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(54) **VARIABLE CAPACITY LUBRICANT VANE PUMP**

SCHMIERMITTEL-SCHAUFELPUMPE MIT VERSTELLBARER KAPAZITÄT

POMPE À PAILLETES À LUBRIFIANT À CAPACITÉ VARIABLE

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## Description

**[0001]** The present invention refers to a mechanically driven variable capacity lubricant vane pump for lubrication of an internal combustion engine, and in particular refers to a pressure controlled pump in which at least to different set pump delivery pressures can be controlled by the pump itself.

**[0002]** Since the rotational speed of a internal combustion engine driving the lubricant pump can vary with a factor of ten or more, the pump chamber volume has to be variable in a similar range to provide a constant lubricant pressure.

**[0003]** Variable capacity lubricant vane pumps which can control two different set pump delivery pressures are known in the state of the art. In WO 2006/066405, a vane pump with a pivotable capacity control ring is disclosed. The control ring position is determined by two control chambers which directly act against the capacity control ring and both are arranged on one single side with respect to the pivot axis. Both control chambers act in the same direction against the spring power of a preload spring preloading the control ring into a high pump chamber volume direction. The two pressure chambers are separated from each other by one single sliding sealing element.

**[0004]** US 2008/0107554 A1 discloses a variable capacity lubricant vane pump with counter-acting control chambers. The first control chamber is directly connected with the pump outlet port and the second control chamber is connected to the pump inlet pressure.

**[0005]** WO 2005/026553 A1 discloses a variable capacity lubricant vane pump with a first control chamber being directly connected with the pump outlet pressure and a second counter acting control chamber connected to the pump outlet pressure via a throttle valve. The second control chamber is also connected to atmospheric pressure via an on/off valve which is itself controlled by the pump outlet pressure. US 2002/0172610 A1 discloses a variable capacity lubricant vane pump with two counter acting control chambers, whereby both control chambers are connected and disconnected by one double-valve arrangement and whereby a throttle valve provided.

**[0006]** DE 2913414 A1 discloses a variable capacity lubricant vane pump with two counter acting control chambers, which are both synchronically switched to different pressure levels by a complex valve arrangement.

**[0007]** DE 10039347 A1 discloses a variable capacity vane pump with two counter acting control chambers whereby both control chambers are connected to different pressure levels by a complex valve mechanism.

**[0008]** WO 2007/128106 A1 discloses a variable capacity vane pump with two or three control chambers. All control chambers are connected to the pump outlet pressure by a switchable valve arrangement.

**[0009]** It is an object of the invention to improve a variable capacity lubricant vane pump with two different set

pump pressures.

**[0010]** This object is, according to the invention, solved with a lubricant pump with the features of claim 1.

**[0011]** The lubricant pump according to the invention is provided with a first and a second control chamber being arranged on different sides with respect to the pivot axis, and therefore act against each other. As a consequence, the first control chamber is acting against the preload spring and the second control chamber is acting in parallel with the preload spring and, if activated, is supporting the preload spring. The preload spring pushes the control ring in a high pump chamber volume direction. Since the two control chambers do not need to share one side of the control ring, the circumferential size of both control chambers can be increased significantly. This gives more freedom for the construction of the pump, and in particular for dimensioning and placing the two control chambers.

**[0012]** The pressure leakage via the control chambers can be reduced when the pump is driven in the higher pump volume constellation. During the high pump volume constellation of the pump, both control chambers are provided with the pump delivery pressure. Both pumping chambers preferably are separated from each other by a pivot bearing in the pivot axis. When the pump is driven in the higher volume constellation, the pressure on both sides of the pivot bearing is equal so that no lubricant leakage can appear in the first control chamber, so that the pump pressure cannot exceed a maximum value.

**[0013]** When the second chamber is not provided with the pump pressure, lubricant leakage via the pivot bearing can appear but is not dangerous because the pump is driven in the low pressure state anyway so that an undesired overpressure does not exceed the maximum allowable pump delivery pressure for the combustion engine.

**[0014]** The pivot bearing in the pivot axis constitutes a sealing between the two control chambers. As already explained, the two control chambers can be separated from each other by the pivot bearing. This is very simple and space effective solution. The sealing between the control chambers needs not to be perfect because in the high pressure state of the pump, both control chambers are provided with the pump pressure at the pump outlet port.

