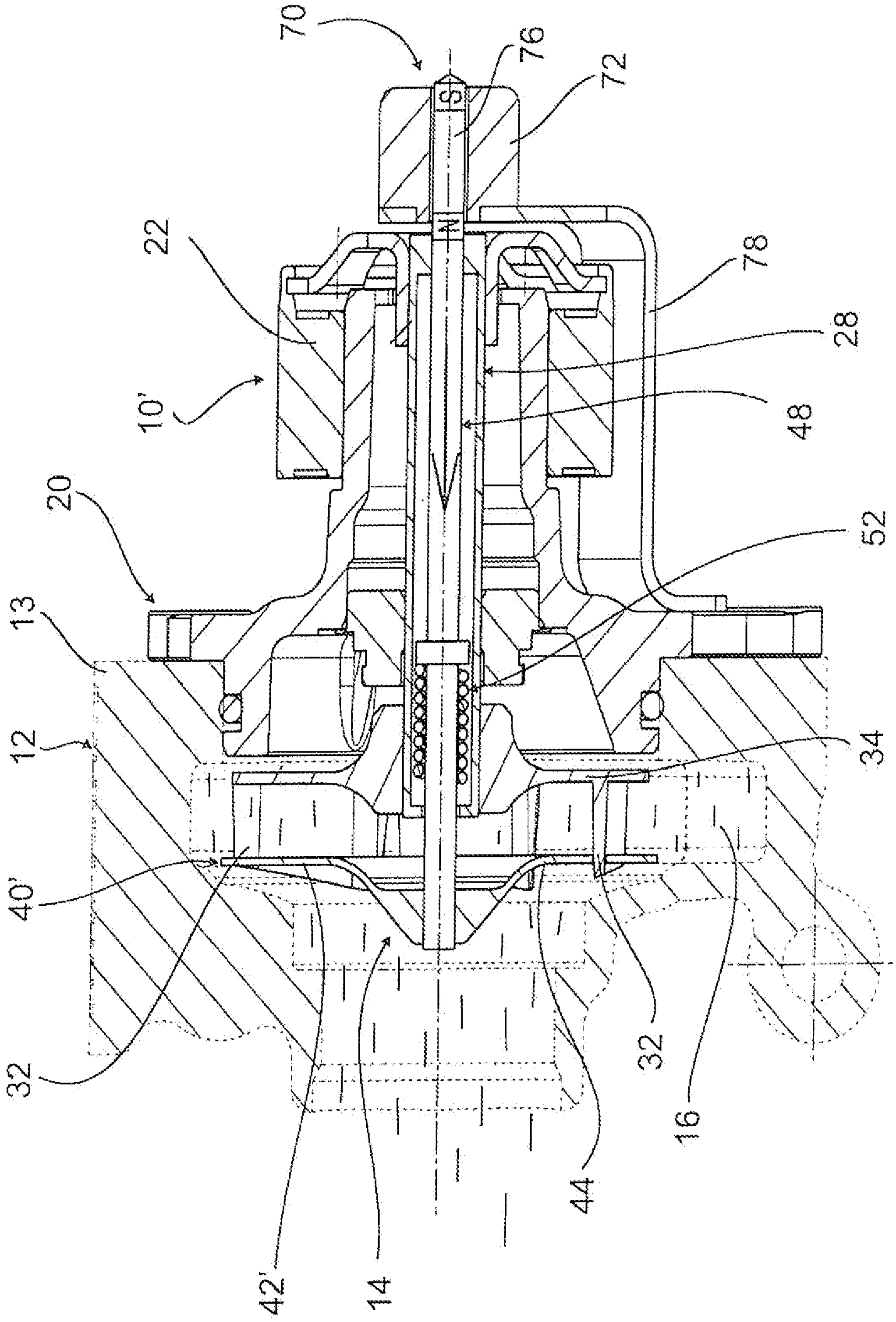

Fig. 5

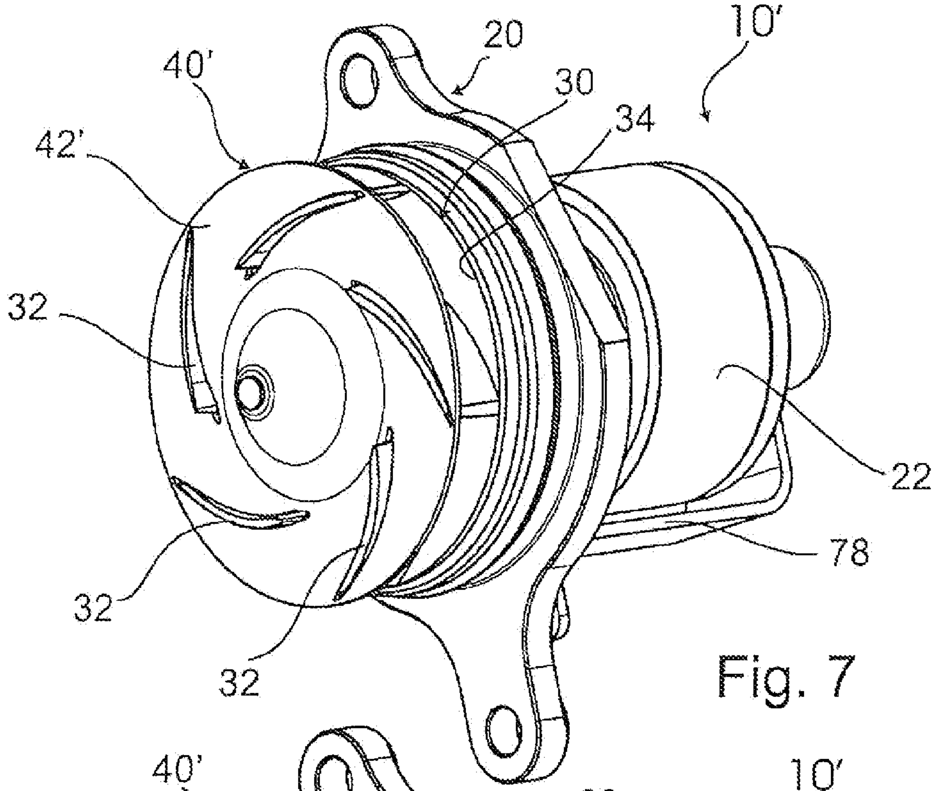

Fig. 7

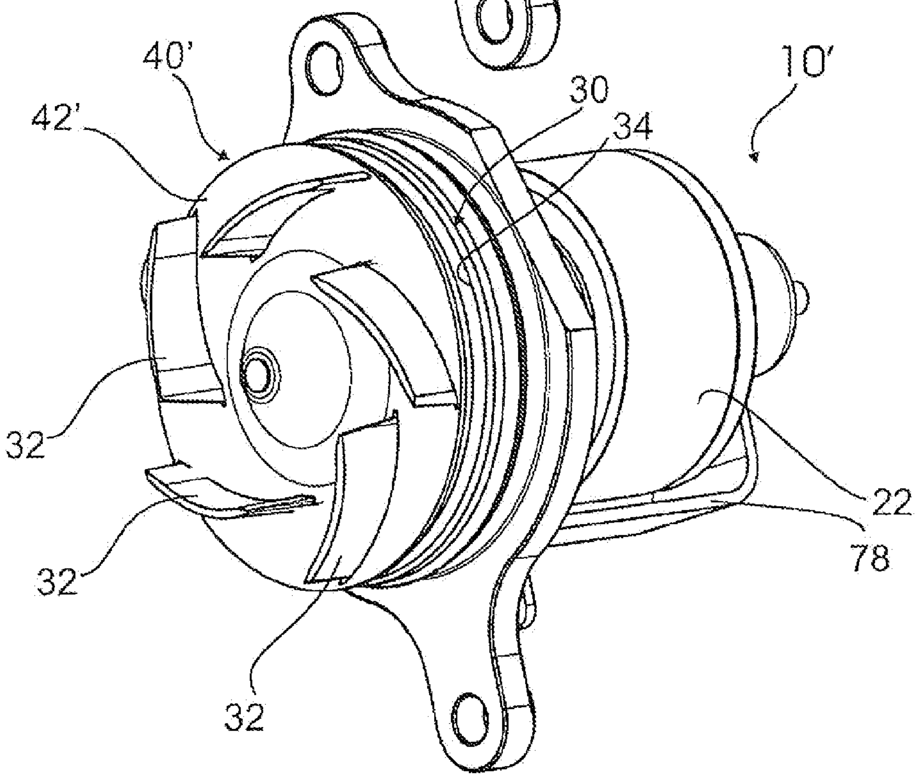

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 0214

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 January 2010	de Martino, Marcello

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TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 January 2010	de Martino, Marcello

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