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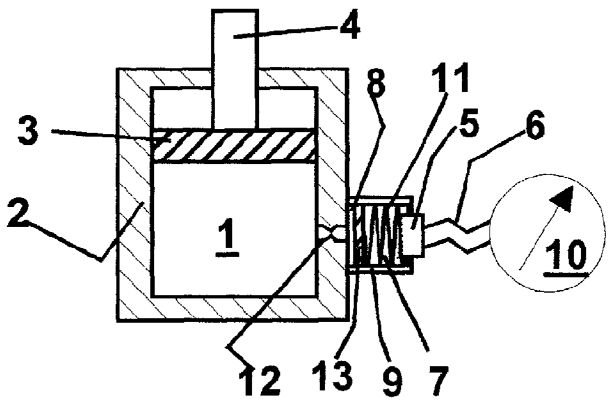
(54) Title: HYDRAULIC PRESSURE SENSOR

(54) Bezeichnung: HYDRAULISCHER DRUCKSENSOR



(57) Abstract: The invention relates to a hydraulic pressure sensor for measuring the pressure in a hydraulic pressure compartment. Said hydraulic pressure sensor is disposed in a sensor compartment which is filled with a liquid with which the sensor element (5) is impinged upon. A reservoir is hydraulically linked with the pressure compartment on the one end and with the sensor compartment on the other end and is disposed upstream of the sensor compartment. The reservoir and the sensor compartment are configured in a compensator reservoir (9) with pressure-resistant walls. The compensator reservoir (9) is fixedly mounted on a wall of the pressure compartment (1). The pressure compartment (1) is linked with the reservoir (8) via a throttle (12). The reservoir is separated from the sensor compartment (7) by a dividing wall (13). Said dividing wall (13) is configured as a piston and is slidingly guided on the walls of the cylindrical compensator reservoir while exerting a friction force. The dividing wall is supported on the compensator reservoir against the pressure of the reservoir (8) by means of a spring (11). The dividing wall (13) can be configured as a differential piston. The dividing wall may consist of two or more piston sections (13.1, 13.2, 13.3) which are guided independently in a gliding and sealing manner and which mutually support one another by means of a spring (intermediate spring 14).

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(57) Zusammenfassung: Ein hydraulischer Drucksensor zur Messung des Drucks in einem hydraulischen Druckraum ist in einer Sensorkammer, welche zur Druckbeaufschlagung des Sensorelementes (5) mit einer Flüssigkeit gefüllt ist, angeordnet. Ein Speicherraum, welcher mit dem Druckraum und andererseits mit der Sensorkammer druckleitend verbunden ist, ist dem Sensorraum vorgeordnet. Speicherkammer und Sensorkammer sind in einem Ausgleichsgefäß (9) mit druckfest-starren Wänden gebildet. Das Ausgleichsgefäß (9) ist an einer Wand des Druckraums (1) fest angebracht. Der Druckraum (1) ist über eine Drossel (12) mit der Speicherkammer (8) verbunden. Die Speicherkammer wird durch eine Zwischenwand (13) von der Sensorkammer (7) getrennt. Die Zwischenwand (13) ist als Kolben ausgebildet und an den Wänden des zylindrischen Ausgleichsgefäßes unter Ausübung einer Reibkraft gleitend geführt. Sie stützt sich dabei mittels einer Feder (11) gegenüber dem Ausgleichsgefäß gegen den Druck der Speicherkammer (8) ab. Die Zwischenwand (13) kann als Differentialkolben ausgebildet sein. Die Zwischenwand kann aus zwei oder mehr Kolbensektionen (13.1, 13.2, 13.3) bestehen, welche unabhängig von einander gleitend und dichtend geführt und zwischen sich jeweils durch eine Feder (Zwischenfeder 14) abgestützt sind.

Translation

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HYDRAULIC PRESSURE SENSOR

The invention relates to a hydraulic pressure sensor for measuring the pressure in a hydraulic pressure chamber as defined in the preamble of claim 1.

When measuring the pressure, in particular in hydraulic consumers, for example, hydraulic working cylinders, there arises the problem that great pressure fluctuations may lead to damage or misalignment of the calibrated pressure sensor. This applies in particular to pressure sensors, namely in the case of sensor elements, which comprise a diaphragm that is deformable under the pressure of the sensor chamber, and to which electronic components are applied by gluing, vapor deposition or otherwise for representing an electric bridge.

It is therefore common practice to accommodate such sensor elements in a sensor chamber, which connects to the pressure chamber in a pressure-conducting manner, but is spatially separated from the pressure chamber such that the sensor element is protected.

