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(54) **MECHANICAL COOLANT PUMP**

MECHANISCHE KÜHLMITTELPUMPE

POMPE MÉCANIQUE DE LIQUIDE DE REFROIDISSEMENT

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EP 2 815 093 B1

Description

[0001] The present invention refers to a mechanical coolant pump for an internal combustion engine. A mechanical coolant pump is driven by the combustion engine, for example by using a driving belt driving a driving wheel of the pump, so that the rotational speed of the coolant pump is proportional to the rotational speed of the combustion engine. As long as the combustion engine is cold, only a minimum coolant flow is needed. Therefore, mechanical coolant pumps are provided with an outlet valve arrangement for controlling the coolant flow leaving the coolant pump. As long as the combustion engine is cold, the outlet valve is closed so that the circulation of the lubricant is reduced, minimized or completely stopped, with the result that the combustion engine warming-up phase is shortened.

[0002] FR2719100 A1 discloses the general principle of a rotary eccentric plug valve used in water circuit.

[0003] WO 2010/146609 A1 discloses a mechanical coolant pump according to the preamble of claim 1. WO2011/95907 A1 and JP 48104103 disclose mechanical coolant pumps with outlet valve arrangements including a valve flap with a valve pivot axis lying within the plane of the flap. WO 2011/101019 A1 discloses an impeller-type coolant pump with an outlet valve arrangement in the root of an outlet channel. The output valve arrangement is provided with a valve flap whereby the pivot axis of the valve flap is arranged at one end of the flap body and is provided in the surface plane of the valve seat. The valve flap should to be pivotable even at high rotational speed of the pump rotor at which a high fluid pressure against the valve flap either in closing direction or in opening direction can occur. However, to guarantee full functionality at all rotational speeds, high actuation power is needed.

[0004] It is an object of the invention to provide a mechanical coolant pump for an internal combustion engine with an outlet valve arrangement for relatively low actuation forces and with good long term tightness of the closed outlet valve.

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

[0006] The mechanical coolant pump according to claim 1 is provided with an impeller pump wheel pumping the liquid coolant incoming in axial direction radially outwardly into an outlet volute. The outlet volute is continuing into an outlet channel of the pump. In the course of the outlet channel an outlet valve arrangement is provided whereby the outlet valve arrangement comprises a valve flap being movable between an open position and a closed position to leave open or to close the valve opening of the outlet channel.

[0007] The valve opening of the outlet channel is defined by and surrounded by a valve seat. The valve seat is a closed contact line of the valve opening and the corresponding flap seat of the valve flap in the closed valve position. The valve seat defines a general valve seat

plane. If the valve seat is not completely lying in one single plane because some portions of the valve seat are somehow curved, then the valve seat plane is defined by a general geometric middle plane comprising two linear lateral seat portions parallel to each other. A symmetry plane is provided in the middle of the valve opening and of the valve seat plane. The symmetry plane is exactly rectangular to the valve seat plane and parallel to a pivot axis of the valve flap.

[0008] The valve flap is pivotable or rotatable around the pivot axis which is parallel to the symmetry plane but the pivot axis is not located in the symmetry plane. The pivot axis is located with a lateral eccentricity from the symmetry plane, whereby the lateral eccentricity is between 1/20 and 1/1 of the pivot axis' distance to the valve seat plane. The valve flap can be realized as a plane body but is preferably realized as a cylindrical body. When the valve flap is rotated into its closed position, the flap seat contacts the valve seat only in the very last moment of the closing movement. During the closing movement of the valve flap, the valve seat and the flap seat are not in contact at all, so that no relevant abrasion of the flap seat and of the valve seat can occur. This ensures a good long term tightness of the closed valve.

[0009] At least one axial end of the valve flap is fixed to a base disc which is arranged rectangular to the pivot axis. According to a preferred embodiment, two base disks are provided at both axial ends of the valve flap. The base disc is provided in a corresponding recess of the pump housing, respectively, so that the proximal surface of the base disk is lying in the plane of the inner wall surface of the outlet channel. In other words, the base disk extends the surface of the volute housing continuously, especially in the open position of the valve flap. The base disk can be, in part, circular with respect to the pivot axis so that the inner surface of the outlet channel is stepless.

[0010] The volute housing is provided with a recess for housing the valve flap in its open position. In the open valve position, the valve flap is substantially housed in the recess so that the valve flap does not project substantially into the outlet volute or into the outlet channel. Therefore, the flow resistance caused by the valve flap is reduced to a minimum.

