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(71) Applicant (for all designated States except US):

PIEBURG PUMP TECHNOLOGY GMBH [DE/DE];
Alfred-Pierburg-Str. 1, 41460 Neuss (DE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): FOURNIER, Arnaud [FR/FR]; 80 rue de la République, F-57970 Yutz (FR). SIMON, Gilles [FR/FR]; 26 la Sapinière, F-57860 Montois la Montagne (FR). MELE, Gabriel [FR/FR]; 84 rue de Vallieres, F-57070 Metz (FR). MAJCHRZAK,

Eric [FR/FR]; 1 B rue Frédéric Chopin, F-57970 Yutz (FR). MAGNIER, Gilles [FR/FR]; 15 Impasse des Maronniers, F-57940 Metzervise (FR).

(74) Agent: PATENTANWÄLTE TER SMITTEN; Burgunderstrasse 29, 40549 Düsseldorf (DE).

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[Continued on next page]

(54) Title: ADJUSTABLE MECHANICAL COOLANT PUMP

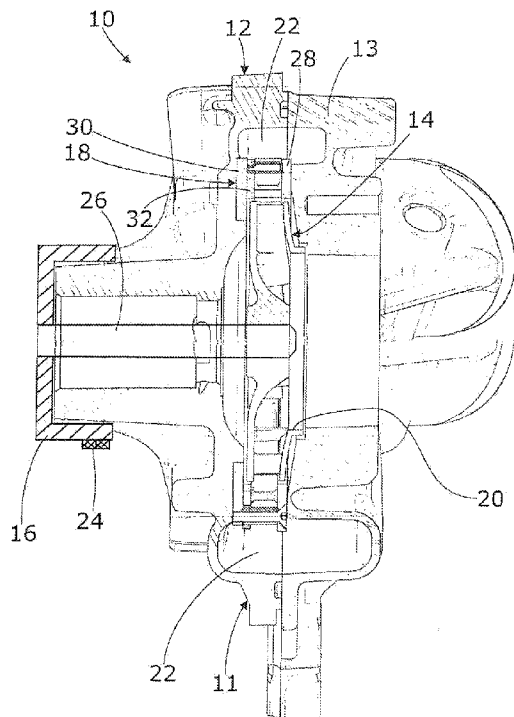


Fig. 1

(57) Abstract: The invention refers to an adjustable mechanical coolant pump (10) for an internal combustion engine. The pump (10) comprises a pump rotor wheel (14) with an axial inlet. The pump rotor wheel (14) pumps a coolant radially outwardly. The pump comprises numerous variable pump stator blades (40) being pivotably arranged radially outwardly of and concentrically with the pump rotor wheel (14). A control ring (32) is provided which simultaneously pivots the blades (40) when the control ring (32) is rotated. The control ring (32) is rotated by an actuator, thereby pivoting the blades (40) between an open and a closed position. A pump housing body (12) supports the pump stator blades (40) and the control ring (32). According to the invention, the pump stator blades (40) and the control ring (32) are captively mounted at a separate static blade holding frame (18) which is mounted to the pump housing body (12).

TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). **Published:** — *with international search report (Art. 21(3))*

Adjustable mechanical coolant pump

5 The present invention refers to an adjustable mechanical coolant pump for an internal combustion engine.

The coolant demand of a combustion engine depends on many factors, such as engine temperature, environment temperature, effective engine
10 power etc. A mechanical coolant pump is directly driven by the internal combustion engine so that the rotational speed of the pump is strictly proportional to the rotation speed of the combustion engine. As a consequence, the mechanical coolant pump does not consider the coolant demand of the combustion engine.

15

Therefore, more sophisticated mechanical coolant pumps are made adjustable by different kinds of valve mechanisms. In WO 2007/025375 A2 and adjustable mechanical coolant pump is provided with pivotable pump stator blades surrounding the pump rotor wheel. The stator blades
20 form an inlet valve so that the coolant flows through the open inlet valve before it is pumped by the pump rotor wheel radially inwardly. When the stator blades are in the closed position and the rotor wheel is rotating with high speed, cavitation can occur which causes undesirable effects.

25 The stator blades are pivotably mounted axially between two mounting rings and are pivoted by a separate control ring surrounding one mounting ring. During the assembly procedure, the control ring can fall off the mounting ring as long as the mounting rings and the control ring are not fixed to the pump housing body. When the control ring falls off, every

single stator blade has to be re-assembled with the control ring which is a time consuming procedure.

It is an object of the invention to provide an adjustable mechanical coolant
5 pump with improved cavitation quality and with an improved assembly procedure.

This object is, according to the invention, solved with the features of claim
1.

10

The adjustable mechanical coolant pump is provided with a pump rotor wheel with an axial inlet and a radial outlet. The rotor wheel pumps the coolant radially outwardly, i.e. from the center radially to the outside. A set of variable pump stator blades is arranged at a circle, the circle being
15 concentrically with and radially outwardly of the pump rotor wheel so that the pump stator blades form an ring-like outlet valve, not an inlet valve. This arrangement of the valve formed by the pump stator blades avoids cavitation when the stator blades are in a closed position thereby minimizing the coolant flow even at high rotation speeds.