**[0015]** The two control chambers have a different circumferential extend around the control ring. The two set pressure levels of the pump are determined by the spring force of the preload spring, the effective surfaces of the two control chambers and the respective moment arms with the two

pressure levels of the pump are in particular determined by the circumferential extend of the control chambers around the control ring.

**[0016]** The first control chamber is in fluidic connection with a pump outlet port and is pushing the control ring in a high pump chamber volume direction, against the

spring force of the preload spring. The fluidic connection between the first control chamber and the outlet port can be realized by one or more bores in the control ring separating the pump outlet port and the first control chamber. The term "fluidic connection with a pump outlet" does not necessarily mean a direct and short connection with the pump outlet itself. The term includes every fluidic connection with the pressurized part between the pump outlet port and the lubricant outlet of the internal combustion engine, as every port which gives information about the lubricant pressure before, in or after the engine.

**[0017]** In one alternative embodiment, the second control chamber is in fluidic connection with the pump outlet port as well, and a control valve controls the fluidic connection of the second control chamber to atmospheric pressure.

**[0018]** This control valve is a simple on/off valve closing and opening a fluidic line between the second control chamber and the atmospheric pressure.

**[0019]** In another alternative embodiment, a control valve realized as a 3-way valve connects the second control chamber to either the pump outlet port or to atmospheric pressure.

**[0020]** If a simple on/off valve is used, the most simple construction can be used, i.e. a valve which is biased into the closed position by a spring and is open when actuated by an actuator. These kinds of valves are the most simple and least expensive valves. In addition, a simple on/off-control valve being biased into the closed position is failsafe as well, because, if opening of the valve is not possible, the pump automatically is running in the high pressure state.

**[0021]** In case the control valve is a simple on/off-control valve connecting the second control chamber to atmospheric pressure, a throttle valve is arranged between the pump outlet port and the second control chamber.

**[0022]** Two preferred embodiments of the present invention are described with reference to the figures, wherein

figure 1 is a cross-sectional view on the variable capacity lubricant vane pump,

figure 2 is showing first embodiment of the variable capacity lubricant vane pump including an on/off-control valve controlling the second control chamber, and

figure 3 is showing a second embodiment of the variable capacity lubricant vane pump including a 3-way control valve.

**[0023]** In figures 2 and 3, two different lubricant pumps 10; 10' are shown which provide an internal combustion engine 12 with a lubricant, i.e. oil. The lubricant finally flows from the combustion engine 12 into a oil sump 13 which is under atmospheric pressure. From the oil sump 13 the lubricant is sucked via the inlet port 40 into the

pump unit 14. The vane pumps 10; 10' provide the lubricant with a constant pumping pressure. The lubricant pumps 10; 10' comprise a variable capacity lubricant vane pump unit 14 and a control valve 16; 16' controlling the pumping pressure of the vane pump unit 14 at a pump outlet port 18.

**[0024]** The vane pump unit 14 is mechanically driven by the combustion engine 12 so that the vane pump unit 14 is driven within a large rotation speed interval. Therefore, the pump chamber volume of the vane pump unit 14 can be varied in a wide range, as well. The control valve 16; 16' is for selecting one of two set pump delivery pressures at the pump outlet port 42.

**[0025]** The pump unit 14 comprises a rotor ring 20 with numerous vane slits 22 wherein radially slidable vanes 24 are arranged. The vanes 24 are surrounded by a capacity control ring 26 which is pivotable around a pivot axis 28. The rotor ring 20, the vanes 24, the control ring 26 and not shown sidewalls define numerous pump chambers 30 therebetween. In one sidewall a circular inlet port 40 and a circular outlet port 42 are provided. The size of the pump chambers 30 can be varied by pivoting the control ring 26 around the pivot axis 28. In the pivot axis 28 a bearing pin 32 is arranged forming a pivot bearing 31.

**[0026]** The position of the control ring 26 is determined by three elements, i.e. a preload spring 34, a first control chamber 36 and a second control chamber 38.

**[0027]** The first control chamber 36 and the second control chamber 38 are provided on different sides with respect to the pivot axis 28 and, therefore, act against each other. The two control chambers 36, 38 are separated by the bearing pin 32 so that the two control chambers 36, 38 are directly adjacent to each other.