[0011] According to a preferred embodiment of the invention, the pivot axis is lying within the projection of the valve seat so that the eccentricity is less than half of the width of the valve seat projection. The lateral eccentricity does not exceed $\frac{1}{2}$ of the valve flap width which is the flaps extend in a direction rectangular to the pivot axis. The arrangement of the pivot axis within the projection of the valve seat ensures that the actuation forces for opening and closing the valve flap are relatively low even at high rotational speeds of the pump wheel generating a relatively high outlet pressure of the liquid coolant.

[0012] According to a preferred embodiment, the valve flap is provided with a valve flap body and the flap seat is coated with a rubber coating. The rubber coating of

the flap seat improves the tight sealing of the closed valve flap.

[0013] According to a preferred embodiment, the outlet volute housing defines a second outlet channel which is not effected by the outlet valve arrangement and remains always open so that a minimum coolant flow is always guaranteed as long as the pump wheel is driven by the internal combustion engine. In particular, internal combustion engines with high performance, as for example truck engines, need always to be cooled with a minimum coolant flow rate to avoid heat pockets. A second outlet channel without any a valve is absolutely fail safe with respect to a minimum coolant flow.

[0014] Preferably, the flap body is actuated by a pneumatic, electric or thermostatic actuator. Independent of the activation force source, the needed actuation force for guaranteeing a reliable function of the valve is relatively low.

[0015] According to a preferred embodiment of the invention, the proximal surface of the valve flap body extends the volute housing wall surface or the channel wall surface continuously in the open position of the flap body. This means that in the open state of the flap body, the proximal flap body surface continues the surface of the volute or the outlet channel smoothly and steplessly so that the flow resistance as low as possible.

[0016] One embodiment of the invention is described referring to the following drawings, wherein

figure 1 shows a perspective view of a mechanical coolant pump without a housing cover with a valve flap in the open position,

figure 2 shows the coolant pump of figure 1 with the valve flap in the closed position,

figure 3 shows a cross section of the valve arrangement of the coolant pump of figure 1 with the valve flap in the closed position,

figure 4 shows a cross-section of the valve arrangement of the coolant pump of figure 1 with the valve flap in the open position,

figure 5 shows another perspective view of the mechanical coolant pump of figure 1 with the valve flap in the closed position, and

figure 6 shows the valve flap including an actuator of the mechanical coolant pump of figure 1.

[0017] The figures 1 to 6 show a mechanical coolant pump 10 for circulating a coolant for an internal combustion engine. The coolant pump 10 can be directly mounted to an engine block of the internal combustion engine. The coolant pump 10 is provided with a driving wheel (not shown) which can be driven by a driving belt which is directly driven by the internal combustion engine. The

rotational speed of the coolant pump 10 is proportional to the rotational speed of the internal combustion engine.

[0018] The coolant pump 10 is provided with a pump housing 12 housing an impeller pump wheel 14 pumping a liquid coolant incoming in axial direction radially into an outlet volute 16. The outlet volute 16 is defined by a volute housing 13 which is a part of the pump housing 12. The axial coolant pump inlet is provided at the bottom side of the coolant pump 10 shown in figures 1 and 2.

[0019] The outlet volute 16 includes a first outlet channel 18 and a second outlet channel 17 which is separated by a separating wall 20 from the first outlet channel 18. The coolant pump 10 is provided with an outlet valve arrangement at a valve opening 19 at the beginning of the first outlet channel 18. The outlet valve arrangement is provided with a valve flap 30 which is pivotable between a closed position and an open position as shown in figures 2 and 1 or in figures 3 and 4. The valve flap 30 closes or opens the valve opening 19 of the first outlet channel 18 but does not effect the coolant flow into and through the second outlet channel 17.

[0020] The integral metal valve flap 30 is provided with a circular flap body 32 with an axial orientation of its general valve seat plane. The flap body 32 has a proximal surface 33 and a distal surface 35. The flap body 32 is, somehow, a circumferential section of a hollow cylinder wall.

[0021] The flap body 32 is axially arranged between a first circular base disk 34 and an identical second base disk 38 at both axial ends of the flap body 32. The valve flap 30 is supported in pivot bearings at both axial ends, so that the valve flap 30 is pivotable around an axial valve pivot axis 31 which is arranged within the outlet volute 16.

