(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
03 October 2019 (03.10.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/186258 A1

(51) International Patent Classification:
F04B 53/10 (2006.01)

(21) International Application Number:
PCT/IB2018/057628

(22) International Filing Date:
02 October 2018 (02.10.2018)

(25) Filing Language: Dutch

(26) Publication Language: English

(30) Priority Data:
2018/5203 27 March 2018 (27.03.2018) BE

(71) Applicant: **ATLAS COPCO AIRPOWER, NAAMLOZE VENNOOTSCHAP** [BE/BE]; Boomsesteenweg 957, 2610 Wilrijk (BE).

(72) Inventors: **MARTENS, Kristof Adrien**; c/o ATLAS COPCO AIRPOWER NV, Boomsesteenweg 957, 2610 Wilrijk (BE). **DE SCHAMPHELAERE, Pieter**; c/o ATLAS COPCO AIRPOWER NV, Boomsesteenweg 957, 2610 Wilrijk (BE).

(74) Agent: **VAN VARENBERG, Patrick** et al.; Arenbergstraat 13, 2000 Antwerpen (BE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, 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, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *of inventorship (Rule 4.17(iv))*

(54) **Title:** IMPROVED MINIMUM PRESSURE VALVE AND METHOD FOR SERVICING SUCH A VALVE

(57) **Abstract:** The invention relates to a minimum pressure valve (10) comprising a housing (17) with the valve inlet (11) and the valve outlet (12) connected with each other by means of a chamber and connecting space (22a, 22b), the minimum pressure valve (10) also comprising a valve body (21) set up in a chamber (20) moveably between a closed position in which the valve inlet (11) is closed and an open position in which the valve inlet (11) is open, the minimum pressure valve (10) also comprising components which are provided with a seal and/or sliding parts (24, 26, 30), whereby a subassembly (22) of the minimum pressure valve (10) can be disassembled and/or assembled through an opening (31) in the housing (17).

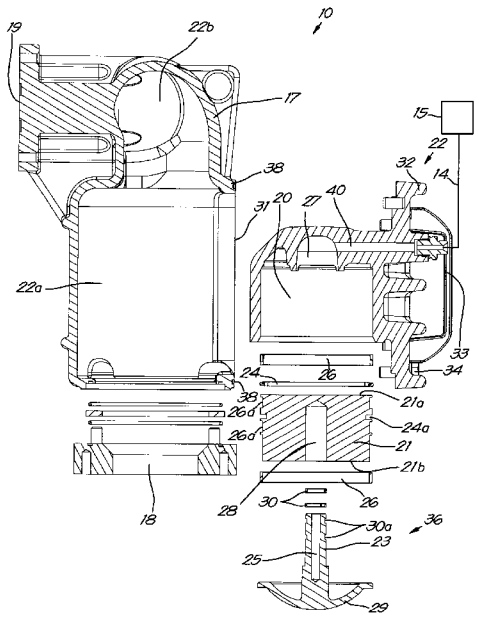

Fig.3

WO 2019/186258 A1

[Continued on next page]

Published:
— *with international search report (Art. 21(3))*

Improved minimum pressure valve and method for servicing such a valve.

The invention relates to a minimum pressure valve, particularly for use with a compressor installation.

It is known that compressor installations comprise a minimum pressure valve, often attached to the outlet of a pressure vessel that can help when separating liquid, such as oil in the case of an oil-injected compressor, from compressed gas exiting the compressor element.

By injecting a liquid, such as for example oil, in the element of the compressor during compression of the gas, the rise in temperature of the compressed gas can be controlled. The coolant is usually separated from the flow of compressed gas in a liquid separator, which is often integrated in a pressure vessel placed downstream from the compressor element. The coolant is then usually recycled and returned from the pressure vessel or liquid separator, through a cooler, to the compressor element.

As the coolant flows through the cooling circuit, the pressure of the coolant will reduce. In order to ensure that the pressure of the coolant remains sufficiently high to be reinjected into the compressor element, the pressure in the pressure vessel must be kept at a sufficiently high level.

A minimum pressure valve ensures that, while loading the compressor installation, the pressure in the pressure

vessel never drops below a certain minimum level. This minimum value is known as the 'setpoint' of the minimum pressure valve.

The setpoint is chosen in such a way that the injection of coolant is always guaranteed whatever the circumstances. This means that, even during temporary conditions, the pressure remains sufficiently high to prevent peaks in temperature. The setpoint is also chosen so that the flow rate through the pressure vessel or the liquid separator is not too high, more specifically that the flow rate through the (coalescence) filter placed in the liquid separator or in a pressure vessel after the liquid separator is not too high so as to prevent damage to this component.

In addition a non-return valve is usually fitted in the minimum pressure valve. This non-return valve ensures that the user network connected to the compressor remains pressurised when the compressor is stopped or operates without a load, so that no energy is lost from the user network.

Such minimum pressure valves are used in the industry, such as for example described in CN 101,520,103 A.

There are, however, certain problems related to minimum pressure valves.

A minimum pressure valve requires maintenance from time to time. More particularly in the course of time there is wear on the slide rings in the piston and/or the stem of the valve, and/or the seals, if present. Such wear can cause

air leaks, which can disrupt the pressure and/or intended pressure balance on the moveable parts and can cause the valve to operate incorrectly. In the worst case, some moveable parts can become jammed, causing the valve to operate ineffectively.

For this reason the slide rings and/or seals are replaced regularly, for example in combination with other maintenance to the compressor, such as an oil change, new inlet filter, oil filter, etc. For an oil-injected compressor this may for example be after every 8000 hours of operation.

In order to replace the slide rings and/or the seals the technician first dismantles the minimum pressure valve. The minimum pressure valve inlet is usually attached to the top of the oil separation vessel and connected to the exit of the oil separation vessel, where the air, after being separated from most of the oil, leaves the oil separation vessel. The outlet of the minimum pressure valve is usually connected to the aftercooler. Both connections can be made either directly or with additional pipes. The connections are generally made with a bolted flange or more flexible connection.

The technician will detach the outlet of the minimum pressure valve from the aftercooler, also often removing the pipes between the minimum pressure valve and the aftercooler, and then detach the minimum pressure valve on the side of the exit of the oil separation vessel and finally remove the minimum pressure valve from the compressor. It is clear that much work is involved in

dismantling the minimum pressure valve.

Depending on the size of the minimum pressure valve, the weight of the minimum pressure valve can be considerable. It is not unusual for the minimum pressure valve to weigh more than 20kg. However, the technician does not always have lifting equipment on site and, even with lifting equipment, it is a challenge to remove the minimum pressure valve from the middle of the compressor. The technician often works alone and has no colleague available to lend a hand. Therefore, in many cases the technician will remove the minimum pressure valve himself by hand. This is not ideal from an ergonomic point of view and can even be dangerous.