20

A separate static blade holding frame is provided to which all pump stator blades as well as the control ring are captively, i.e. unloosably, mounted. Before the blade holding frame is mounted to the pump housing body, the pump stator blades as well as the control ring are undetechably pre-
25 assembled to the blade holding frame. Neither the pump stator blades nor the control ring can fall off the blade holding frame when the frame is mounted to the pump housing body. This facilitates the assembling of the coolant pump and reliably avoids any time-consuming re-assembling of the control ring and the stator blades.

According to a preferred embodiment of the invention, the blade holding frame comprises a first frame ring and a second frame ring. The control ring is mounted axially between the second frame ring and the blades. The stator blades and the control ring are sandwiched between the two frame rings. This constellation ensures that the control ring is fixed to the blade holding frame and cannot fall off until the blade holding frame is mounted to the pump housing body.

10 Preferably, the second frame ring is provided with axial guiding projections cooperating with respective guiding openings of the control ring so that a rotation of the control ring is allowed and the control ring can not move radially with respect to the second frame ring. It is self-evident that the guiding openings alternatively can be provided in the second frame ring
15 and the projections at the control ring.

According to a preferred embodiment of the invention, the two frame rings are stiffly connected to each other by at least two, preferably by three axial connection screws. The two frame rings and the connection screws
20 together form the blade holding frame which is a cradle for the pump stator blades and the control ring.

Preferably, the control ring is provided with a long hole for every connection bolt projecting therethrough. The long holes have a circular
25 coaxial orientation. The control ring is guided by the connection screws so that the control ring can rotate within a defined rotation angle.

According to a preferred embodiment, the connection spacer sleeves are provided with an axial bore. The connection screw is projecting through

the axial bore of the sleeve which defines a constant axial distance of the two frame rings.

According to a preferred embodiment, the pump stator blades are provided with an axial pivot pin. The pivot pin is lying in the pivot axis of the stator blades and is seated in respective pivot bores of the first frame ring.

Preferably, the pump stator blades are provided with an axial actuation pin projecting into respective actuation long holes of the control ring. The orientation of the actuation long holes is not coaxially circular so that a rotation of the control ring causes a synchronous pivot movement of all stator blades. By moving the control ring, the stator blades are moved into a closed or into the open position. In the closed position, the stator blades overlap each other at their tangential front and back ends to completely close the radial outlet of the pump rotor wheel.

The following is a detailed description of the invention with reference to the drawings, wherein:

20

- figure 1 shows a longitudinal cross section of an adjustable mechanical coolant pump,
- figure 2 shows a top view of the opened coolant pump of figure 1,
- figure 3 shows a detail of the pump of figure 1 in cross section,
- 25 figure 4 shows perspective view of a blade holding frame of the coolant pump of figure 1,
- figure 5 shows a variable pump stator blade of the coolant pump of figure 1,
- figure 6 shows a first frame ring of the blade holding frame of figure 4,

figure 7 shows a second frame ring of the blade holding frame of figure 4,

figure 8 shows an axial connection bolt of the blade holding frame of figure 4, and

5 figure 9 shows a control ring of the blade holding frame of figure 4.

In figures 1 and 2 an adjustable mechanical coolant pump 10 is shown which is typically configured to provide coolant for a truck internal combustion engine.

10

The coolant pump 10 comprises a housing 11 which is composed of two metal pump housing bodies 12, 13. Figure 2 shows a top view of the opened pump housing showing one pump housing body 12 wherein a separate blade holding frame 18 and a pump rotor wheel 14 are provided.

15

The pump rotor wheel 14 is provided with an axial inlet opening 20 constituting an axial inlet for the coolant flowing-in axially from an engine block (not shown). The pump rotor wheel 14 is connected to and co-rotating with a driving wheel 16 which is driven by a driving belt 24. The driving belt 24 is driven by the combustion engine so that the pump rotor wheel 14 is rotating with a rotational speed which is proportional to the rotational speed of the combustion engine.

The pump rotor wheel 14 is radially surrounded by the static blade holding frame 18 which comprises a set of numerous variable pump stator blades 40 being arranged at a coaxial circle and being pivotable around axial pivot axis, respectively, between an open and a closed position. When the pump stator blades 40 are in their open position and the pump rotor 14 is rotating, the coolant is pumped by the pump rotor 14 radially outwardly

into an outlet volute 22, and from the outlet volute 22 into an outlet channel 25. When the pump stator blades 40 are in the closed position, they form a closed ring around the pump wheel 14 so that the coolant can not leave the rotating pump wheel 14.

5

The blade holding frame 18 is shown in detail in figure 4. The blade holding frame 18 comprises a first frame ring 28, a second frame ring 30 being stiffly and unloosably connected in a constant axial distance to the first frame ring 28 by three axial connection screws 46 and spacer sleeves
10 34 with an axial screw bore 50. Numerous pump stator blades 40 are arranged axially adjacent to the first frame ring 28, and a control ring 32 is arranged axially between the pump stator blades 40 and the second frame ring 30.