[0022] In the open position of the valve flap 30, as shown in figures 1 and 4, the flap body 32 is housed in a housing recess 24 of the volute housing 13 so that the proximal surface 33 of the flap body 32 continues or extends the inside wall surface of the volute housing 13 continuously and without any relevant surface steps. As a result, the flow resistance caused by the flap body 32 in the open position is low even at high coolant flow rates. In the open position of the valve flap 30, as shown in figure 4, the proximal side 33 of the flap body 32 is orientated to the outlet volute 16, whereas the distal side 35 of the flap body 32 is orientated to the housing recess 24 recessing the flap body 32. At the distal side 35 of the flap body 32 a rubber coating 40 is provided over the entire flap seat. The rubber coating 40 improves significantly the sealing quality of the flap body 32 in the closed valve position, as shown in figures 3 and 5.

[0023] The first and the second base disk 34, 38 are both completely recessed in corresponding housing recesses 42, 44 of the volute housing 13. As a consequence, both base disks 34, 38 do not cause any relevant flow resistance even at high coolant flow rates, in the open valve position. The valve is provided with a valve shaft 52 fixed to one base disk 38. The valve shaft 52 defines the pivot axis 31. The valve shaft 52 is provided

with a lever arm 54 which is actuated by a pneumatic actuator 50, as can be seen in figures 5 and 6.

[0024] The geometric constitution of the valve arrangement can best be seen in figures 3 and 4. The valve opening 19 is surrounded by a valve seat 66 which corresponds with a flap seat of the valve flap 30. The valve seat 66 and the flap seat are completely in contact with each other in the closed valve position as shown in figure 3. The valve seat 66 defines a valve seat plane 60 which represents the general plane 60 of the complete valve seat 66. The valve seat 66 is defined by two linear lateral seat portions which are parallel to each other and by two circular seat portions connecting the lateral portions. The diameter of the circular seat portions is almost equal to the diameter of the flap body 32. The lateral seat portions are parallel to the pivot axis 31. The valve seat 66 has a width W which is the lateral distance between the two linear lateral seat portions. A symmetry plane 62 is defined in the middle of the valve seat plane 60. The symmetry plane 62 is rectangular to the valve seat plane 60.

[0025] The pivot axis 31 of the valve flap 30 is parallel to the symmetry plane 62 and to the valve seat plane 60. The pivot axis 31 is provided with a distance D to the valve seat plane. The distance D of the pivot axis 31 to the valve seat plane 60 is between $\frac{1}{2}$ and $\frac{3}{1}$ of the valve seat width W. The pivot axis 31 is not lying in the symmetry plane 62 but is provided with an eccentricity E distant from the symmetry plane 62. The eccentricity E is between $\frac{1}{20}$ and $\frac{1}{1}$ of the pivot axis' distance D of the valve seat plane 60. In the present case, the eccentricity E is about $\frac{1}{3}$ of the pivot axis' distance D. This geometrical arrangement ensures that the valve seat 66 and the flap seat are in touch to each other in the closed valve position, only.

Claims

1. Mechanical coolant pump (10) for an internal combustion engine, comprising
 - an impeller pump wheel (14) pumping the liquid coolant incoming in axial direction radially into an outlet volute (16),
 - a pump housing (12) including a volute housing (13) defining the outlet volute (16) including an outlet channel (18), and
 - an outlet valve arrangement in the route of the outlet channel (18), the outlet valve arrangement comprising a valve flap (30) being pivotable between an open position and a closed position to leave open or close a valve opening (19) of the outlet channel (18), whereby
 - the valve opening (19) is defined and surrounded by a valve seat (66) comprising two linear lateral seat portions parallel to each other defining a valve seat plane (60) and a symmetry plane (62) in the middle of and rectangular to the valve seat plane (60), a valve flap (30) is provided being rotatable around a

pivot axis (31) which is parallel to the symmetry plane (62), the mechanical coolant pump being **characterized in that** the valve flap (30) is provided with a flap seat on one side of the valve flap (30), the flap seat corresponding to the valve seat (66), the valve flap (30) being located with a lateral eccentricity (E) from the symmetry plane (62), whereby the lateral eccentricity (E) is between $\frac{1}{20}$ and $\frac{1}{1}$ of the pivot axis' distance (D) to the valve seat plane (60), at least one axial end of the valve flap is fixed to a base disk (34) being arranged rectangular to the pivot axis (31), whereby the proximal surface of the base disk (34) is lying in a plane defined by an inner wall surface of the the volute housing (13) is provided with a recess (24) for housing the valve flap (30) in its open position.