The technician will then take the minimum pressure valve to a place where it can be checked. This may be in a workshop, if available, in his company vehicle or sometimes simply in an open space on the floor. In any case the technician must take the minimum pressure valve to a suitable location. Sometimes the technician will have a trolley available to transport the minimum pressure valve, but he will often just carry the minimum pressure valve himself. Again, this is not ideal from an ergonomic point of view.

The technician will then dismantle the minimum pressure valve, replace the slide rings and/or seals and reassemble the minimum pressure valve. The technician will therefore put the minimum pressure valve back in the compressor, again with all the same inconveniences as mentioned above.

It is clear that the maintenance of the minimum pressure

valve is time consuming, often not very ergonomic and sometimes even dangerous.

An additional problem is that, after dismantling the minimum pressure valve, the exit of the oil separation vessel is exposed (particularly when the minimum pressure valve is mounted directly on the oil separation vessel). Dirt and moisture can enter the vessel and oil circuit, causing a variety of possible consequences, ranging from minor (dirt in the oil filter) to major (for example more rapid failure of the bearings in the compressor element). What can also happen is that objects, such as nuts or bolts, fall into the oil separation vessel. Attempts to remove these from the oil separation vessel are often complicated, but may be necessary as the technician often has no extra spare parts and furthermore it is essential to avoid at all costs that objects remain in the oil separation vessel.

The technician can prevent all such occurrences by temporarily sealing the exit of the oil separator, but this requires extra tools and work.

The purpose of the present invention is to provide a solution to at least one of the aforementioned and other disadvantages.

An aim of the present invention is to provide a minimum pressure valve whereby the repair or maintenance is less time consuming, more ergonomic, less dangerous and there is less exposure to dirt and other contamination during maintenance.

The present application therefore concerns an improved design of a minimum pressure valve.

To this end the invention relates to a minimum pressure valve consisting of a housing with a valve inlet and a valve outlet which are connected with other by way of a connecting space; the minimum pressure valve also comprises a valve body that is placed in a chamber moveably between, on the one hand, a closed position in which the valve inlet is sealed and on the other hand, an open position in which the valve inlet is open; the minimum pressure valve also comprises components provided with a seal and/or sliding parts, whereby a subassembly of the minimum pressure valve can be assembled and/or disassembled through an opening in the housing.

Preferably said subassembly of the minimum pressure valve can be assembled and/or disassembled through an opening in the side wall in the housing of the minimum pressure valve.

In a preferred embodiment of a minimum pressure valve according to the invention, the subassembly typically comprises the components which are provided with a seal and/or sliding parts, such as sealing rings and/or slide rings.

The advantage is that the sealing and/or sliding parts that are exposed to wear and/or aging can easily be checked and, if necessary, replaced without the hard work and time loss involved in dismantling the entire minimum pressure valve.

In addition, the subassembly of the minimum pressure valve that is removed weighs considerably less than the entire minimum pressure valve, whereby its removal and replacement can be done much more ergonomically. All other manipulations of the subassembly are therefore also much more simple and practical.

A further advantage is that, to seal the connection between the minimum pressure valve and the oil separation vessel and/or the aftercooler (or pipe leading to the oil separation vessel and/or the aftercooler), seals can be used that do not need to be suited for reuse, since they no longer need to be broken. This means that seals made of metal glue or flat seals can also be used, which may be cheaper and/or last longer.

Yet another advantage is that the connection with the oil separation vessel and/or the aftercooler is at least partly covered when the subassembly of the minimum pressure valve is removed.

In a first embodiment of a minimum pressure valve according to the invention, the opening in the side wall of the housing of the minimum pressure valve is covered with a lid.

This lid is preferably attached with bolts or another type of fastener that can be detached and then reattached.

Preferably a seal is placed between the lid and the housing of the minimum pressure valve in order to guarantee air tightness.

In another preferred embodiment of a minimum pressure valve according to the invention the subassembly with the components which are provided with a seal and/or sliding parts can pass through the opening in the side wall of the housing of the minimum pressure valve.

In yet another preferred embodiment of a minimum pressure valve according to the invention, the subassembly with the components which are provided with a seal and/or sliding parts can be fixed within the minimum pressure valve, for example using clamps or another fastener suitable for detachment and then reattachment.

The advantage is that the connection with the oil separation vessel remains at least partly covered thus reducing the risk of penetrating dirt and/or moisture or other objects entering/falling into the oil separation vessel.

Preferably, the subassembly with the components which are provided with a seal and/or sliding parts has a specific shape, so that it can only fit into the housing of the minimum pressure valve in one particular manner.

In a second embodiment of a minimum pressure valve according to the invention, the lid and the subassembly with the components which are provided with a seal and/or sliding parts, are connected, so that the subassembly with the components which are provided with a seal and/or sliding parts can be removed together with the lid.

Preferably, the subassembly with the components which are provided with a seal and/or sliding parts and/or the lid, can be equipped with extra functions to aid manipulation, such as a handle on the lid.

Another example is extra legs/extensions on the subassembly with the components which are provided with a seal and/or sliding parts, so that the subassembly can be placed in a stable manner on a surface, allowing the technician easy access for inspection and/or revision.

In another embodiment of a minimum pressure valve according to the invention, the subassembly with the components which are provided with a seal and/or sliding parts can be equipped with a connection, so that a particular air pressure can be applied to the components, for example a particular pressure exerted on the piston.

In a first embodiment of such a connection, this connection can be connected to a connection in the housing of the minimum pressure valve.

In a particular embodiment of such a connection this could be a connection, realised by clamping the subassembly with the components which are provided with a seal and/or sliding parts against the housing, whereby an outlet in the housing is connected with an inlet on the subassembly, whereby preferably the connection also has a seal that is suitable for a particular tolerance and for ensuring the air tightness.

In a second embodiment of such a connection, this

connection can be connected to a connection in the housing of the minimum pressure valve via a flexible pipe and screw or using a bayonet catch.

In a third embodiment of such a connection according to the invention, this connection can be integrated in the lid connected with the subassembly with the components which are provided with a seal and/or sliding parts, so that after assembling the subassembly with the lid, an external flexible pipe can be connected to the lid opening in order to provide air pressure to the subassembly with the components which are provided with a seal and/or sliding parts.