**[0028]** The bearing pin 32 in the pivot axis 28 forms a pivot bearing 31.

**[0029]** The control ring 26 is provided with two pressure equalization bores 44, 45 which directly provide the first control chamber 36 with the pump pressure at the outlet port 42.

**[0030]** In the first embodiment of the invention, the second control chamber 38 is connected with the pump pressure via a throttle valve 48, as shown in figure 2. In addition, the second control chamber 38 can be connected to the oil sump 13 being under atmospheric pressure.

**[0031]** The fluidic connection between the second control chamber 38 and the atmospheric pressure of the oil sump 13 is opened and closed by the control valve 16 which is a simple on/off valve. The control valve 16 is closed in its non-actuated position by a preload spring, as shown in figure 2. When the valve actuator 17 is not active, the second control chamber 38 is provided with the pump pressure, as well.

**[0032]** The circumferential extend of the first control chamber 36 is larger than the circumferential extend of the second control chamber 38 so that identical pressures in both control chambers 36, 38 lead to a higher torque caused by the first control chamber 36 compared

to the torque caused by the second control chamber 38. When the control valve 16 is not activated the second control chamber is provided with the pump delivery pressure. The second control chamber 38 then supports the preload spring 34 so that a higher set pump pressure is adjusted. When the control valve 16 is activated in its open position, the control chamber 38 is provided with atmospheric pressure. In this case, the first control chamber 36 acts only against the preload spring 34 so that the pump chambers 30 become smaller which leads to a reduced set pump pressure.

**[0033]** The vane pump 10 is failsafe with respect to the control valve 16 because, if the actuator 17 fails to work, the control valve 16 is in the closed position and the higher set pump pressure is selected.

**[0034]** In the second embodiment shown in figure 3, the control valve 16' is designed as a 3-way valve which alternatively connects the second control chamber 38 with the pump outlet port 42 or the oil sump 13 being under atmospheric pressure. In this embodiment, the throttle valve 48 of the first embodiment can be omitted.

**[0035]** The control valve 16' connects the second control chamber 38 with the pump pressure, when the control valve 16' is not actuated, and connects the second control chamber 38 with the atmospheric pressure of the oil sump 13, when the control valve 16' is actuated by the actuator 17.

## Claims

1. Variable capacity lubricant vane pump (10') for lubrication of an internal combustion engine (12), with radially slidable vanes (24) being arranged in vane slits (22) of a rotor ring (20), the vanes (24) defining pump chambers (30) therebetween, a capacity control ring (26) surrounding the vanes (24) and being pivotable around a pivot axis (28) thereby varying the volume of the pump chambers (30), a first and a second hydraulic control chamber (36,38), both control chambers (36, 38) being in part defined by the control ring (26) and thereby pivoting the control ring (26), and a preload spring (34) preloading the control ring (26) in one direction, the first control chamber (36) and the second control chamber (38) being arranged on different sides with respect to the pivot axis (28) and acting against each other, the preload spring (34) pushing the control ring (26) in a high pump chamber volume direction, **characterised by** the first control chamber (36) being in fluidic connection with a pump outlet port (42) and pushing the control ring (26) in a low pump chamber volume direction, and either the second control chamber (38) being in fluidic con-

nection with the pump outlet port (42) and a control valve (16) controlling the fluidic connection of the second control chamber (38) to atmospheric pressure, and the control valve (16) being an on/off valve opening or closing the connection between the second control chamber (38) and atmospheric pressure, or

a control valve (16') being a 3-way switching valve connecting the second control chamber (38) either with the pump outlet port (42) or with the atmospheric pressure,

wherein a pivot bearing (31) in the pivot axis (28) constitutes a sealing between the two control chambers (36,38), and

wherein the two control chambers (36,38) have different circumferential extents around the control ring (26), and, the circumferential extent of the second control chamber (38) is shorter than that of the first control chamber (36), so that identical pressures in both control chambers (36, 38) lead to a higher torque caused by the first control chamber (36) compared to the torque caused by the second control chamber (38).