2. Mechanical coolant pump (10) of claim 1, whereby the pivot axis (31) is lying within the projection of the valve seat (66), so that the eccentricity (E) is less than half of the width (W) of the valve seat projection.
3. Mechanical coolant pump (10) of one of the preceding claims, whereby the valve flap (30) is made of metal and the flap seat is coated with a rubber coating (40).
4. Mechanical coolant pump (10) of one of the preceding claims, whereby the outlet volute housing (13) defines a second outlet channel (17) which is not affected by the outlet valve arrangement.
5. Mechanical coolant pump (10) of one of the preceding claims, whereby the valve flap (30) is actuated by a pneumatic, electric or thermostatic actuator (50).

Patentansprüche

1. Mechanische Kühlmittelpumpe (10) für einen Verbrennungsmotor, mit
 - einem Flügelumpfenrad (14), welches das in axialer Richtung einströmende flüssige Kühlmittel radial in eine Auslassspirale (16) pumpt,
 - einem Pumpengehäuse (12) mit einem die Auslassspirale (16) bildenden Auslassspiralgewölbe (13), das einen Auslasskanal (18) aufweist, und einer Auslassventilanordnung im Verlauf des ersten Auslasskanals (18), wobei die Auslassanordnung eine Ventilklappe (30) aufweist, die zwischen einer offenen Position und einer geschlossenen Position bewegbar ist, um eine Ventilöffnung (19) des Auslasskanals (18) offen zu lassen oder zu schließen, wobei
 - die Ventilöffnung (19) durch einen Ventilsitz (66) definiert und von diesem umgeben ist, der zwei zueinander parallele lineare seitliche Sitzbereiche auf-

weist, die eine Ventilsitzebene (60) und eine Symmetrieebene (62) in der Mitte der Ventilsitzebene (60) und rechtwinklig zu dieser definieren, eine Ventilklappe (30) vorgesehen ist, welche um eine Schwenkachse (31), die zur Symmetrieebene (62) parallel verläuft, drehbar ist, wobei die mechanische Kühlmittelpumpe **dadurch gekennzeichnet ist, dass** die Ventilklappe (30) mit einem Klappensitz auf einer Seite der Ventilklappe (30) versehen ist, wobei der Klappensitz dem Ventilsitz (66) entspricht, wobei die Ventilklappe (30) mit einer seitlichen Exzentrizität (E) in Bezug auf die Symmetrieebene (62) angeordnet ist, wobei die seitliche Exzentrizität (E) zwischen 1/20 und 1/1 der Entfernung (D) der Schwenkachse von der Ventilsitzebene (60) beträgt, mindestens ein axiales Ende der Ventilklappe an einer Basisscheibe (34) befestigt ist, die rechtwinklig zur Schwenkachse (31) angeordnet ist, wobei die proximale Fläche der Basisscheibe (34) in einer Ebene liegt, die durch eine Innenwandfläche des Auslasskanals (18) definiert ist, und das Spiralgehäuse (13) mit einer Ausnehmung (24) zum Aufnehmen der Ventilklappe (30) in deren offenen Position versehen ist.

2. Mechanische Kühlmittelpumpe (10) nach Anspruch 1, bei welcher die Schwenkachse (31) in der Verlängerung des Ventilsitzes (66) liegt, so dass die Exzentrizität (E) geringer als die Hälfte der Breite (W) der Ventilsitzverlängerung ist.
3. Mechanische Kühlmittelpumpe (10) nach einem der vorhergehenden Ansprüche, bei welcher die Ventilklappe (30) aus Metall besteht und der Klappensitz mit einer Gummibeschichtung (40) beschichtet ist.
4. Mechanische Kühlmittelpumpe (10) nach einem der vorhergehenden Ansprüche, bei welcher das Auslassspiralgehäuse (13) einen zweiten Auslasskanal (17) definiert, der nicht von der Auslassventilanordnung betroffen ist.
5. Mechanische Kühlmittelpumpe (10) nach einem der vorhergehenden Ansprüche, bei welcher die Ventilklappe (30) durch einen pneumatischen, elektrischen oder thermostatischen Aktuator (50) betätigt ist.

Revendications

1. Pompe mécanique à liquide de refroidissement (10) destinée pour moteur à combustion interne, avec une roue de pompe à ailettes (14), qui pompe le liquide de refroidissement liquide, qui entre dans la direction axiale, radialement dans une volute de sortie (16), un carter de pompe (12) comprenant un carter de