In a second aspect the invention relates to a compressor comprising a compressor element with a gas inlet and an outlet for compressed gas, the compressor also comprising a pressure vessel with an inlet connected to the outlet for compressed gas, whereby a minimum pressure valve, such as described above, is provided directly or at a certain distance (using an intermediate connection piece) on an outlet of the pressure vessel, the minimum pressure valve being connected with the valve inlet to the outlet of the pressure vessel and the valve outlet being adapted to be connected to a user network, whereby the minimum pressure valve comprises a housing whereby the valve inlet and the valve outlet are connected by means of a chamber and connecting space, the minimum pressure valve also comprises a valve body that is placed in a chamber moveably between a closed position in which the valve inlet is closed and an open position in which the valve inlet is open, whereby a part (the subassembly) of the minimum pressure valve

comprising the components which are provided with a seal and/or sliding parts, such as sealing rings and/or slide rings can be disassembled and/or assembled through an opening in the housing, preferably in the side wall of the housing.

The compressor is preferably a liquid or oil-injected compressor.

In a third aspect the invention relates to a method for servicing a minimum pressure valve of a compressor such as described above, the compressor comprises a compressor element with a gas inlet and an outlet for compressed gas, the compressor also comprises a pressure vessel with an inlet connected to the compressed gas outlet, whereby a minimum pressure valve, such as described above, is provided directly or at a certain distance (using an intermediate connection piece) on an outlet of the pressure vessel, the minimum pressure valve comprises the valve inlet connected to the outlet of the pressure vessel and the valve outlet is adapted to be connected to a user network, whereby the minimum pressure valve comprises a housing whereby the valve inlet and the valve outlet are connected by means of a chamber and connecting space; the minimum pressure valve also comprises a valve body placed in a chamber moveably between a closed position in which the valve inlet is closed and an open position in which the valve inlet is open, whereby a subassembly of the minimum pressure valve that comprises the components which are provided with a seal and/or sliding parts, such as sealing rings and/or slide rings can be disassembled and/or assembled through an opening in the housing, preferably in

the side wall of the housing, the subassembly comprises the components which are provided with a seal and/or sliding parts to replace said seal and/or slide rings.

The method comprises the following steps: a) detaching the bolts (or other fasteners) from the subassembly, b) removing the subassembly, for example using the handle, from the opening in the minimum pressure valve, c) removing the valve body, d) replacing the seal(s) and slide ring(s), e) removing the non-return valve and replacing the slide ring(s), f) reassembling the non-return valve and the valve body, g) tightening the bolts of the subassembly on the housing of the minimum pressure valve.

In the context of the present invention it should be understood that the above advantages related to the minimum pressure valve also apply to the compressor and the method.

With the intention of better showing the characteristics of the invention, a preferred embodiment of a minimum pressure valve according to the invention is described hereinafter, by way of an example without any limiting nature, with reference to the accompanying drawings, wherein:

figure 1 schematically shows a compressor according to the invention;

figures 2 and 3 schematically show a cross-section of a minimum pressure valve of an embodiment according to the invention;

figures 4 and 5 schematically illustrate a seal that

can be used with the minimum pressure valve according to the invention; and

figures 6 and 7 schematically show a view and cross-section of a minimum pressure valve according to a preferred embodiment of the invention.

Figure 1 illustrates a compressor 1 consisting of a compressor element 2 with a gas inlet 3 and a compressed gas outlet 4. The compressor 1 is usually driven by a fixed or variable-speed motor 5.

The compressor element 2 must be interpreted as the housing in which the compressor process takes place by means of a rotor or via a piston compressor movement.

The compressor 1 comprises a pressure vessel 6 with an inlet 7 connected to the compressed gas outlet 4 and an outlet 8 connected to a user network 9. This pressure vessel 6 is also known as a liquid separator, because it is inside this vessel that the air is separated from most of the liquid. The separated liquid is then returned to the compressor element[KM1][G2] via the return pipe 16.

The compressor 1 also comprises a (coalescence) filter which is either mounted in the liquid separator 6, or in a separate pressure vessel 13 after the liquid separator 6.

A minimum pressure valve 10 is provided at the outlet 8, on the liquid pipe provided between the pressure vessel 6 and the user network 9.

The minimum pressure valve 10 has a valve inlet 11 connected to the outlet 8 of the pressure vessel 6 and a valve outlet 12 adapted to be connected to a user network 9.

A pipe 14 connects the outlet 8 of the pressure vessel 6 with the pressure control entry of the minimum pressure valve 10; in this pipe a control unit 15 is provided which regulates the pressure supply via the supply pipe 14.

Figures 2 and 3 show a cross-section of a minimum pressure valve 10 according to the invention.

The minimum pressure valve 10 comprises a housing 17 with a housing inlet 18, a housing outlet 19, a chamber 22a for receiving a removable subassembly 22 and a connecting space 22b between the chamber 22a and the housing outlet 19.

The housing inlet 18 is brought in fluid connection with the valve inlet 11 and the housing outlet 19 is brought in fluid connection with the valve outlet 12 when the minimum pressure valve is mounted within the compressor 1.

The minimum pressure valve 10 comprises a valve body 21 that is moveable in a chamber 20 between a closed position in which the valve inlet 11 is closed and an open position in which the valve inlet 11 is opened.

When the valve inlet 11 is closed, no or practically no liquid is allowed to flow through the minimum pressure valve 10, thus from the housing inlet 18 to the housing outlet 19 and further towards the user network 9.

Considering that, when the valve inlet 11 is open, liquid is allowed to flow through the minimum pressure valve 10, from the housing inlet 18 to the housing outlet 19 and further reaching the user network 9.

The pressure which determines whether the valve body 21 moves to an open position, is determined by a control unit 15.

In commonly used minimum pressure valves 10, a spring is used to set the pressure value whereby the minimum pressure valve is opened and such a spring is selected to suit the capacity and the pressure range of the compressor 1.

In the embodiment of the figures a control unit 15 replaces said spring, hereby avoiding the need for components which would be difficult to fit or replace as described in BE 2018/5011.

The control unit 15 comprises a pipe 14 which forms a connection between the outlet 8 of the pressure vessel 6 and a space contained between the valve body 21 and the chamber [KM3]20[G4].

The channel 40 will be used to transport air to a first end 21a of the valve body 21.

The chamber 20 comprises a groove 27 or recess above a first end 21a of the valve body 21.

Such a groove 27 creates a hollow space between the inside of the chamber 20 and the valve body 21 at the level of the

first end 21a.

In the context of the present invention it should be understood that minimum pressure valves containing on the one hand a spring or on the other a control unit 15, are within the scope of the invention.

The valve body 21 comprises a seal 24 that is adapted to be mounted on the outer contour 24a of the valve body 21, thus between the valve body 21 and the internal side of the chamber 20.

The seal 24 is mounted between the first end 21a and the second end 21b of the valve body 21.