It is an object of the invention to provide hydraulic pressure sensors of this type in such a manner that while they permit measuring very high pressures without damage or misalignment, great pressure fluctuations, pressure surges, or jumps of the pressure being measured will likewise have no damaging effects.

The solution is defined in claim 1.

As a measure for protecting pressure sensors, in particular against pressure fluctuations, pressure surges, and pressure jumps, one resorts in practical operation to connecting the sensor chamber via a hose to the pressure chamber. This hose is made of an elastic material. In this connection, the hose acts as a reservoir, which absorbs and damps sudden pressure fluctuations, pressure surges, and pressure jumps on the one hand by its volume and on other hand by the elasticity of its sidewall. The disadvantage of this measure lies in that the hose connection is susceptible to damage, ageing, and leakage. Furthermore in many cases, it also represents an obstacle. This applies in particular to pressure sensors on working cylinders for development machines in mining, where it is necessary to consider pressures of more than 200 bars with pressure fluctuations and pressure surges of more than 100 bars.

The invention avoids the disadvantage of the hose connection. An equalizing reservoir, which accommodates the reservoir connecting to the pressure chamber and the sensor chamber may be integrated into the hydraulic machine or be flanged to the pressure chamber. Between the pressure chamber and the sensor chamber a reservoir is arranged, which connects hydraulically to the pressure chamber via a throttle or nozzle, and mechanically to the other side via a movable partition. While the partition is arranged in the reservoir for sliding movement in the fashion of a piston, it is arranged in such a manner that it is movable only when frictional forces are applied. The flow control effect of the throttle or nozzle, as well as the frictional forces of the partition in the reservoir are adapted to one another such that pressure surges, pressure fluctuations, and pressure jumps in the pressure chamber can be transmitted to the sensor chamber -- as much as possible - only without jerk or shock and in an integral behavior. Likewise, sudden pressure changes are thus transmitted into the sensor chamber only in the form of a continuous function, the slope of which can be determined by dimensioning the throttle and by dimensioning the frictional forces. A spring, which is used to support the partition on the equalizing reservoir, likewise limits the amount of the mechanical pressure transmission, since the spring counteracts the pressure that builds up in the reservoir. In this connection, it is not necessary that also the sensor chamber connect in a fluid conducting manner to the pressure chamber or the reservoir, since the pressure of the reservoir is transmitted to the sensor chamber mechanically, i.e., by the movement of the partition. In this connection, it is presumed that not only the reservoir is filled with the hydraulic medium, but that also the pressure chamber contains the hydraulic medium or another fluid. The latter may be fats or other nonaggressive fluids, in particular when water is used as hydraulic medium, which should be kept away from the sensor element because of its aggressiveness.

It should however be remarked that the pressure chamber and the sensor chamber or, however, the reservoir and the sensor chamber may also be hydraulically connected. This occurs by means of a flow control channel or a nozzle. In this case, the complete pressure equalization between the pressure chamber and the sensor chamber also occurs hydraulically. Preferably, the flow control channel extends between the reservoir and the sensor chamber as a thin bore in the partition.

As has previously been described, the invention is also suited for very high pressures and very high pressure fluctuations.

This applies to the further development of claim 2. In this configuration of the invention, the pressure that is mechanically transmitted from the partition to the sensor chamber upon occurrence of a pressure surge is relatively low in accordance with the ratio of the small piston surface that is exposed to the pressure surge, to the large piston surface that faces the sensor chamber. In addition, this compressive force is at least partially absorbed by the frictional force of the partition, which is necessary for overcoming the friction.

The piston sections of the partition that is constructed as a differential piston may axially interconnect, i.e., they may be made in one piece, be screwed together, or be otherwise rigidly joined.

When the piston sections are movable independently of one another, a somewhat different transmission behavior will result, namely upon occurrence of a pressure surge, the first differential chamber adjoining the pressure chamber is biased by the pressure surge via the throttle and by the mobility of the first piston section. Thereafter, the pressure developing in the first differential chamber is transmitted and reduced via the second - larger - piston section over the entire piston surface. In this case, it is especially advantageous to support the piston sections against one another by means of springs.

The support of the piston sections by means of springs accomplishes that the mechanical pressure transmission is limited by the anyhow only very small mobility of the partition and that it is partially absorbed on the springs.

As previously pointed out, the absorbing capacity of the pressure sensor depends with respect to pressure jumps, pressure fluctuations, and pressure surges on the size or on the hydraulic resistance of the flow control channels or nozzles, the mechanical resistance of the partition, and the design of the springs which are used to support the partition stationarily. It is obvious that limitations are set to each of these quantities. To achieve nonetheless a protection against very high pressure fluctuations, the invention is further developed in accordance with claim 3.