volute (13) définissant la volute de sortie (16) qui comprend un canal de sortie (18), et un ensemble de soupape de sortie dans le chemin du canal de sortie (18), ledit ensemble de soupape de sortie comportant un clapet (30) pivotable entre une position ouverte et une position fermée, afin de laisser une ouverture de soupape (19) dudit canal de sortie (18) ouverte ou fermée, dans laquelle ladite ouverture de soupape (19) est définie et entourée par un siège de soupape (66) comportant deux sections de siège linéaires latérales, qui sont parallèles l'une à l'autre et définissent un plan de siège de soupape (60) et un plan de symétrie (62) au milieu de et à angle droit au plan de siège de soupape (60), un clapet (30) est prévu, qui peut tourner autour d'un axe de pivotement (31) parallèle au plan de symétrie (62), la pompe mécanique à liquide de refroidissement étant **caractérisée en ce que** le clapet (30) est muni d'un siège de clapet sur un côté du clapet (30), ledit siège de clapet correspondant au siège de soupape (66), ledit siège de clapet (30) étant agencé avec une excentricité latérale (E) par rapport au plan de symétrie (62), ladite excentricité latérale (E) étant entre 1/20 et 1/1 de la distance de l'axe de pivotement (D) au plan du siège de soupape (60), au moins une extrémité axiale du clapet est fixé à un disque de base (34) disposé à angle droit par rapport à l'axe de pivotement (31), la face proximale de disque de base (34) étant située dans un plan défini par une face d'une paroi intérieure dudit canal de sortie (18), et le carter de volute (13) présente un évidement (24) pour accommoder le clapet (30) dans son position ouverte.

2. Pompe mécanique à liquide de refroidissement (10) selon la revendication 1, dans laquelle l'axe de pivotement (31) est situé dans la projection du siège de soupape (66), de sorte que l'excentricité (E) est moins que la moitié de la largeur (W) de la projection du siège de soupape.
3. Pompe mécanique à liquide de refroidissement (10) selon l'une quelconque des revendications précédentes, dans laquelle le clapet (30) est fabriqué de métal et le siège du clapet est revêtu d'un revêtement en caoutchouc.
4. Pompe mécanique à liquide de refroidissement (10) selon l'une quelconque des revendications précédentes, dans laquelle le carter de volute de sortie (13) forme un deuxième canal de sortie (17) non affecté par l'ensemble de soupape de sortie.
5. Pompe mécanique à liquide de refroidissement (10) selon l'une quelconque des revendications précédentes,

dentés, dans laquelle le clapet (30) est actionné par un actionneur (50) pneumatique, électrique ou thermostatique.