Such a seal 24 is therefore positioned so that there is a separation between on the one hand the space contained between the seal 24, the groove 27 and the first end 21a, whereby the pressure value is defined by the pressure of the liquid flowing through the channel 40, and on the other hand the space contained between the seal 24, the second end 21b and the connecting space in the housing 17 between the housing inlet 18 and the housing outlet 19, whereby the pressure value is defined by the pressure supplied to the housing inlet 18 in the case that the valve body is in the open position or by the relevant pressure in the valve outlet 19 in the case that the valve body is in the closed position.

Depending on the requirements for the minimum pressure valve 10, more than one seal 24 may be fitted, such as for example 2, 3 or more seals.

Preferably, a bi-directional seal is used. Such a seal will work in both directions. Figures 4 and 5 show a cross-section of such a seal.

Alternatively, two single-action seals can be used, placed back-to-back or front-to-front in series.

Although the figures show the seal placed around the valve body 21, it is also possible to place this in the housing 17 of the minimum pressure valve 10 by providing a groove in the chamber 20.

Preferably, but without limiting nature, these seals can be characterised by very low friction and little stick-slip.

The valve body 21 comprises a conductive element 26, adapted to be fitted on the outer contour 26a of the valve body 21, between the valve body 21 and the inside of the chamber 20.

Such a conductive element 26 reduces the wear on the valve body 21 and on the inside of the chamber 20. This wear is caused by the movement of the valve body 21 within the chamber 20 and the friction caused upon this.

One or more conductive elements can be provided. In addition the conductive elements 26 absorb the transverse forces that occur during the movement of the valve body 21 within the chamber 20. Consequently, these conductive elements 26 prevent the valve body 21 from tipping within the chamber 20 and subsequently becoming stuck in the

chamber 20.

The seal 24 is fitted between two conductive elements 26.

The conductive element 26 can be executed in the form of a seal, a slide ring or a conductive tape.

Although in the figures the conductive element 26 is placed around the valve body 21, it would also be possible to place this in the housing 17 of the minimum pressure valve 10 by providing a groove in the chamber 20.

The valve body 21 comprises a bore 28 in which the piston 23 of the non-return valve 36 is mounted. This non-return valve is moveable between a closed position in which the housing inlet 18 is closed and an open position in which the housing inlet 18 is opened.

In the piston 23 a channel 25 is provided to ensure that no air mounts up between the end of the piston 23 and the end of the internal bore 28 in the valve body 21 in which the piston 23 moves.

For a stable and balanced operation of the non-return valve the axis of the bore 28 is aligned or almost aligned with the axis of the valve body 21.

The step section 29 of the non-return valve 36 ensures a seal between the outlet 12 of the minimum pressure valve 10 and the outlet of the pressure vessel 6.

For a flowing movement between the piston 23 and the valve

body 21 and for the protection of the piston 23 and the valve body 21 from the harmful effects of the friction that is caused upon it, the piston 23 also comprises a second conductive element 30 which is adapted so that this can be mounted in position 30a between the piston 23 and the valve body 21.

Although in the figures the second conductive element 30 is placed around the piston 23, it would also be possible to place this in the valve body 21 of the minimum pressure valve 10 by providing a groove in the central bore 28 of the valve body 21.

Depending on the design the minimal pressure valve 10 can consist of some or even all technical characteristics and functions mentioned herein and in any desired combination thereof. 'Technical characteristics and functions' refers here to: all components of the compressor 1 and the control unit 15 (can also be replaced with a spring), the pipe 14, the valve body 21, the channel 25, the piston 23, the seal 24, the conductive unit 26, the groove 27, the step section 29 and the second conductive unit 30. These functions do not all need to be present.

As indicated in the figures 2, 3, 6 and 7, part of the minimum pressure valve 10 is removable (the subassembly 22) through an opening 31 in the housing 17; we call this removable part the subassembly. Subassembly refers here to: the lid 32, the valve body 21, the seal 24, the conductive unit 26, the piston 23, the step section 29 and the second conductive unit 30. These components do not all need to be present.

The subassembly has an integrated cover plate or lid 32 which covers the opening 31 in the housing 17 of the minimum pressure valve 10, preferably in the side wall of the housing 17. An optional handle 33 used to easily remove the subassembly is fixed to the outside of the lid 32.

The subassembly is attached to the outside of the housing 17 of the minimum pressure valve 10 with the help of four bolts 34.

In addition, the subassembly, which can be taken out of the minimum pressure valve 10, is provided with a connection 40 so that a particular air pressure can be applied to the components.

Servicing of the minimum pressure valve 10, according to the invention, is carried out as follows:

First the four bolts 34 on the subassembly and the connection of the pressure supply pipe coming from the control unit 15 on the connection 40 in the housing 17 are detached. Next the subassembly is taken out of the housing 17 using the handle 33. Then the valve body 21 is taken out of the chamber 20.

The seal 24 and the two slide rings 26 are now easily accessed for replacement.

The non-return valve 36 (including the piston 23) is taken out of the valve body 21 whereby the two slide rings 30 can be replaced.

The piston 23 and the non-return valve 36 are mounted in the valve body 21 using self-alignment; the same occurs with the valve body 21 in the chamber 20.

Finally the four bolts 34 on the subassembly are tightened on the housing 17 of the minimum pressure valve 10, and the pressure supply pipe coming from the control unit 15 is reattached to the connection 40 in the housing 17.

In the example shown a seal 38 is provided between the lid 32 and the housing 17 of the minimum pressure valve 10 in order to guarantee air tightness. This seal 38 will also be easily accessed for replacement when the subassembly is removed from the housing 17 using the handle 33.

The present invention is by no means limited to the embodiment described as an example and shown in the drawings, but a minimum pressure valve, compressor and method according to the invention as defined by the claims, can be realised in all kinds of variants without departing from the scope of the invention.

Claims.

1. Minimum pressure valve (10) comprising a housing (17) with a valve inlet (11) and a valve outlet (12) connected with each other by means of a chamber and connecting space (22a, 22b), whereby the minimum pressure valve (10) also comprises a valve body (21) that is set up in a chamber (20), moveably between, on the one hand, a closed position in which the valve inlet (11) is closed off and, on the other hand, an open position in which the valve inlet (11) is open, whereby the minimum pressure valve (10) also comprises components which are provided with a seal and/or sliding parts (24, 26, 30), characterised in that a subassembly (22) of the minimum pressure valve (10) can be disassembled and/or assembled through an opening (31) in the housing (17).

2. Minimum pressure valve (10) according to claim 1, characterised in that the opening (31) is located in the side wall of the housing (17) of the minimum pressure valve (10).

3. Minimum pressure valve (10) according to claim 1 or 2, characterised in that said subassembly (22) comprises the components which are provided with a seal and/or sliding parts (24, 26, 30), such as sealing rings and/or slide rings, said components comprising the chamber (20), the valve body (21) and the non-return valve (36).