In this case, the last piston section, which seals the sensor chamber, is supported in a stationary manner relative the equalizing reservoir by a spring. The other piston sections are each supported on the adjacent piston section. Between one another, the piston sections form chamber sections of the reservoir, which connect to the pressure chamber via a flow control channel. This flow control channel is preferably arranged in the piston sections, so that in the case of pressure fluctuations, a staggered pressure buildup results from chamber section to chamber section.

The individual piston sections in turn extend for sliding movement in the reservoir while exerting a frictional force. In this connection it is also possible to construct individual piston sections as differential pistons, preferably the first piston section adjacent to the pressure chamber, or the following second piston section. In this connection, it should be emphasized that the hydraulic pressure equalization occurs on the partitions that are constructed as differential pistons respectively via a flow control channel between the differential chamber and the subsequent chamber section.

The further development of claim 5 serves the purpose of ensuring a robust elastic support of the partition or piston sections.

The further development of claim 6 prevents the rubber rings in use from being damaged as a consequence of the occurring high compressive forces. In other words, the rubber rings are prevented from laterally yielding and from being squeezed under the great force of the pressure being measured.

As aforesaid, the partitions or piston sections of the partition extend along the inside wall of the reservoir in a sliding and sealing manner. The further development of claim 7 represents a suitable seal that is also suited because of its dimensioning for adjusting the desired frictional forces.

The elastic rings in use for this seal may also have a double function, in that they serve for sealing and exerting sliding forces on the one hand. On the other hand, they are used to support the piston sections. This will apply in particular when the rings have a rectangular cross section, i.e., they are longer in the axial direction than in the radial direction. In this case, the high pressure that develops in the reservoir or in the chamber sections will cause the rings to bulge outward, thereby increasing the frictional forces that are needed for the movement of the partition or piston sections.

In the following, the invention is described by means of embodiments shown in Figures 1-8, of which:

Figure 1 is a cross sectional view of a hydraulic cylinder with a connected pressure sensor; and

Figures 2-8 are detail views illustrating individual modifications.

The following description and the applied numerals will apply to all embodiments, unless express reference is made to special features.

The invention is used for measuring the pressure of hydraulic fluids in hydraulic engines or machines. Preferably, the invention is applied to high pressures of more than 100 bars, since in this case pressure fluctuations have a high absolute value, and therefore tend to damage or misalign the sensor element in particular.

Figure 1 illustrates a hydraulic machine in the form of a cylinder **2** with a piston **3** and a plunger **4**. Of this cylinder **2**, the further embodiments show each only a wall **2** as well as a nozzle **11**, which connects a pressure chamber **1** of the machine to a sensor chamber **7**. To this end, a cylindrical equalization reservoir **9** is flanged to the wall **2** of the cylinder and connects via a nozzle or flow control channel **11** to the pressure chamber **1**. The equalization reservoir **9** includes two chambers, which are named in the present application reservoir **8** and sensor chamber **7**. As shown in the embodiments, the sensor chamber **7** accommodates a sensor element **5**. Same is constructed as a diaphragm sensor **5**, primarily when measuring high hydraulic pressures. The Figure indicates a diaphragm that is equipped with electronic components, in particular resistors, which are interconnected to a bridge circuit, and which permit measuring differential currents or differential voltages that are representative of the pressure.

The sensor element **5** connects via supply lines **6** to a display unit **10**. It should be emphasized that it is not necessary to accommodate the sensor element **5** directly in the chamber of the equalizing reservoir **9**, which is also known as sensor chamber **7**. The technical purpose of the pressure sensor according to the invention will also be attained, when the sensor chamber **7** connects via hydraulic supply lines to the sensor element or a chamber, in which the sensor element is directly arranged.

As described, a partition **13** subdivides the equalizing reservoir into a reservoir **8** and the sensor chamber **7** that accommodates the sensor element **5**, or which hydraulically connects to the sensor element or a chamber that accommodates the sensor element.

The partition is adapted for movement in the cylindrical equalizing reservoir in the fashion of a piston. A spring **11** supports the partition on the equalizing reservoir against the pressure of the reservoir **8**. On its circumference, a combined friction and sealing ring **16** seals the partition relative to the equalizing reservoir **9**. The sliding properties of the partition **13** relative to the equalizing reservoir are chosen from a corresponding selection of guides (friction and sealing rings) **16**, so that the partition opposes to its axial movement a certain frictional resistance

As aforesaid, the partition **13** subdivides the equalizing reservoir into the reservoir **8** and the sensor chamber **7**, in which the sensor element **5** is arranged, or which is hydraulically connected to the sensor element or a chamber that accommodates the sensor element.