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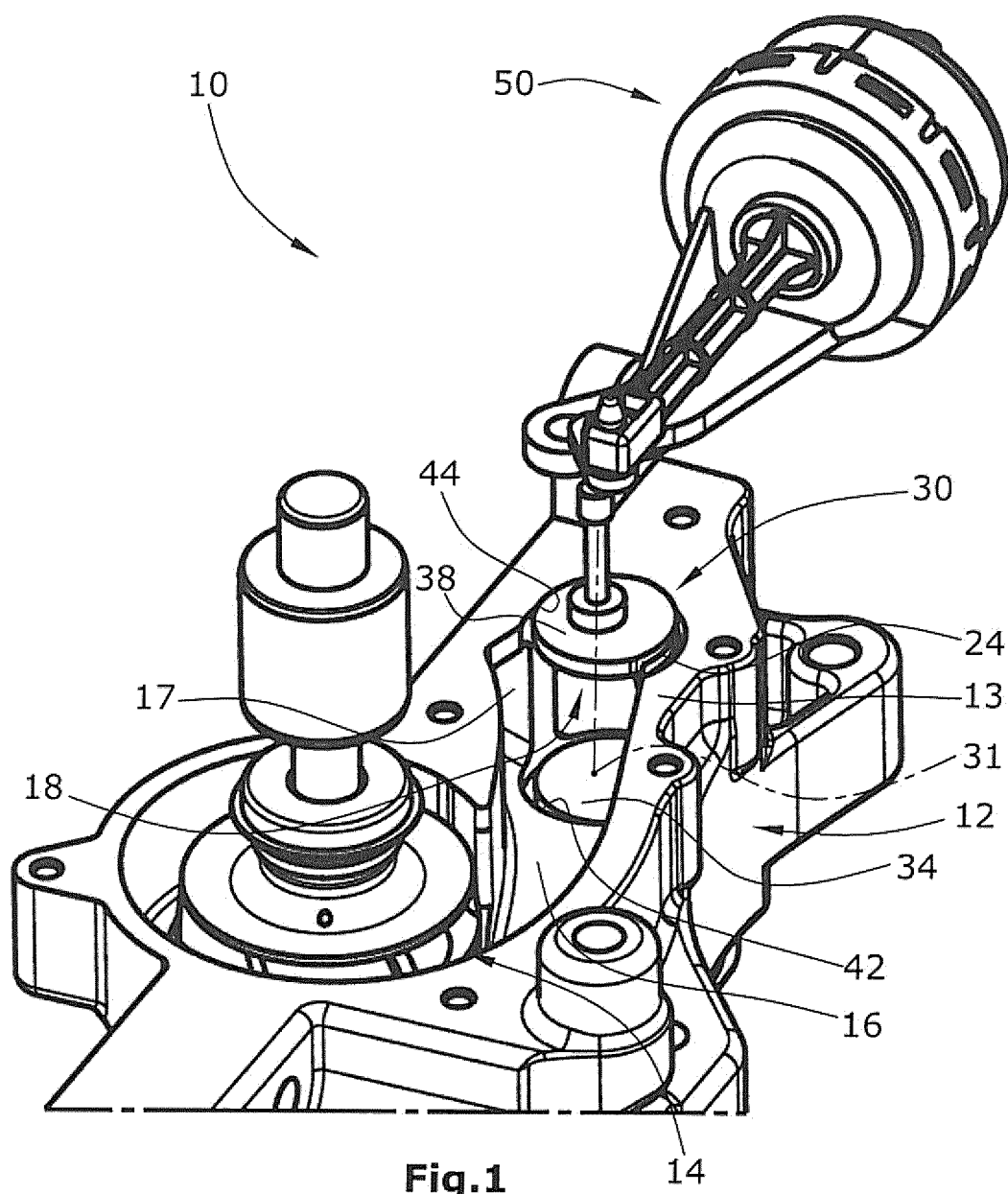
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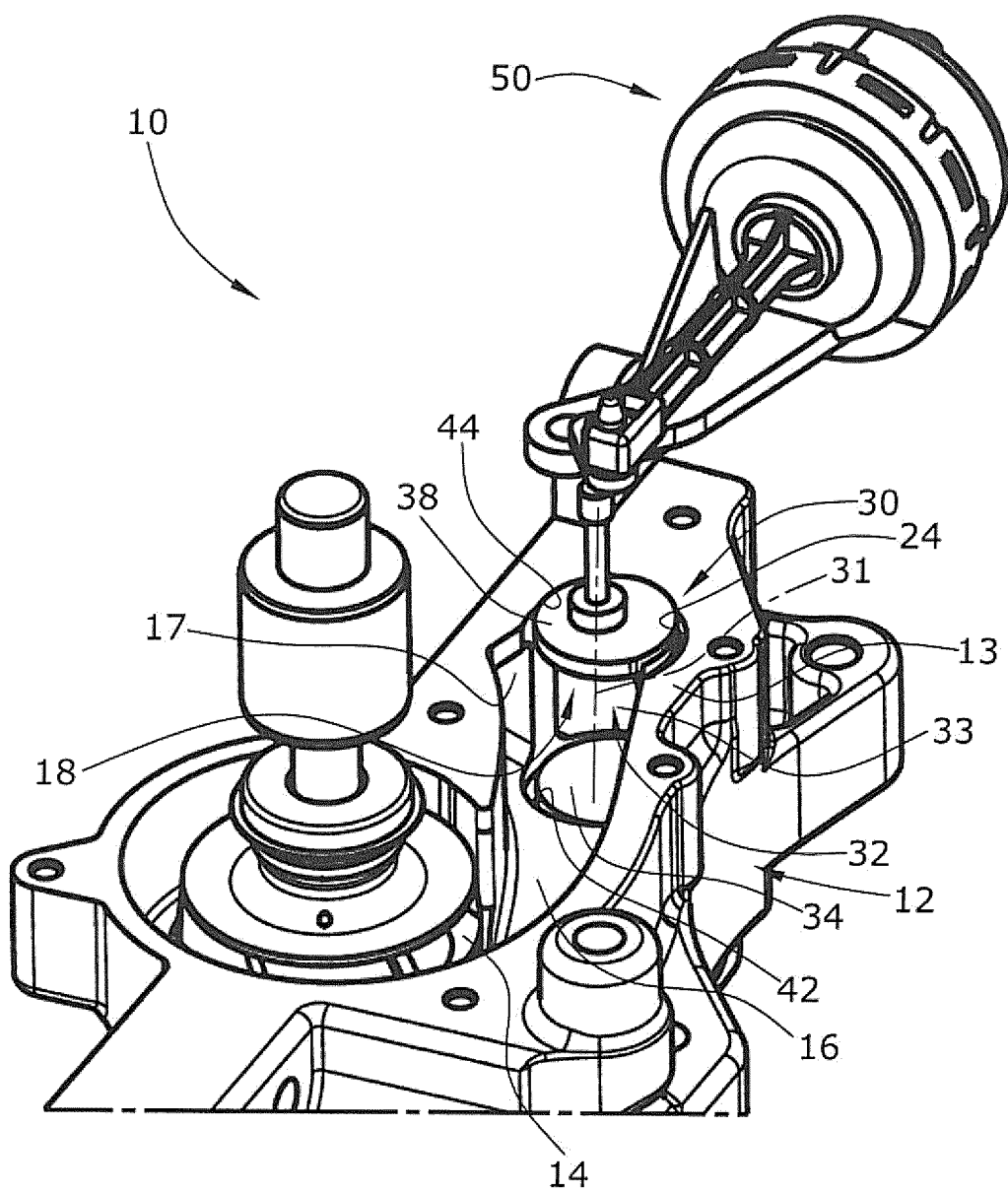