15 Each pump stator blade 40 is provided with an axial pivot pin 42, an axial guiding pin 44 and an axial actuation pin 43. The pivot pin 42 and the guiding pin 44 are axially in-line and define the pivot axis of the pump stator blade 40. The pivot pins 42 of the blades 40 are seated in respective pivot bores 36 of the first frame ring 28. The axially opposite
20 guiding pin 44 is seated in respective guiding long holes 62 of the control ring 32. The guiding long holes 62 and the guiding pins 44 support the stator blade 40 with respect to a radial forces. The guiding pins 44 can be seated in respective bores of the second frame ring 30.

25 Each actuation pin 43 of the stator blades 40 is projecting into and is guided by respective actuation long holes 64 of the control ring 32. The orientation of the actuation long holes 64 is not coaxially circular so that the pump stator blades 40 are pivoted between an open position and a closed position when the control ring 32 is rotated.

30

The control ring 32 is provided with an actuation bore 68 to which an actuator (not shown) is connected which is, for example, an electric actuation motor (not shown).

5 The second frame ring 30 has the same outer diameter as the first frame ring 28 but has a smaller inner diameter. The outer ring section of the second frame ring 30 is provided with three threaded holes 54 into which the connection screws are screwed. The inner ring section of the second frame ring 30 which projects to the inside is an assembling ring section
10 with three assembling bores 56. The second frame ring 30 is provided with an actuator cut-out 52 in the moving range of the actuation bore 68 of the control ring 32.

The pump assembling procedure is as follows:

15

First, the static blade holding frame 18 and all the components which are to be mounted to the frame 18 are assembled. The pivot pins 42 of the blades 40 are inserted into the respective pivot bores 36 of the first frame ring 28. Then the control ring 32 is mounted and the guiding pins 44 and
20 the actuation pins 43 of the blades 40 are inserted into the respective long holes 62, 64. Finally, the second frame ring 30 is attached to the control ring 32, and the first frame ring 28 and the second frame ring 30 are stiffly connected by the spacer sleeves 34 and the connection screws 46. The connection bolts 34 are, for example, connected to the frame rings
25 28, 30 by screwing.

After the blade holding frame 18 is completely assembled, the blade holding frame 18 is fixed to the pump housing body 12 by three assembling screws 70 projecting through the respective assembling bores
30 56 of the second frame ring 30. Then, the actuation mechanism (not

shown) including the electric actuation motor is mounted, and the actuation mechanism is connected with the actuation bore 68 of the control ring 32.

5 After that, the pump wheel 14 and the driving wheel 16 are mounted to the rotor shaft 26. Finally, the other pump housing body 13 is mounted to the first pump housing body 12 to close the pump housing 11, whereby the pump wheel 14 is inserted into the circular opening defined by the blade holding frame 18.

Claims

1. Adjustable mechanical coolant pump (10) for an internal combustion engine, comprising
5 a pump rotor wheel (14) with an axial inlet, the pump rotor wheel (14) pumping a coolant radially outwardly,
variable pump stator blades (40) being pivotably arranged radially outwardly at a circle concentrically with the pump rotor wheel (14),
a control ring (32) simultaneously pivoting the blades (40) when the
10 control ring (32) is rotated,
an actuator rotating the control ring (32) thereby pivoting the blades (40) between an open and a closed position, and
a pump housing body (12) supporting the pump stator blades (40) and the control ring (32),
15 whereby the pump stator blades (40) and the control ring (32) are captively mounted at a separate static blade holding frame (18) which is mounted to the pump housing body (12).
2. Adjustable mechanical coolant pump (10) of claim 1, whereby the
20 blade holding frame (18) comprises a first frame ring (28) and a second frame ring (30), and the control ring (32) is mounted axially between the second frame ring (30) and the pump stator blades (40).
- 25 3. Adjustable mechanical coolant pump (10) of claim 2, whereby the second frame ring (30) is provided with axial guiding projections (56) cooperating with respective guiding openings of the control ring (32) to allow a rotation of the control ring (32).

4. Adjustable mechanical coolant pump (10) of one of the preceding claims, whereby the two frame rings (28, 30) are stiffly connected to each other by at least two axial connection screws (46).
5. Adjustable mechanical coolant pump (10) of claim 4, whereby the control ring (32) is provided with a fixation long hole (60) for every connection screw (46) projecting therethrough.
6. Adjustable mechanical coolant pump (10) of claim 4 or 5, whereby spacer sleeves (34) are provided with an axial bore (50), and the connection screws (46) are projecting through the axial bore (50) so that the two frame rings (28, 30) are kept in a constant and fixed distance to each other.
7. Adjustable mechanical coolant pump (10) of one of the preceding claims, whereby the pump stator blades (40) are provided with an axial pivot pin (42), respectively, the pivot pin (42) being seated in respective pivot bores (36) of the first frame ring (28).
8. Adjustable mechanical coolant pump (10) of one of the preceding claims, whereby the pump stator blades (40) are provided with an axial actuation pin (43), respectively, projecting into respective actuation long holes (64) of the control ring (32), the actuation long holes orientation being not coaxially circular.