In operation, the pressure in the working chamber **1** of the cylinder **2** is hydraulically transmitted into the reservoir **8** via the flow control channel or nozzle **12**. The pressure buildup in the reservoir **8** proceeds with a certain delay because of the flow resistance of the throttle, i.e., nozzle **12**. The frictional resistance of the partition **13** on the equalizing reservoir **9** causes a further impediment during the pressure buildup in the sensor chamber **7**. This mechanical pressure transmission is additionally reduced by the spring **11** that supports the partition relative the equalizing reservoir, and is operative for the purposes of enlarging the sensor chamber **7**.

In the past, it has been assumed that the sensor chamber **7** and the reservoir **8** are not hydraulically connected in a fluid-conducting manner. In fact, a connection of this type is unnecessary. However, one has to take into account that as a function of the frictional force which the partition opposes to its axial movement, and that furthermore as a function of the amount of the elastic force of the spring **11**, the pressure measured on the pressure sensor **5** does not fully correspond to the pressure in pressure chamber **1**. This must be taken into account when calibrating the sensor. At any rate, it is necessary that also the sensor chamber **7** contain a pressure-conducting fluid, which need not be the same fluid that is also used as hydraulic fluid. In particular, it will be possible to use oil, glycerin, or a similar inert fluid, when an aggressive medium, such as, for example, water is used as hydraulic medium.

To avoid the pressure variations between the reservoir **8** on the one hand and the sensor chamber **7** on the other, a preferred embodiment provides for arranging a flow control channel between the reservoir and the sensor chamber **7**. This flow control channel may be arranged, for example, in the walls **2** of the cylinder and the equalizing reservoir **9**, for example, as a channel with a small cross section that interconnects the reservoir **8** and the sensor chamber **7**. However, it is preferred to arrange this flow control channel in the partition. This channel is indicated at **15** in each of the embodiments, in particular the embodiments of Figures 3-6. In this configuration, the partition causes the mechanical pressure transmission of pressure surges, pressure jumps, and other unsteady pressure characteristics to be impeded or reduced because of its friction on the equalizing reservoir **9** and because of its elastic support. As a result of the hydraulic connection between the working chamber **1** and the sensor chamber **7**, the hydraulic pressure transmission is however time delayed and damped to such an extent that the sensor element **5** is not damaged or misaligned. Rather, the pressure changes are transmitted into the sensor chamber in the form of a continuous function, which has no disadvantageous effect on the sensor and the calibration of the sensor.

Figure 2 shows an enlarged detail of Figure 1, namely the pressure equalizing reservoir **9** with the sensor element **5**, partition **13**, support spring **11**, and flow control channel **12** that interconnects the pressure chamber **1** and the reservoir **8**. A hydraulic connection between the reservoir **8** and the sensor chamber **7** is absent. Thus, the pressure transmission between the reservoir **8** and the sensor chamber **7** occurs merely mechanically, i.e., by the movement of the partition **13**. In this connection, it should be remarked that both the sensor chamber **7** and the reservoir **8** are filled with fluid and hermetically sealed -- with the exception of the supply via the flow control channel **12**. This movement is mechanically damped by the friction of sealing elements **16**, and it is also impeded by the bias of spring **11**.

Therefore, when calibrating the sensor **5**, one will have to take into account that the pressure in the sensor chamber is not totally representative of the pressure in the pressure chamber **1**.

The embodiments of Figures 3 and 4 show further possibilities of transmitting pressure. In this case, it is accomplished that the mechanically transmitted pressure is always less than the pressure being measured in the pressure chamber **1**. This is realized in that the partition **13** is constructed as a differential piston and consists of a piston section **13.1** with a smaller diameter and a piston section **13.2** with a larger diameter. The wall of the equalizing reservoir **9** is adapted to the diameters of the piston sections **13.1** and **13.2**. As a result, the reservoir **8** is subdivided into a differential chamber **8.1** with a smaller cross sectional area, and a differential chamber **8.2**, whose cross sectional area is equal to the area difference of the piston section sections **13.1** and **13.2**. The differential chamber **8.1** connects to the differential chamber **8.2** via an intermediate channel **15** in the small piston section **13.1**. The differential chamber **8.2** connects to the sensor chamber **7** via a flow control channel **15.2** in the large piston section **13.2**. Also in this instance, it should be remarked that the flow control channels **15.1** and/or in particular **15.2** are not absolutely necessary, so that a merely mechanical pressure transmission would occur.

Otherwise, the last piston section **13.2** of the partition is also supported relative the equalizing reservoir by means of support spring **11**. As aforesaid, also in the present embodiment the mechanical pressure transmission caused by the piston movement is damped by the frictional resistance of the piston and reduced by the biasing force of the support spring **11**. In addition, a reduction occurs by the differential piston at the ratio of the cross sectional areas of the piston sections **13.1** and **13.2**.