Fig.2

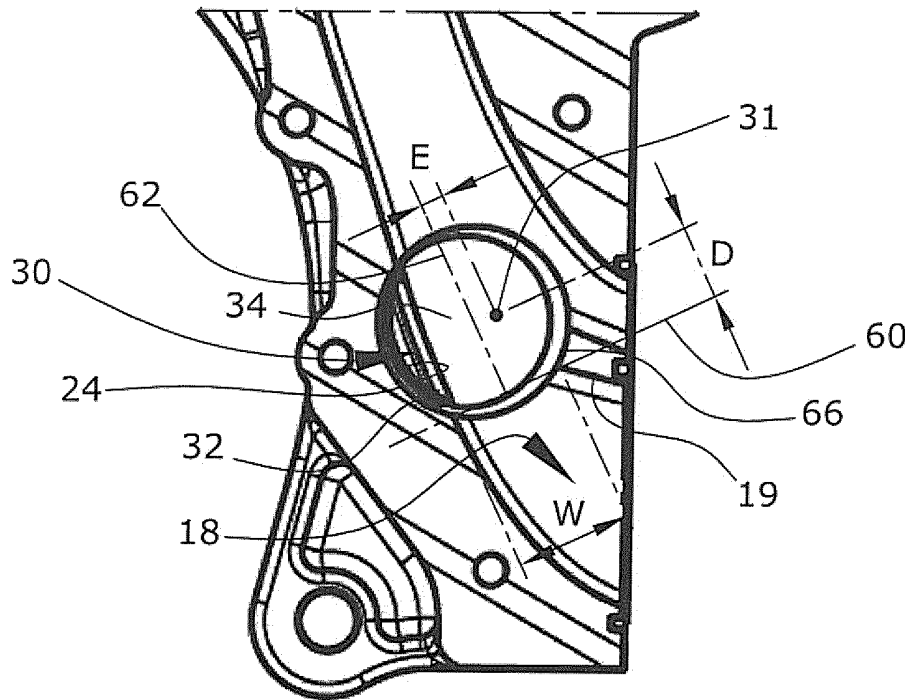


Fig.3

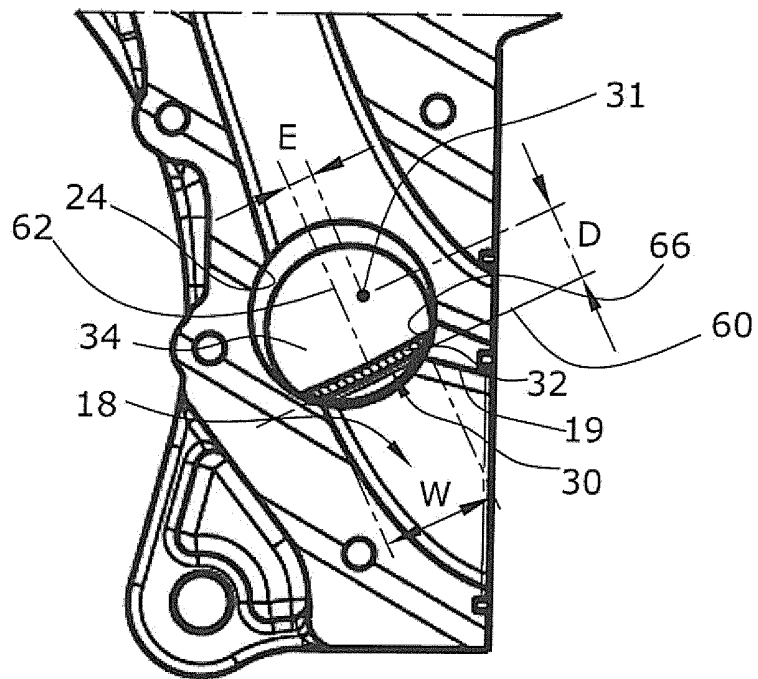
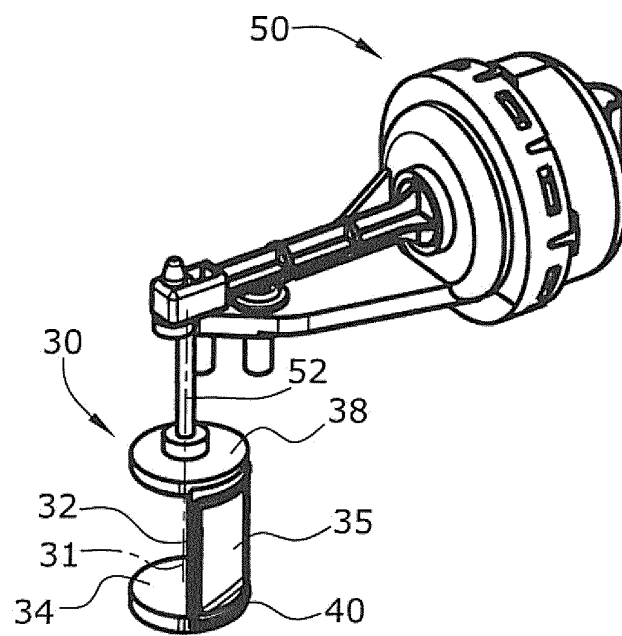