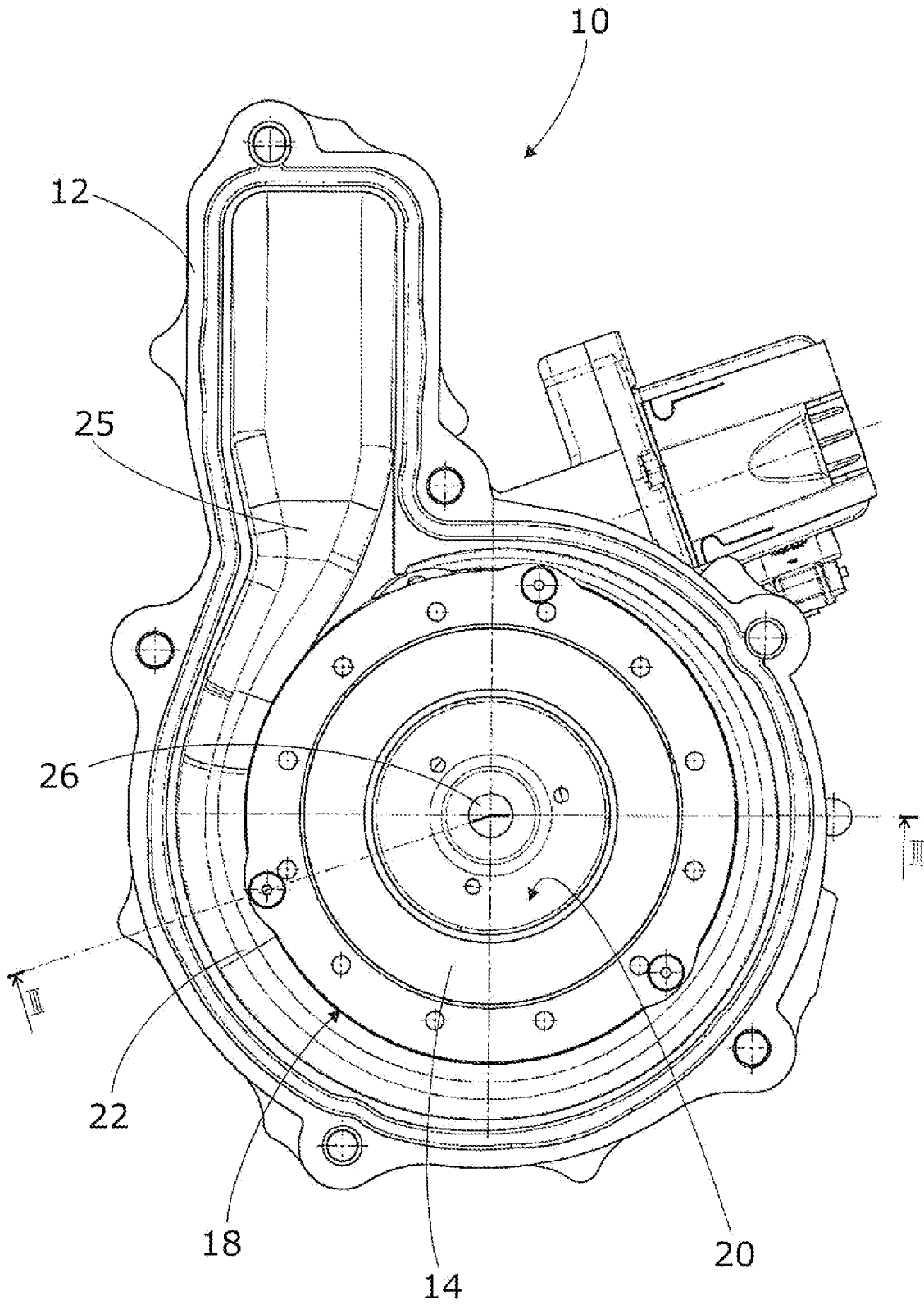


Fig. 2

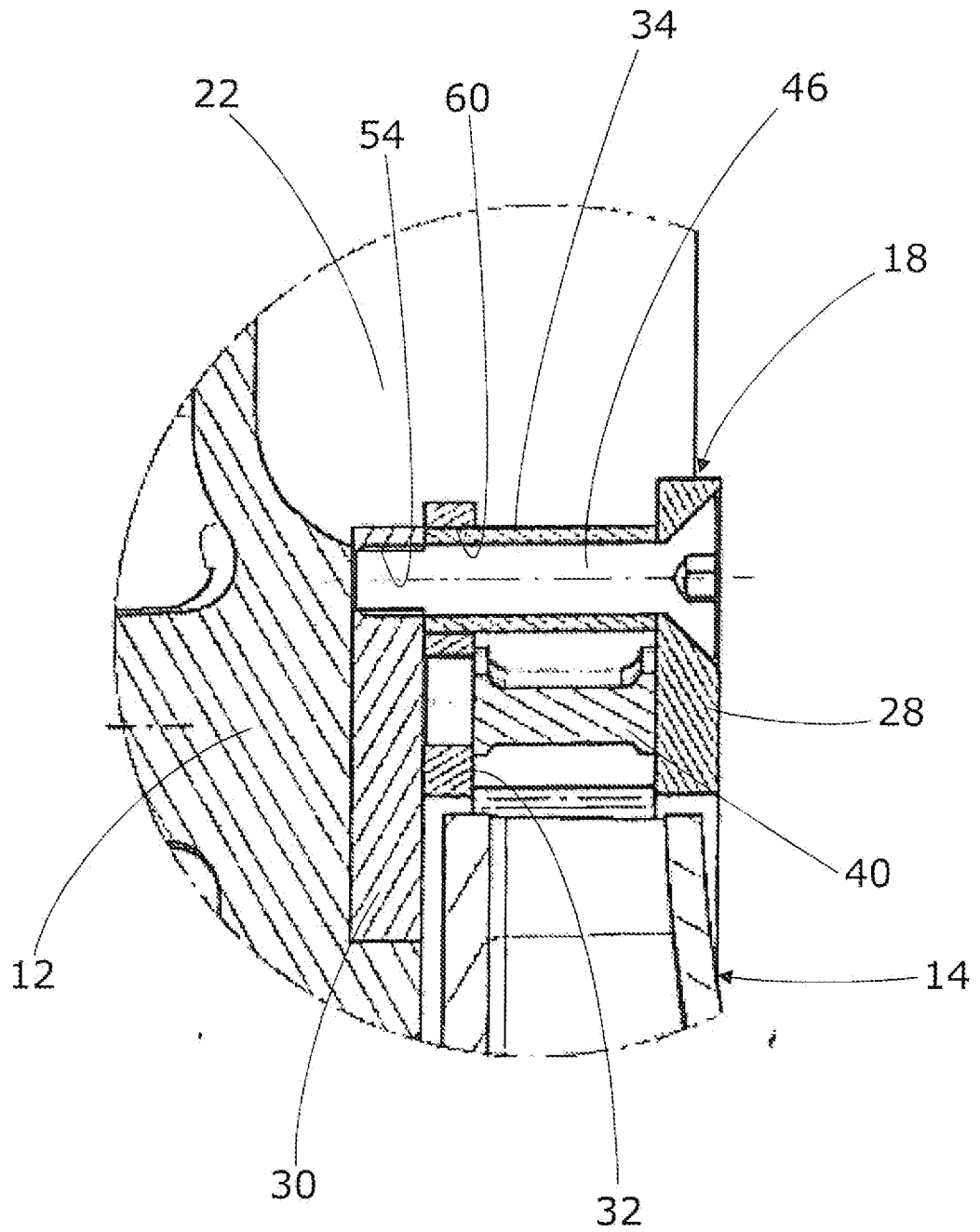


Fig. 3

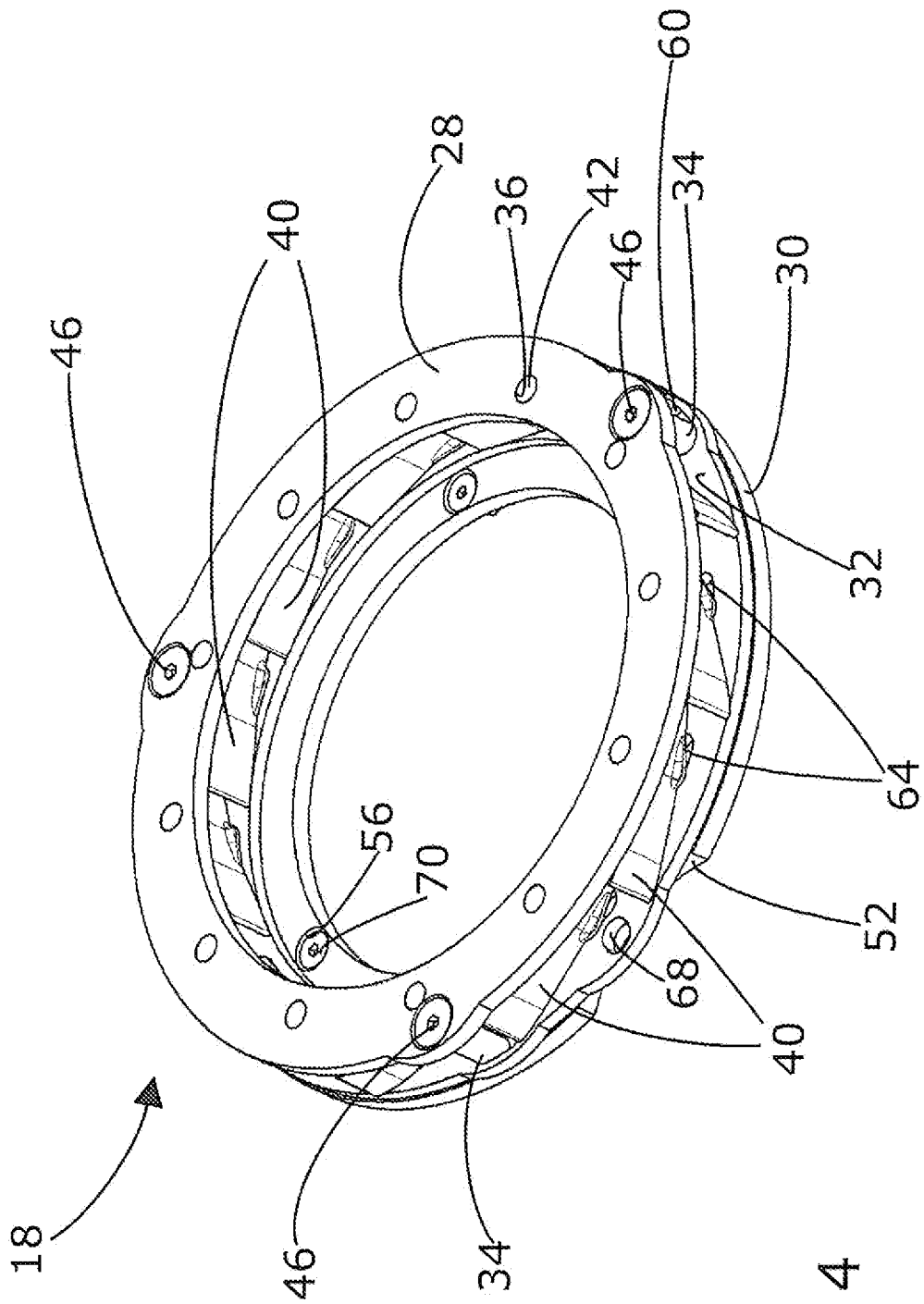


Fig. 4

5/8

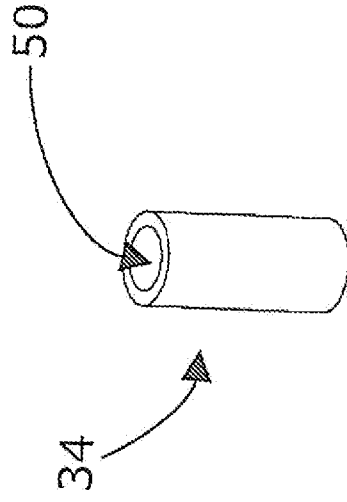


Fig. 8

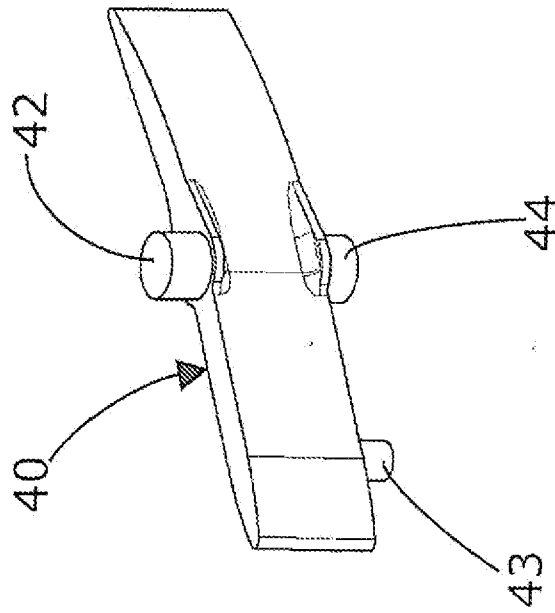


Fig. 5

6/8

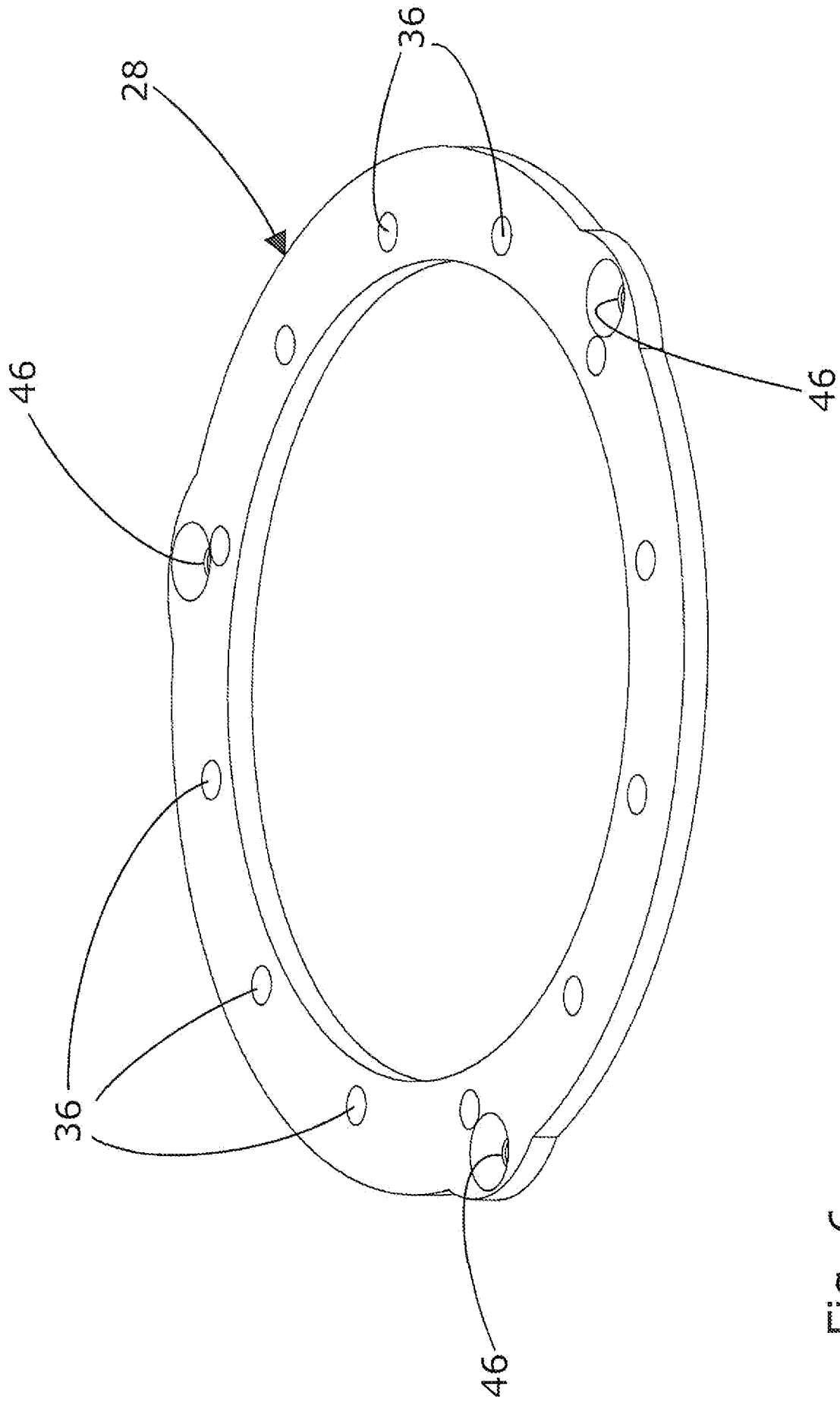


Fig. 6

7/8

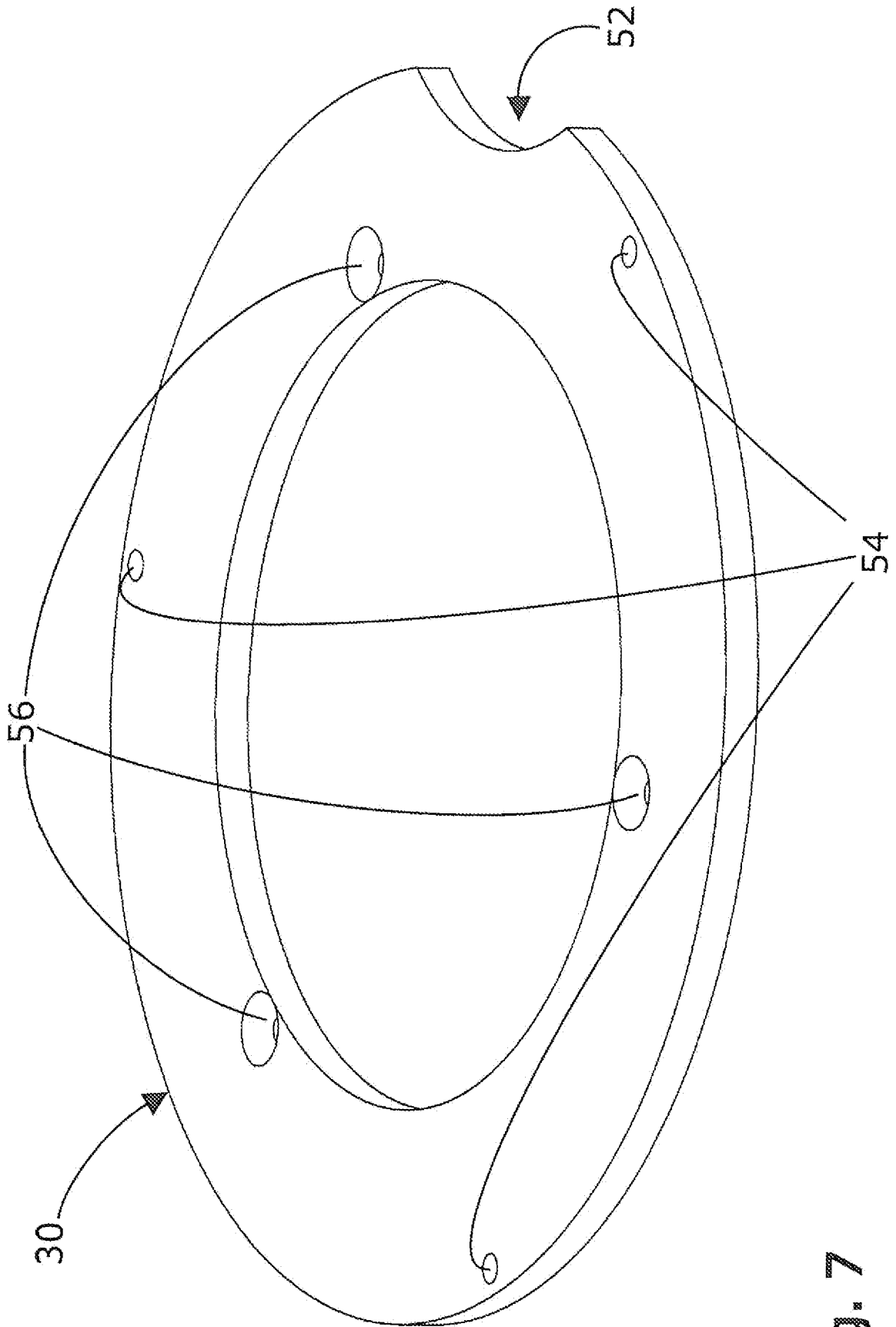


Fig. 7