4. Minimum pressure valve (10) according to any one of the previous claims, characterised in that the opening (31) in the housing (17) of the minimum pressure valve (10) is covered by a lid (32).

5. Minimum pressure valve (10) according to claim 4, characterised in that said lid (32) is mounted on the housing (17) with bolts (34) or another type of fastener that can be detached and then reattached.

6. Minimum pressure valve (10) according to claim 4 or 5, characterised in that a seal (38) is provided between the lid (32) and the housing (17) of the minimum pressure valve (10) in order to guarantee air tightness.

7. Minimum pressure valve (10) according to any one of the previous claims, characterised in that the subassembly (22) with the components which are provided with a seal and/or sliding parts (24, 26, 30) can pass through the opening (31) in the side wall of the housing (17) of the minimum pressure valve (10).

8. Minimum pressure valve (10) according to any one of the previous claims, characterised in that the subassembly (22) with the components which are provided with a seal and/or sliding parts (24, 26, 30) can be fixed inside the minimum pressure valve (10), for example using clamps or another type of fastener that can be detached and reattached.

9. Minimum pressure valve (10) according to any one of

the previous claims, characterised in that the subassembly (22) has a specific shape so that it can only fit in the housing (17) of the minimum pressure valve (10) in one particular way.

10. Minimum pressure valve (10) according to any one of the previous claims, characterised in that the lid (32) and the subassembly (22) with the components which are provided with a seal and/or sliding parts (24,26, 30) are connected, so that said subassembly (22) can be removed together with the lid (32).

11. Minimum pressure valve (10) according to any one of the previous claims, characterised in that said subassembly (22) and/or the lid (32) are equipped with extra functions, such as a handle (33) on the lid (32), in order to facilitate handling.

12. Minimum pressure valve (10) according to any one of the previous claims, characterised in that the subassembly (22) is provided with a connection (40) so that a particular air pressure can be applied to the components.

13. Minimum pressure valve (10) according to claim 12, characterised in that said connection (40) is connected to a connection in the housing (17) of the minimum pressure valve (10).

14. Minimum pressure valve (10) according to claim 13, characterised in that said connection (40) is realised by clamping the subassembly (22) with the

components which are provided with a seal and/or sliding parts (24, 26, 30) against the housing (17), whereby an outlet in the housing is connected with an inlet of the subassembly (22), whereby the connection preferably also has a seal suitable for a particular tolerance and for guaranteeing air tightness.

15. Minimum pressure valve (10) according to claim 12, characterised in that said connection (40) is connected to a connection in the housing (17) of the minimum pressure valve (10) using a flexible pipe and screw or bayonet catch.

16. Minimum pressure valve (10) according to claim 12, characterised in that said connection (40) is integrated in the lid (32), and this lid (32) is connected with the subassembly (22) with the components which are provided with a seal and/or sliding parts (24, 26, 30), so that after assembly of the subassembly (22) provided with the lid (32), an external flexible pipe can be connected to the lid (32) in order to provide air pressure to the subassembly (22) with the components which are provided with a seal and/or sliding parts (24, 26, 30).

17. Compressor (1) comprising a compressor element (2) with a gas inlet (3) and an outlet (4) for compressed gas, the compressor (1) also comprising a pressure vessel (6) with an inlet (7) connected to the outlet (4) for compressed gas, whereby a minimum pressure valve (10) according to one of the claims 1

to 16 is provided on an outlet (8) of the pressure vessel (6), the minimum pressure valve (10) being connected with the valve inlet (11) to the outlet (8) of the pressure vessel (6) and the valve outlet (12) being adapted to be connected to a user network (9), whereby the minimum pressure valve (10) comprises a housing (17) whereby the valve inlet (11) and the valve outlet (12) are connected by means of a chamber and connecting space (22a & 22b), the minimum pressure valve (10) also comprises a valve body (21) set up in in a chamber (20) moveably between a closed position in which the valve inlet (11) is closed and an open position in which the valve inlet (11) is open, whereby a subassembly (22) of the minimum pressure valve (10) can be disassembled and/or assembled through an opening (31) in the housing (17), preferably in the side wall of the housing (17).

18. Compressor (1) according to claim 17, characterised in that the compressor is a liquid or oil-injected compressor.

19. Compressor (1) according to claims 17 or 18, characterised in that the compressor (1) comprises a minimum pressure valve (10) according to one of the claims 1 to 16.

20. Method for servicing a minimum pressure valve (6) of a compressor (1), the compressor (1) comprising a compressor element (2) with a gas inlet (3) and an outlet (4) for a compressed gas, the compressor (1) also comprising a pressure vessel (6) with an inlet

(7) connected to the outlet (4) for compressed gas, whereby a minimum pressure valve (10) according to one of the claims 1 to 16 is provided on an outlet (8) of the pressure vessel (6), the minimum pressure valve (10) is connected with the valve inlet (11) to the outlet (8) of the pressure vessel (6) and the valve outlet (12) is adapted to be connected to a user network (9), whereby the minimum pressure valve (10) comprises a housing (17) whereby the valve inlet (11) and the valve outlet (12) are connected by means of a chamber and connecting space (22a, 22b), the minimum pressure valve (10) also comprising a valve body (21) set up in a chamber (20) moveably between a closed position in which the valve inlet (11) is closed and an open position in which the valve inlet (11) is open, characterised in that a subassembly (22) of the minimum pressure valve (10) can be disassembled and/or assembled through an opening (31) in the housing (16), preferably in the side wall of the housing, said subassembly (22) comprising the components which are provided with a seal and/or sliding parts (24, 26, 30), such as sealing rings and/or slide rings.

21. Method according to claim 20, containing the following steps:

a. detaching the bolts (34) of the subassembly (22),
b. removing the subassembly (22) from the opening (31) in the minimum pressure valve (10),
c. removing the valve body (21),
d. replacing the seal (24) and slide rings (35),
e. removing the non-return valve (36) and replacing the slide rings (37),

f. reassembling the non-return valve (36) and the valve body (21),

g. tightening the bolts (34) of the subassembly (22) on the housing (17) of the minimum pressure valve (10).