## Patentansprüche

1. Schmiermittel-Flügelpumpe (10') mit verstellbarer Kapazität zur Schmierung eines Verbrennungsmotors (12), mit radial verschiebbaren Flügeln (24), die in Flügelschlitzen (22) eines Rotorrings (20) angeordnet sind, wobei die Flügel (24) auf diese Weise das Volumen der Pumpkammern (30) definieren, einem Kapazitätssteuerring (26), der die Flügel (24) umgibt und um eine Schwenkachse (28) verschwenkbar ist, wodurch das Volumen der Pumpkammern (30) verändert wird, einer ersten und einer zweiten Hydraulik-Steuerkammer (36, 38), wobei beide Steuerkammern (36, 38) zum Teil durch den Steuerring (26) definiert sind und auf diese Weise den Steuerring (26) verschwenken, und einer Vorspannfeder (34), die den Steuerring (26) in eine Richtung vorspannt, wobei die erste Steuerkammer (36) und die zweite Steuerkammer (38) in Bezug auf die Schwenkachse (28) auf verschiedenen Seiten angeordnet sind und gegeneinander wirken, wobei die Vorspannfeder (34) den Steuerring (28) in Richtung eines hohen Pumpkammervolumens drückt, **dadurch gekennzeichnet, dass** die erste Pumpkammer (36) in Fluidverbindung mit einem Pumpenauslassport ist und den Steuerring (26) in Richtung eines geringen Pumpkammervolumens drückt, und entweder die zweite Steuerkammer (28) in Flu-

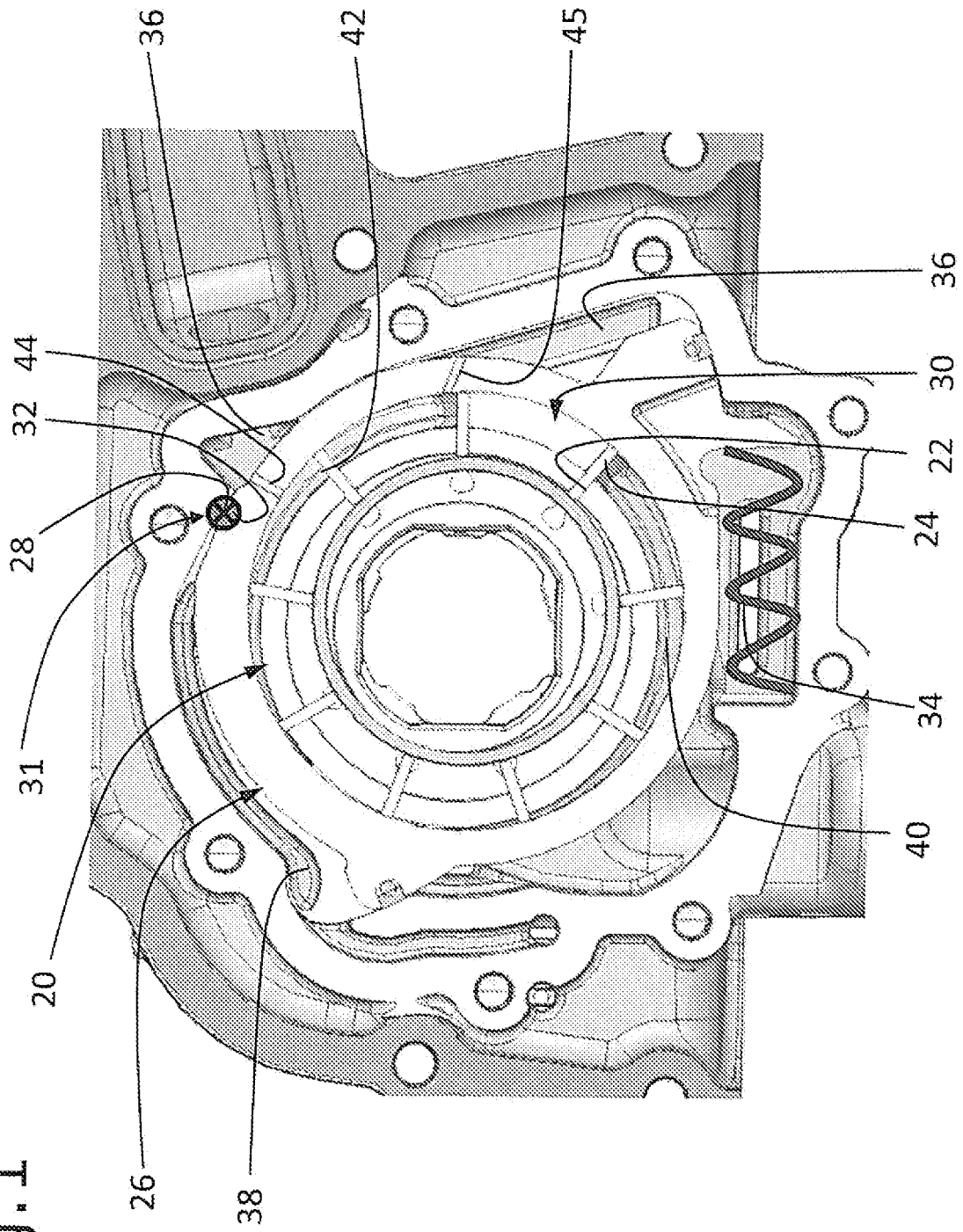
idverbindung mit dem Pumpenauslassport (42) ist und ein Steuerventil (16) die Fluidverbindung der zweiten Steuerkammer (38) mit Atmosphärendruck steuert, und das Steuerventil (16) ein Ein/Aus-Ventil zum Öffnen oder Schließen der Verbindung zwischen der zweiten Steuerkammer (38) und dem Atmosphärendruck ist, oder das Steuerventil (16) ein 3-Wege-Schaltventil ist, das die zweite Steuerkammer (38) entweder mit dem Pumpenauslassport (42) oder mit Atmosphärendruck verbindet, wobei ein Schwenklager (31) in der Schwenkachse (28) eine Dichtung zwischen den beiden Steuerkammern (36, 38) bildet, und wobei die beiden Steuerkammern (36, 38) unterschiedliche Umfangserstreckungen um den Steuer- ring (26) aufweisen und die Umfangserstreckung der zweiten Steuerkammer (38) kürzer als diejenige der ersten Steuerkammer (36) ist, so dass identische Drücke in beiden Steuerkammern (36, 38) zu einem im Vergleich mit dem von der zweiten Steuerkammer (38) bewirkten Drehmoment höheren, von der ersten Steuerkammer (36) bewirkten Drehmoment führen.