In the embodiment of Figure 3, the piston is made in one piece, i.e., the sections **13.1** and **13.2** are mechanically joined.

In the embodiment of Figure 4, the sections **13.1** and **13.2** are not contiguous. Instead, the sections are supported against each other by intermediate springs **14**. The section with the larger cross section **13.2** is furthermore supported relative the equalizing reservoir **9** by support spring **11**. Likewise in this embodiment, the piston sections include flow control channels, i.e., intermediate channels **15**, with the intermediate channel **15.1** interconnecting the differential chambers **8.1** and **8.2**, and the intermediate channel **15.2** connecting the differential chamber **8.2** to the sensor chamber **7**. Likewise to this embodiment, the foregoing description applies with respect to the mechanical pressure transmission by the piston movement, with a further absorption occurring by the intermediate springs **14**.

In the embodiments of Figures 5 and 6, the principle of reducing pressure by differential pistons is applied twice. As a first differential piston use is made of the contiguous piston sections **13.1** and **13.2**. The second differential piston consists of contiguous piston sections **13.3** and **13.4**. Between each other, the two differential pistons are supported by intermediate springs **14**. Likewise here, the support spring **11** supports the last differential piston relative the equalizing reservoir **9**. In the present embodiments, the differential chambers **8.1** and **8.2** are interconnected by intermediate channel **15.1**. The differential chamber **8.2** connects via a flow control channel, i.e., intermediate channel **15.2** to the differential chamber **8.3** that also accommodates the intermediate springs. The differential chamber **8.3** connects to the differential chamber **8.4** via an intermediate channel **15.3**. An intermediate channel **15.4** interconnects the differential chamber **8.4** and the sensor chamber **7**. As previously described, these intermediate channels are also here not needed, when a corresponding pressure difference between a pressure being measured and a measured pressure is considered in the calibration.

The embodiments of Figures 5 and 6 differ in that in Figure 5 facing piston sections **13.2** and **13.3** have the same diameter, whereas in the embodiment of Figure 6, there is one more time a change to the smaller cross section between the piston sections **13.2** and **13.3**. This results in a further reduction of the mechanical pressure transmission.

In the embodiments of Figures 7 and 8, the partition consists -- as has also been described with reference of the embodiments of Figures 5 and 6 -- of a plurality to intermediate pistons **13.1-13.3**, which have however the same diameter. It should be noted that the intermediate piston that defines the intermediate reservoir **8.1** may also be a differential piston as has been described in the foregoing.

The resultant intermediate reservoirs **8.1**, **8.2** as well as the sensor chamber **7** are interconnected by intermediate channels **15.1-15.3** that are provided in the intermediate pistons, so that a pressure transmission also occurs hydraulically. For a circumferential sealing, standard sealing rings **16** are used, which are inserted into grooves provided in the casing surface of the intermediate pistons. The present embodiment uses rubber bodies as support spring **11** and intermediate springs **14**. These rubber bodies may have any shape. The advantage lies in that rubber has also excellent damping characteristics. Preferably, the bodies are rubber rings that are inserted into annular grooves **18** provided in the face end of the one piston, and which are pressed into the groove by an annular bead **19** on the face of the respectively other piston. This results in a spring system with a very high constant of elasticity. The short travels of the spring system account for the circumstance that also the partitions or piston sections are subjected to only little movements in the case of pressure changes and pressure fluctuations in particular.

Likewise the embodiment of Figure 8 uses a plurality of intermediate pistons **13.1-13.3** of the same cross section. One and the same ring **20** is used for frictional engagement on the circumference and mutual elastic support as well as elastic support relative the equalizing reservoir. This ring is inserted respectively between two opposite faces of two adjacent pistons and radially held by an annular support rim **19** on one of the faces or both faces. The support rims do not touch, so that the rings **20** are subjected to the pressures in the intermediate reservoirs **8.1, 8.2**, etc. This causes the rings to expand outward and to provide on the one hand the desired frictional force and frictional resistance to the piston movement and on the other hand the necessary hydraulic sealing. The same applies to the ring **20** that is used as support spring relative the equalizing reservoir **9**.