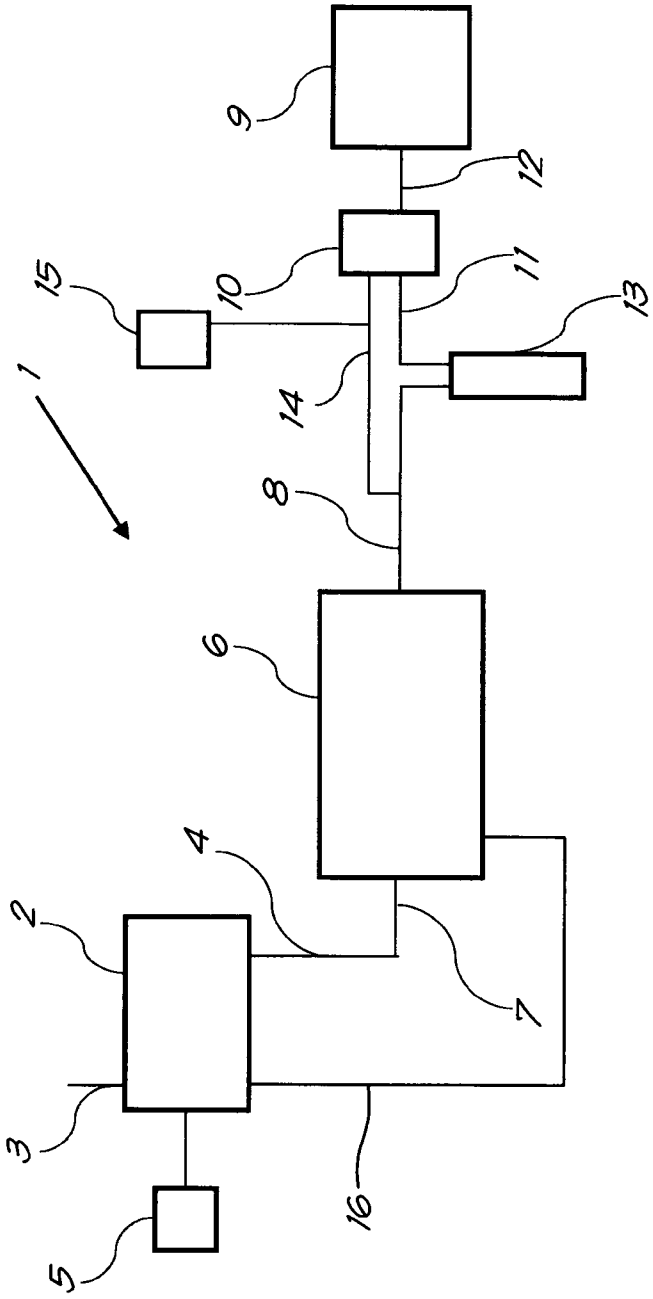

Fig. 1

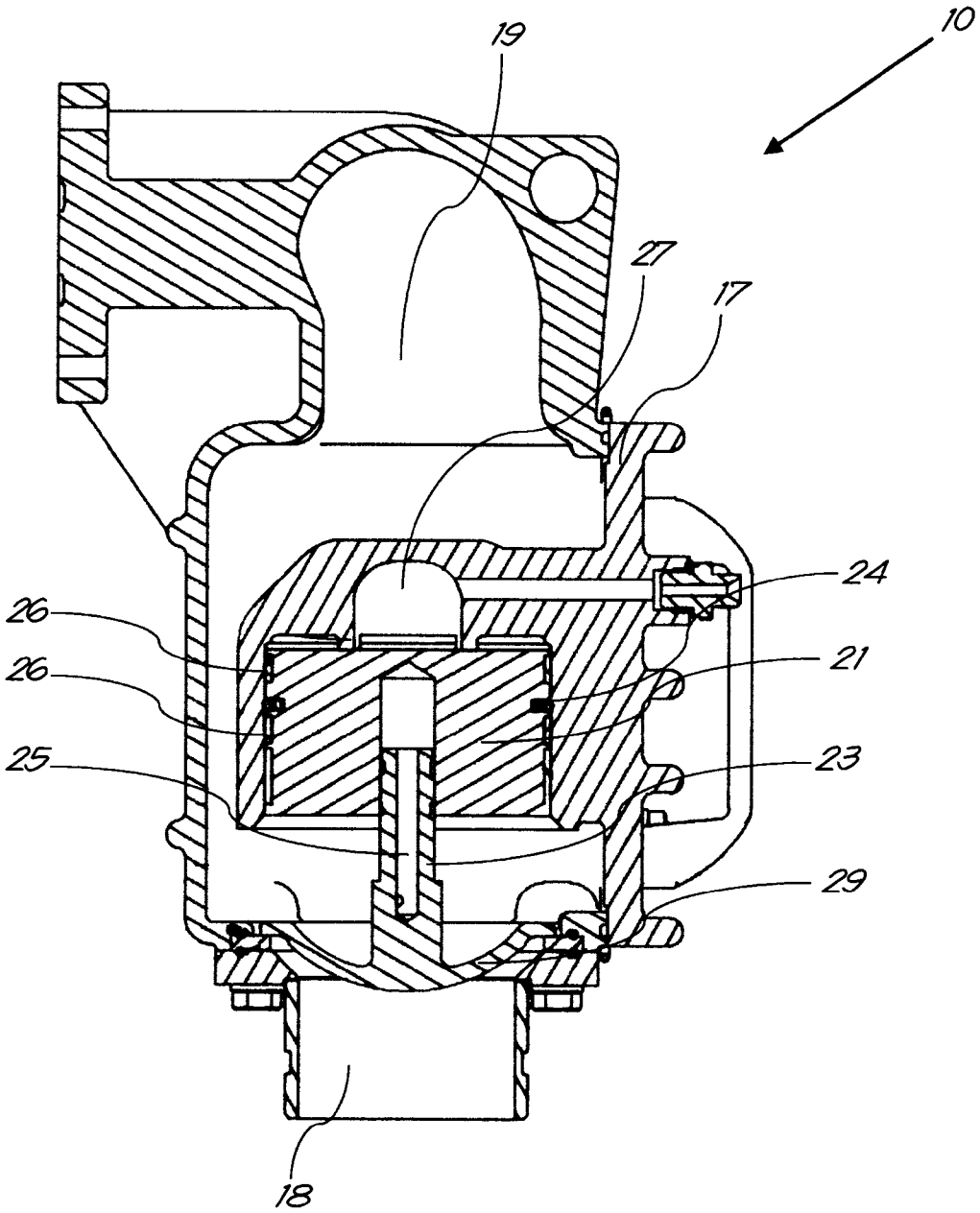

Fig.2

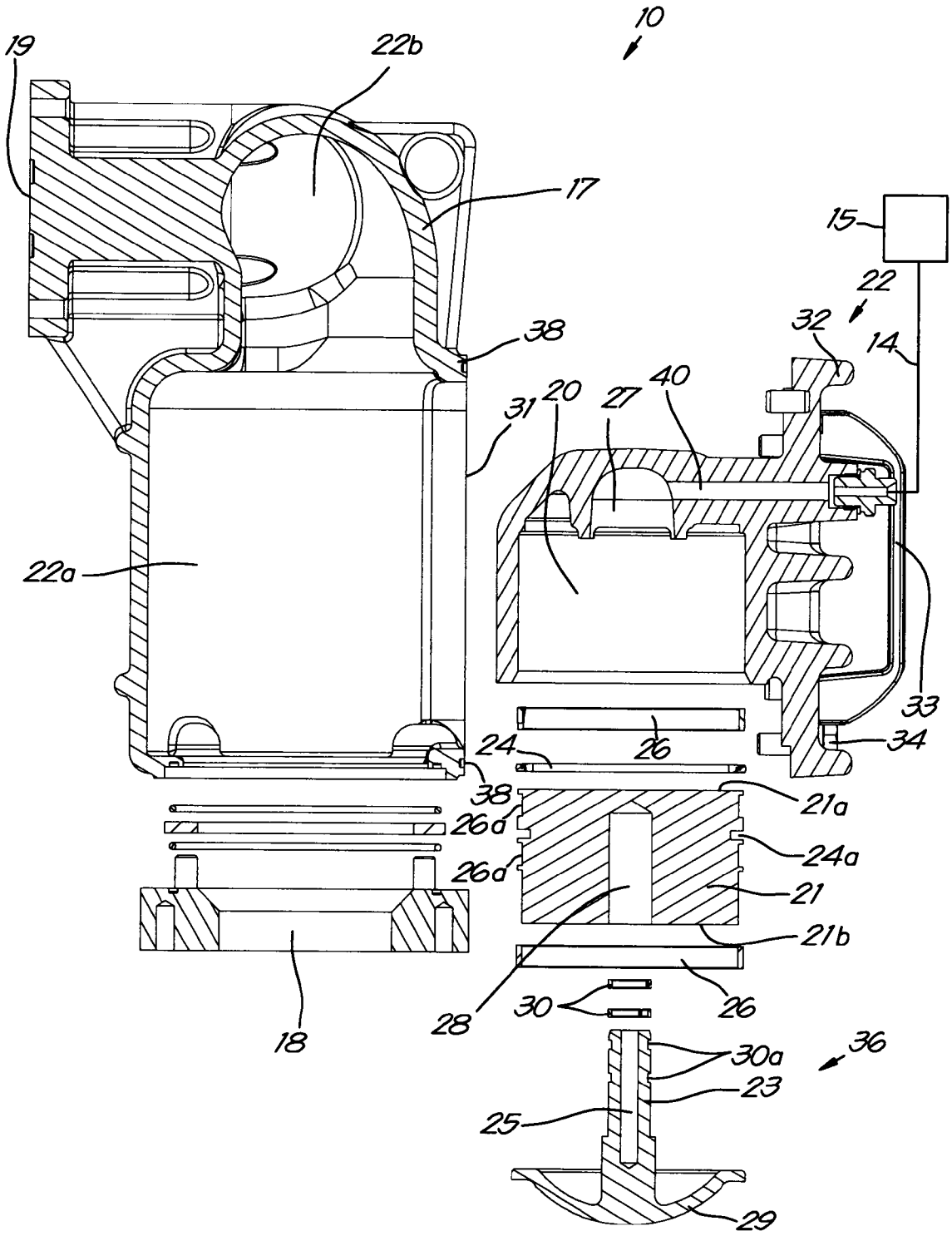
10
19
22b
17
15
22
32
14
38
40
20
27
31
22a
33
24
26
34
38
21a
26a
24a
26a
21
21b
18
28
30
26
36
30a
23
25
29