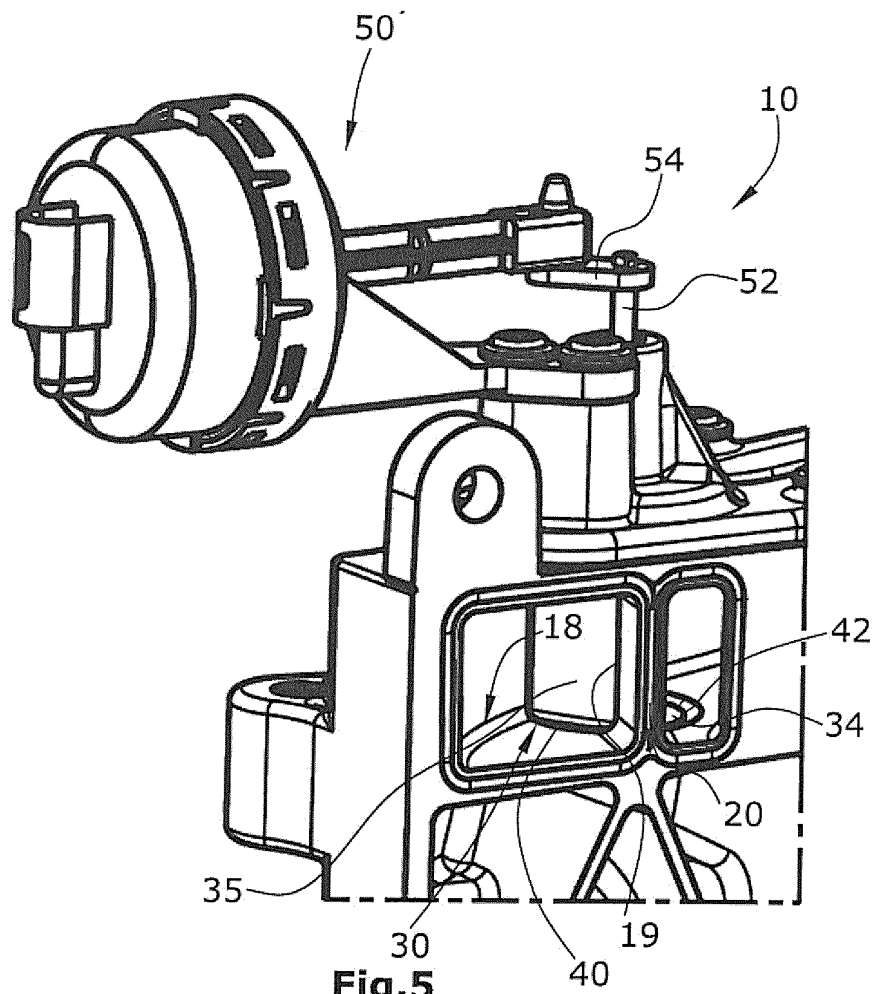


Fig.4



REFERENCES CITED IN THE DESCRIPTION

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