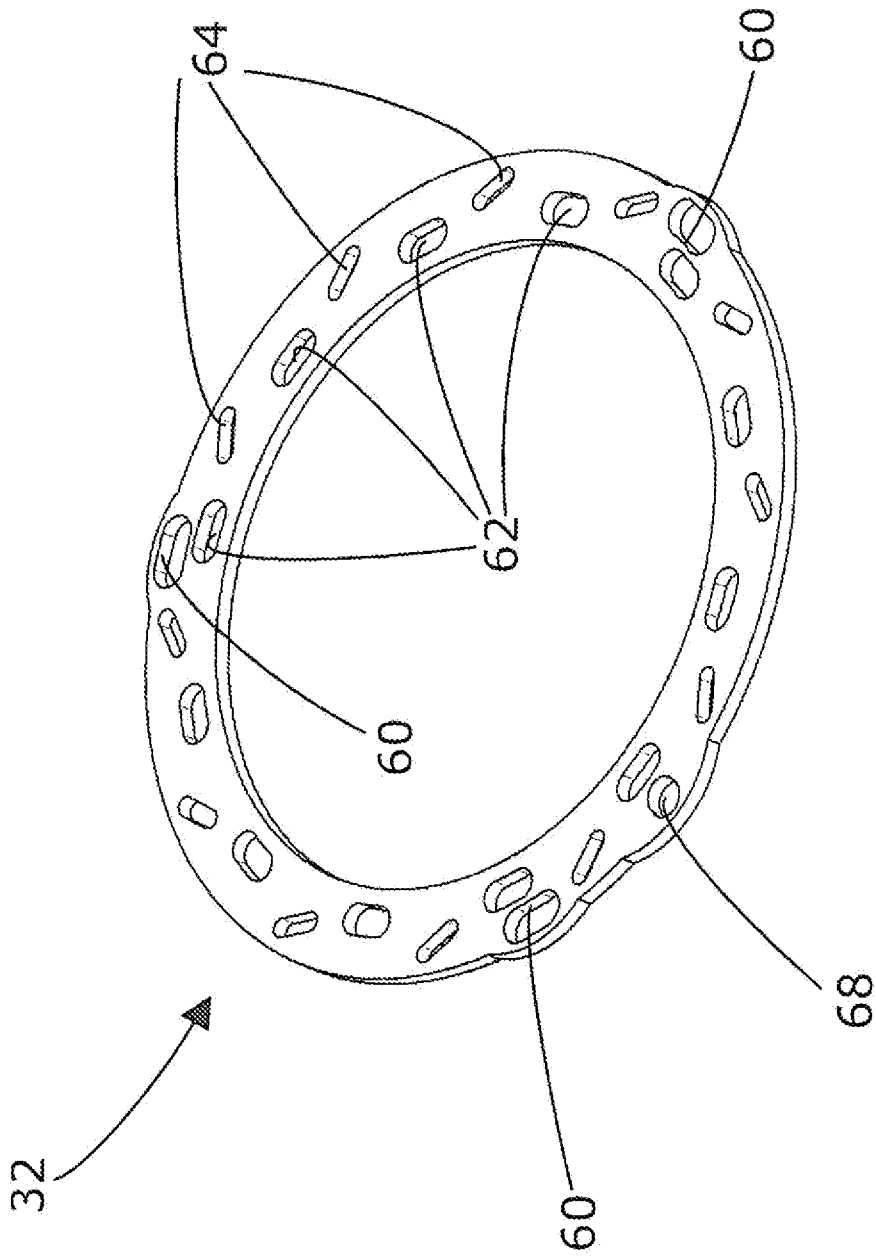


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/052796

A. CLASSIFICATION OF SUBJECT MATTER
 INV. F04D15/00 F04D29/46 F04D29/58 F04D29/62 F01P5/10
 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)
 F04D F01P F01D

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.
Y	EP 2 131 042 A2 (PIERBURG GMBH [DE]) 9 December 2009 (2009-12-09) paragraph [0001] paragraph [0025] - paragraph [0037] figures 1-8	1-8
Y	WO 2007/018529 A1 (HONEYWELL INT INC [US]; PHILIPPE NOELLE [FR]) 15 February 2007 (2007-02-15) page 1, line 3 - line 30 page 2, line 18 - line 28 page 8, line 13 - page 10, line 7 figures 1-4	1-8
Y	EP 1 413 763 A1 (CARRIER CORP [US]) 28 April 2004 (2004-04-28) paragraph [0020] - paragraph [0034] figures 1-12	1-8
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 3 May 2010	Date of mailing of the international search report 18/05/2010
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Homan, Peter
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/052796

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>WO 2007/025375 A2 (FLOWORK SYSTEMS II LLC [US]; REPPLE WALTER OTTO [CA]; FULTON JOHN ROBE) 8 March 2007 (2007-03-08) cited in the application paragraph [0001] paragraph [0010] - paragraph [0015] paragraph [0028] figures 4,5,11</p> <p style="text-align: center;">-----</p>	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2010/052796

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