Fig.3

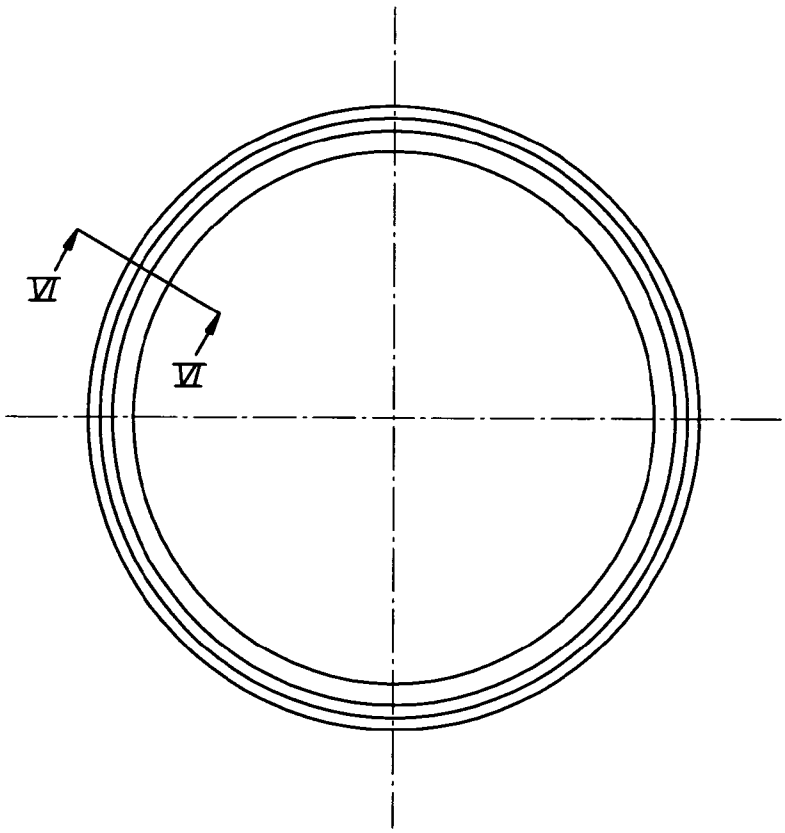

Fig.4

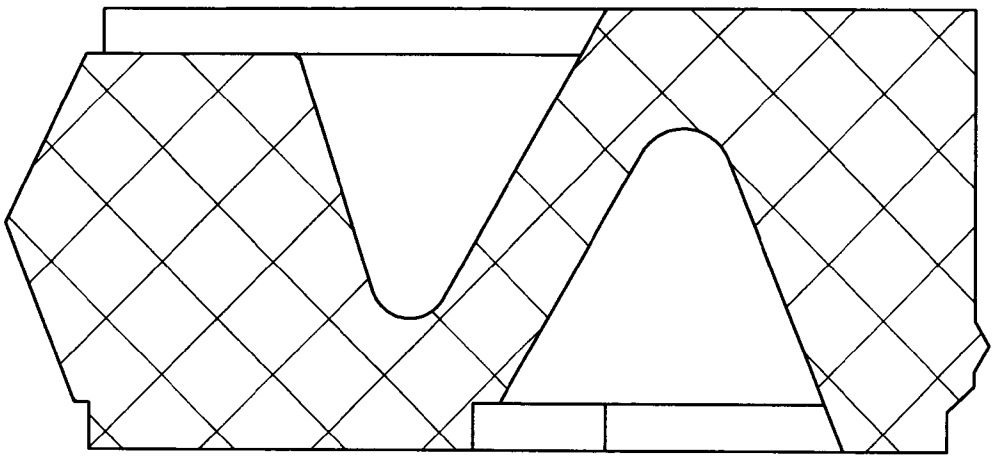

Fig.5

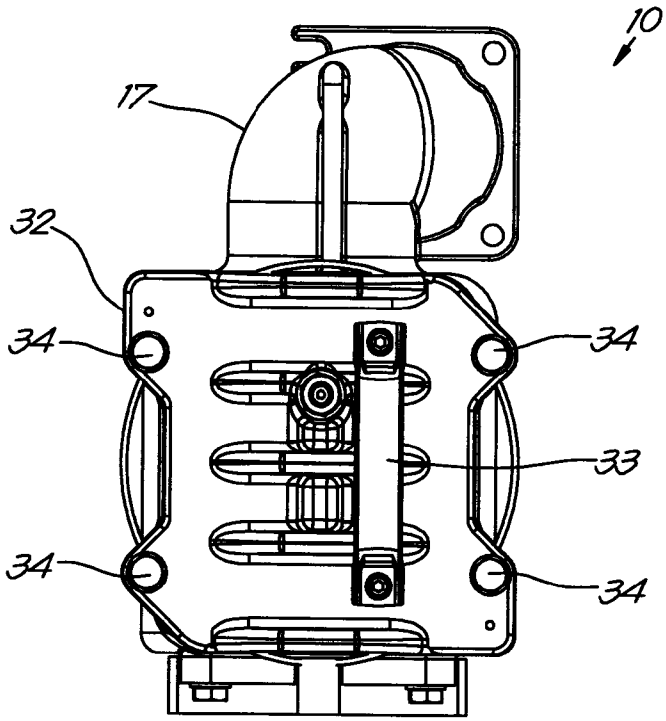

Fig.6

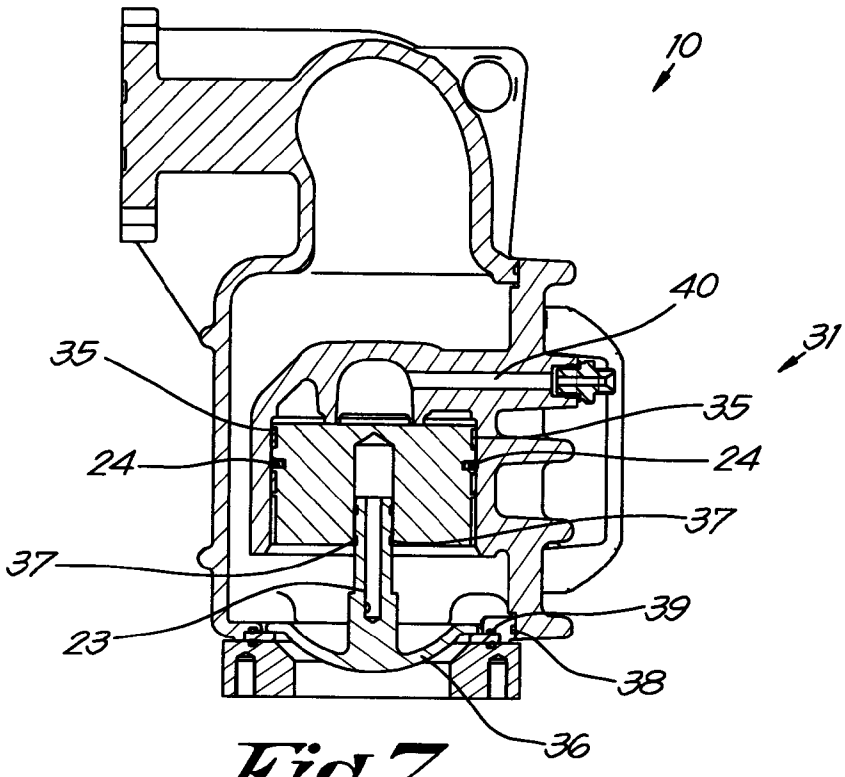

Fig.7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/057628

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04B53/10
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)
F04B

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 practicable, 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.
X Y	US 3 526 246 A (LEITGEB ANTON) 1 September 1970 (1970-09-01) the whole document	1-13, 15-21 14
X	GB 953 755 A (ATLAS COPCO AB) 2 April 1964 (1964-04-02) the whole document	1-13, 15-21
X	WO 2009/117788 A1 (ATLAS COPCO AIRPOWER NAAMLOSE [BE]; MARTENS KRISTOF ADRIEN LAURA [BE]) 1 October 2009 (2009-10-01) the whole document	1-13, 15-21
X	CN 101 520 103 A (NANTONG HONGXING AIR COMPRESSO) 2 September 2009 (2009-09-02) figures 1-5	1-13, 15-21

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2018	20/12/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lange, Christian

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/057628

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 31 07 775 A1 (REXROTH MANNESMANN GMBH [DE]) 16 September 1982 (1982-09-16)	14
A	the whole document	1-3, 7-13, 16-21

A	GB 2 150 266 A (TEVES GMBH ALFRED) 26 June 1985 (1985-06-26) the whole document	1-13, 15-21

A	EP 0 121 999 A1 (CASH ENG CO PTY LTD [AU]) 17 October 1984 (1984-10-17) the whole document	1,17-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/057628

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3526246 A	01-09-1970	NONE	
GB 953755 A	02-04-1964	NONE	
WO 2009117788 A1	01-10-2009	BE 1018073 A3	06-04-2010
		BR PI0905872 A2	30-06-2015
		CA 2697676 A1	01-10-2009
		CN 101836020 A	15-09-2010
		CY 1115515 T1	04-01-2017
		DK 2255112 T3	29-09-2014
		EP 2255112 A1	01-12-2010
		ES 2507087 T3	14-10-2014
		JP 5296190 B2	25-09-2013
		JP 2011517484 A	09-06-2011
		PT 2255112 E	30-07-2014
		RU 2010143875 A	10-05-2012
		SI 2255112 T1	30-10-2014
		US 2010219364 A1	02-09-2010
		WO 2009117788 A1	01-10-2009
CN 101520103 A	02-09-2009	NONE	
DE 3107775 A1	16-09-1982	DE 3107775 A1	16-09-1982
		IT 1154480 B	21-01-1987
		JP S57161374 A	04-10-1982
		US 4463929 A	07-08-1984
GB 2150266 A	26-06-1985	DE 3342427 A1	05-06-1985
		ES 282536 U	01-05-1985
		FR 2555700 A1	31-05-1985
		GB 2150266 A	26-06-1985
		IT 1196337 B	16-11-1988
EP 0121999 A1	17-10-1984	NONE	