NOMENCLATURE

1 Pressure chamber
2 Wall, cylinder
3 Piston
4 Plunger
5 Sensor, sensor element
6 Supply lines
7 Sensor chamber
8 Reservoir
8.1 Intermediate reservoir, differential chamber with smaller diameter
8.2 Intermediate reservoir, differential chamber with larger diameter.
8.3 Intermediate reservoir
8.4 Intermediate reservoir with larger diameter
9 Equalizing reservoir
10 Display unit
11 Support spring, spring, spring element, rubber ring
12 Throttle, nozzle, flow control channel
13 Partition, piston, piston section
13.1 Intermediate piston, piston section, differential piston section with smaller diameter
13.2 Intermediate piston, piston section, differential piston section, piston section with larger diameter
13.3 Intermediate piston, piston section, differential piston section, piston section with larger diameter
14 Intermediate spring, rubber ring
15 Intermediate channel
15.1 Intermediate channel to differential chamber
15.2 Intermediate channel between differential chamber

8.2 and sensor chamber 7

15.3 Intermediate channel between differential chamber 8.3 and sensor chamber 7

16 Combined friction and sealing ring

17 Radial support

18 Annular groove

19 Support rim, bead

20 Combined friction and sealing ring

CLAIMS

1. Hydraulic pressure sensor for measuring the pressure in a hydraulic pressure chamber,
with a sensor chamber which is filled with a fluid for biasing a sensor element (5) by pressure, and
with a reservoir which connects to the pressure chamber and on the other hand to the sensor chamber in a pressure-conducting manner,
characterized in that
the reservoir and the sensor chamber are formed in an equalizing reservoir (9) with pressure-resistant rigid walls,
that the equalizing reservoir (9) is rigidly mounted to a wall of the pressure chamber (1),
that the pressure chamber (1) connects via a throttle (12) to the reservoir (8),
that the reservoir is separated from the sensor chamber (7) by a partition (13),
and that the partition (13) is constructed as a piston, and extends for sliding movement along the walls of the cylindrical equalization reservoir (9) while exerting a frictional force, and in so doing, it is supported by a spring (11) relative the equalizing reservoir against the pressure of the reservoir (8).

2. Pressure sensor of claim 1,
characterized in that
the partition (13) is constructed as a differential piston, whose piston sections have a cross section that enlarges in steps from piston section (13.1) to piston section (13.2),

that the reservoir is divided into corresponding chamber sections, whose cross section corresponds to the respective piston cross section,
that the piston sections extend in the chamber sections in a sliding and sealing manner,
that the chamber section with the smallest diameter is located closest to the pressure chamber, and
that the chamber sections connect to the pressure chamber via a flow control channel (12, 15).

3. Pressure sensor of one of the foregoing claims,
characterized in that
the partition is formed by two or more piston sections (13.1, 13.2, 13.3),
that the piston sections extend independently of one another in a sliding and sealing manner, and are supported between one another by a spring (intermediate spring 14), and
that the piston sections form between one another a chamber section (8.1, 8.2) of the reservoir, which connects to the pressure chamber via a flow control channel (intermediate channel 15).

4. Pressure sensor of claim 2 or 3,
characterized in that
the chamber sections (8.1, 8.2) of the reservoir are each interconnected by a flow control channel (intermediate channel 15), which is preferably located in the piston section (13.1, 13.2, 13.3) that extends between the chamber sections.

5. Pressure sensor of claim 3 or 4,
characterized in that

the support spring (11) and/or intermediate springs (14) are formed by rubber bodies, which lie against facing piston surfaces of adjacent piston sections.

6. Pressure sensor of claim 5, characterized in that a circular rubber ring is inserted as rubber body into a circular groove of the one of the facing piston surfaces for mutually supporting two adjacent piston sections, and that the other piston section is supported on the rubber ring, preferably with a circular bead (19) that corresponds to the size of the circular groove.

7. Pressure sensor of one of the foregoing claims, characterized in that the partition or partitions or pistons are sealed relative the reservoir wall by sealing rings arranged on the circumference in grooves, and mounted for sliding movement while exerting a frictional force.

8. Pressure sensor of claim 7, characterized in that the springs are constructed as rubber rings, which essentially have the same diameter or a somewhat larger diameter than the partitions or pistons, and which simultaneously form the support and/or intermediate springs and the circumferential seals.