## Revendications

1. Pompe (10') á aubes á lubrifiant á capacité variable destinée á lubrifier un moteur á combustion interne (12), avec des aubes (24) glissables dans la direction radiale, disposées dans des fentes de aubes (22) d'un anneau de rotor (20), les aubes définissant des chambres de pompe (30) entre eux, un anneau de commande de capacité (26) entourant les aubes (24) et étant pivotable autour d'un axe de pivotement (28), ainsi variant le volume des chambres de pompe (30), une première et une deuxième chambre de commande hydraulique (36, 38), les deux chambres de commande (36, 38) étant partiellement définies par ledit anneau de commande (26) et ainsi pivotent ledit anneau de commande (26), et un ressort de sollicitation (34) sollicitant ledit anneau de commande (26) dans une direction, ladite première chambre de commande (36) et ladite deuxième chambre de commande (38) étant disposées sur différents côtés par rapport à l'axe de pivotement (28) et agissent l'une à l'encontre de l'autre, le ressort de sollicitation (34) poussant ledit anneau de commande (26) vers une direction d'un haut volume de la chambre de pompe, **caractérisée en ce que** la première chambre de commande (36) est en liaison fluide avec un port de sortie de pompe (42) et pousse ledit anneau de commande (26) vers une direction d'un bas volume de la chambre de pompe, et soit ladite deuxième chambre de commande (38)

est en liaison fluide avec le port de sortie de pompe (42) et une vanne de commande (16) commande la liaison fluide de la deuxième chambre de commande (38) avec la pression atmosphérique, et ladite vanne de commande (16) est une vanne tout ou rien ouvrant ou fermant la liaison entre ladite deuxième chambre de commande (38) et la pression atmosphérique, soit ladite vanne de commande (16) est une vanne de commutation á trois voies reliant ladite deuxième chambre de commande (38) soit avec le port de sortie de pompe (42), soit avec la pression atmosphérique, un palier de pivotement (31) dans l'axe de pivotement (28) formant un joint entre les deux chambres de commande (36, 38), et les deux chambres de commande (36, 38) ayant des dimensions circonférentielles différentes autour dudit anneau de commande (26), et la dimension circonférentielle de ladite deuxième chambre de commande (38) est plus courte que celle de ladite première chambre de commande (36), de sorte que des pressions identiques dans les deux chambres de commande (36, 38) mènent á un couple fourni par la première chambre de commande (36), qui est plus grand comparé au couple fourni par la deuxième chambre de commande (38).

Fig. 1



29.

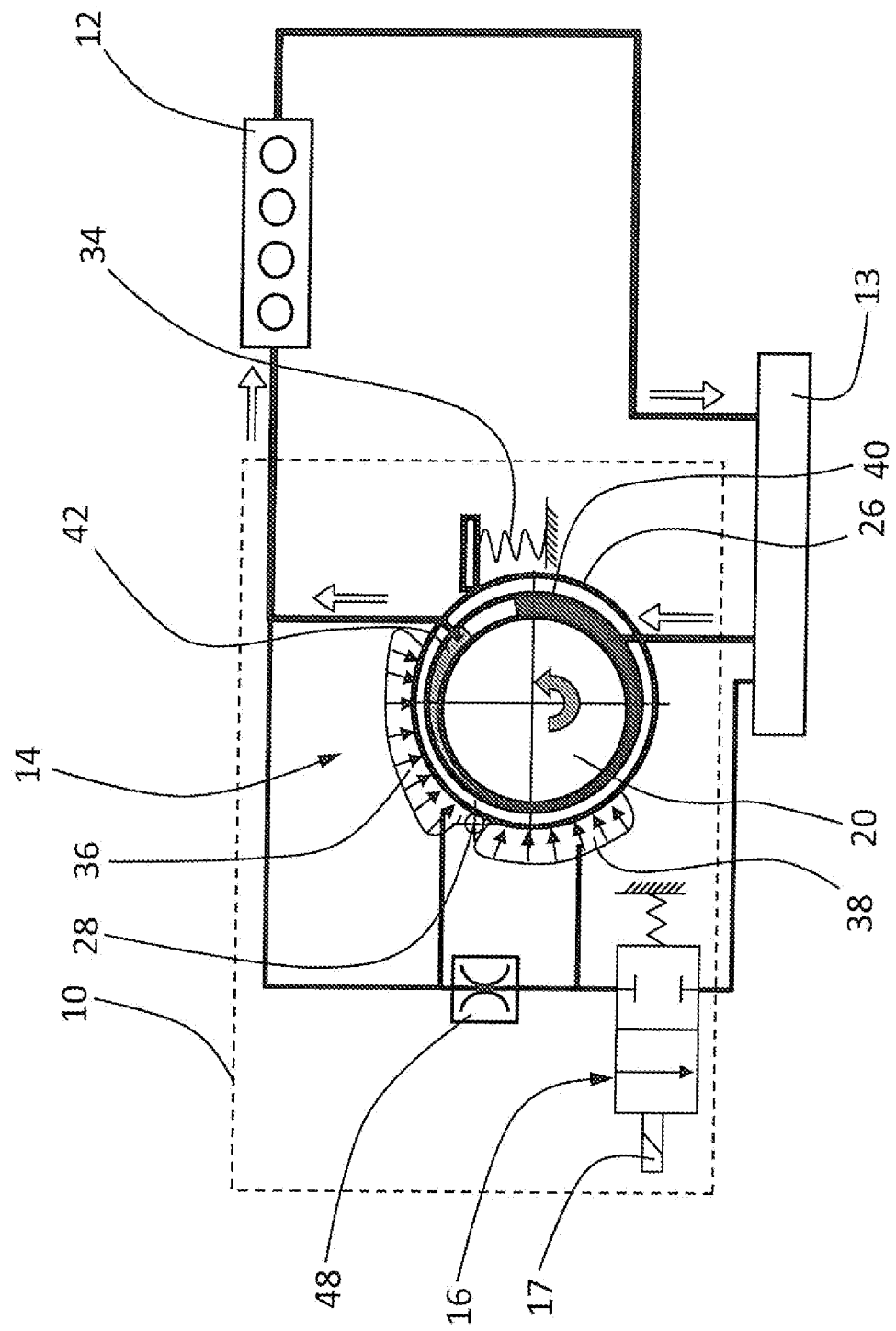
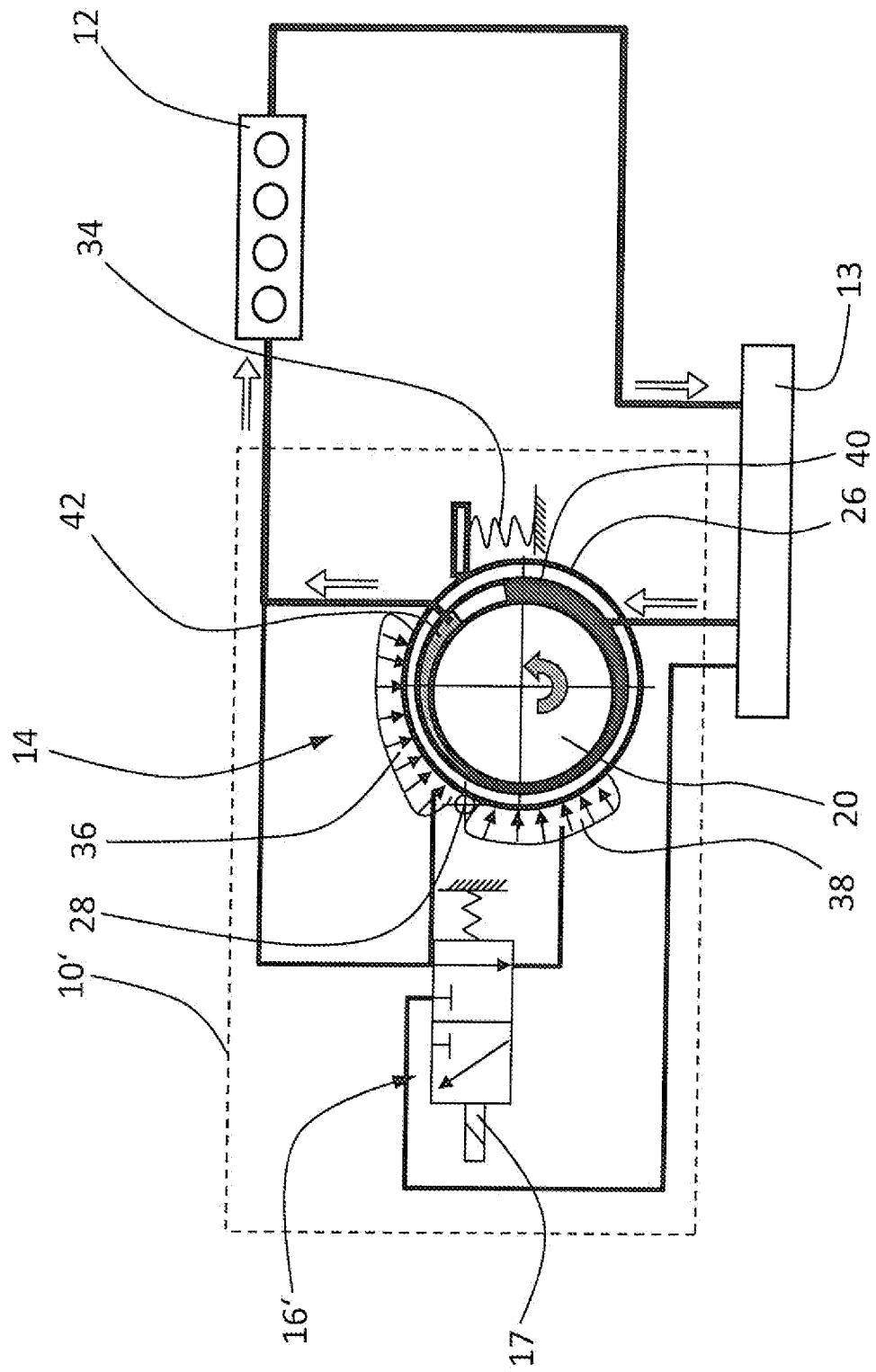


Fig.3



**REFERENCES CITED IN THE DESCRIPTION**

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