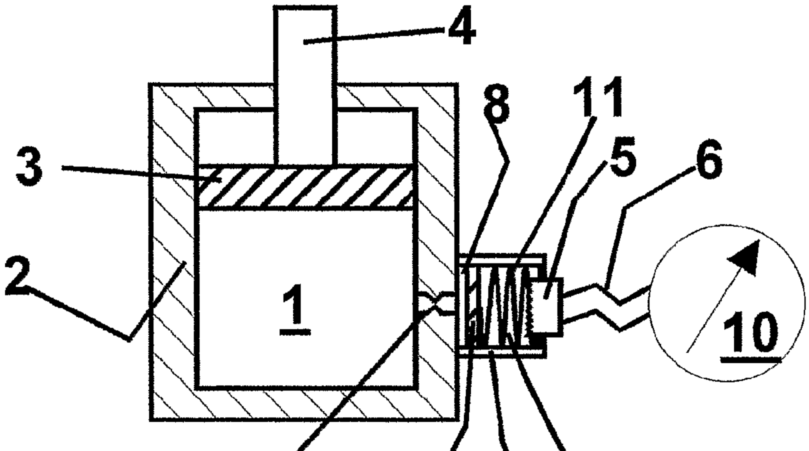


Fig. 1

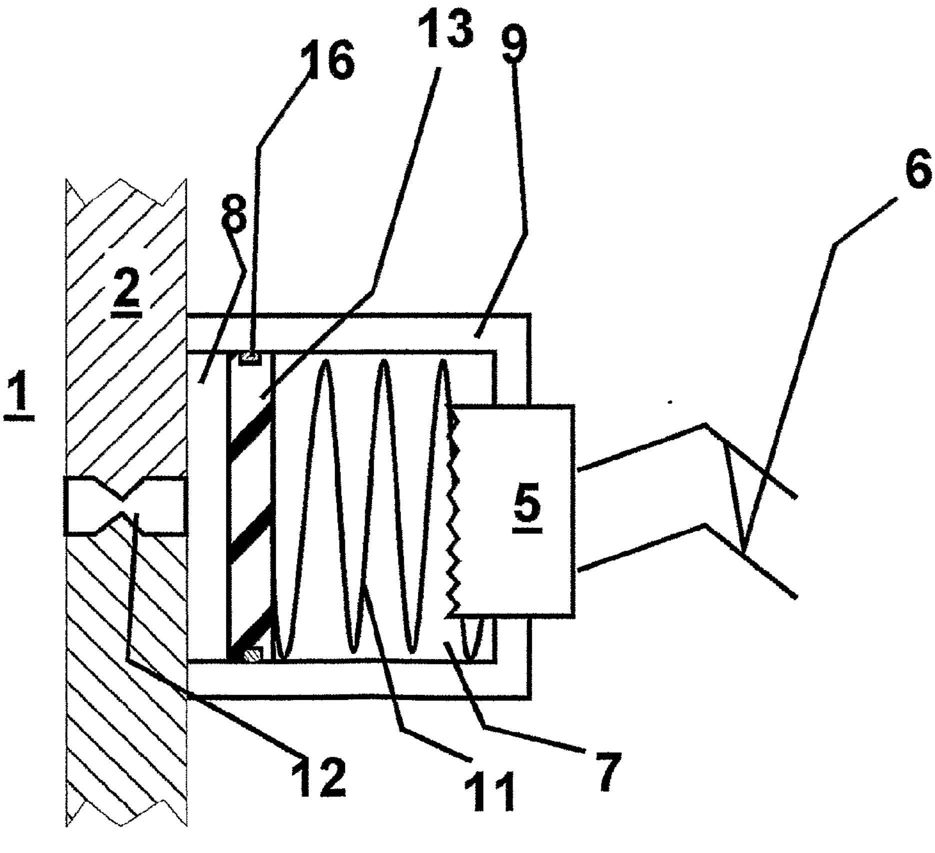


Fig. 2

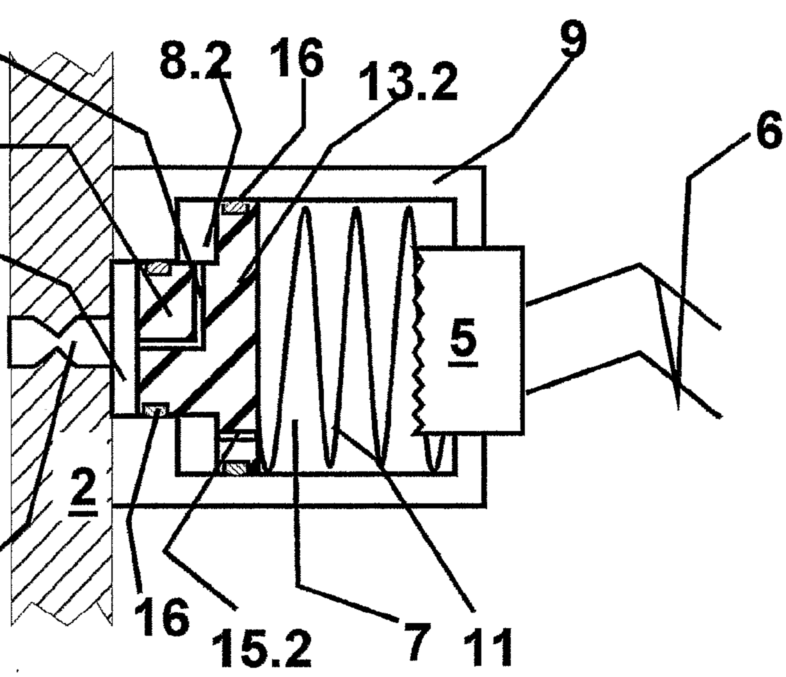
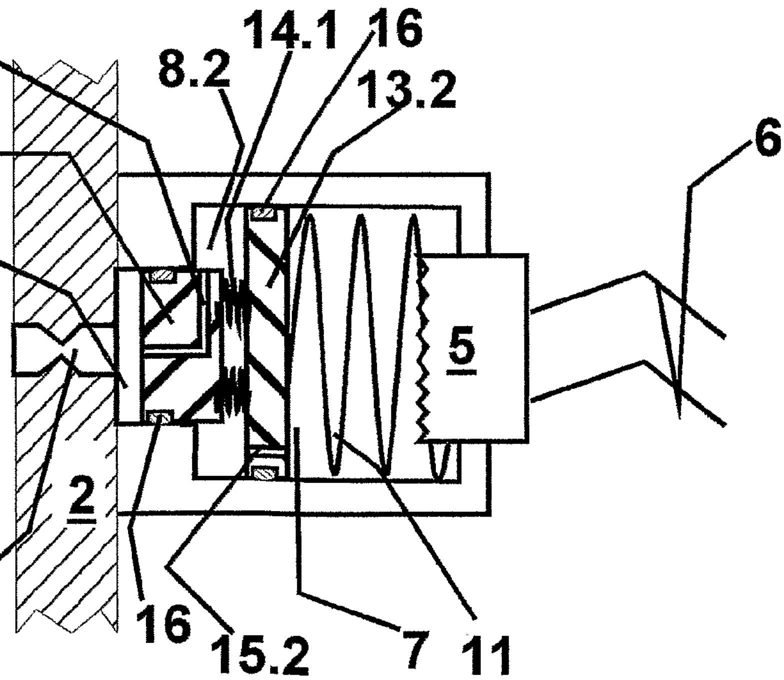

15.1
8.2
16
13.2
9
13.1
6
8.1
5
2
12
16
15.2
7
11

Fig. 3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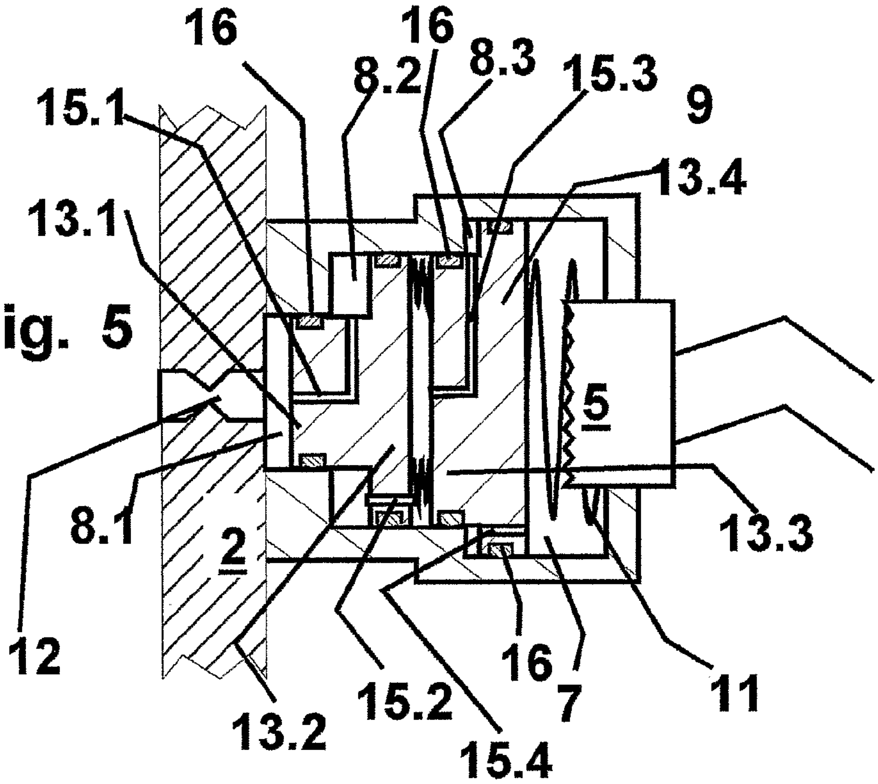
14.1
16
8.2
13.2
6
13.1
8.1
5
2
12
16
15.2
7
11

Fig. 4

Fig. 5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8.3
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9
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13.4
13.1
5
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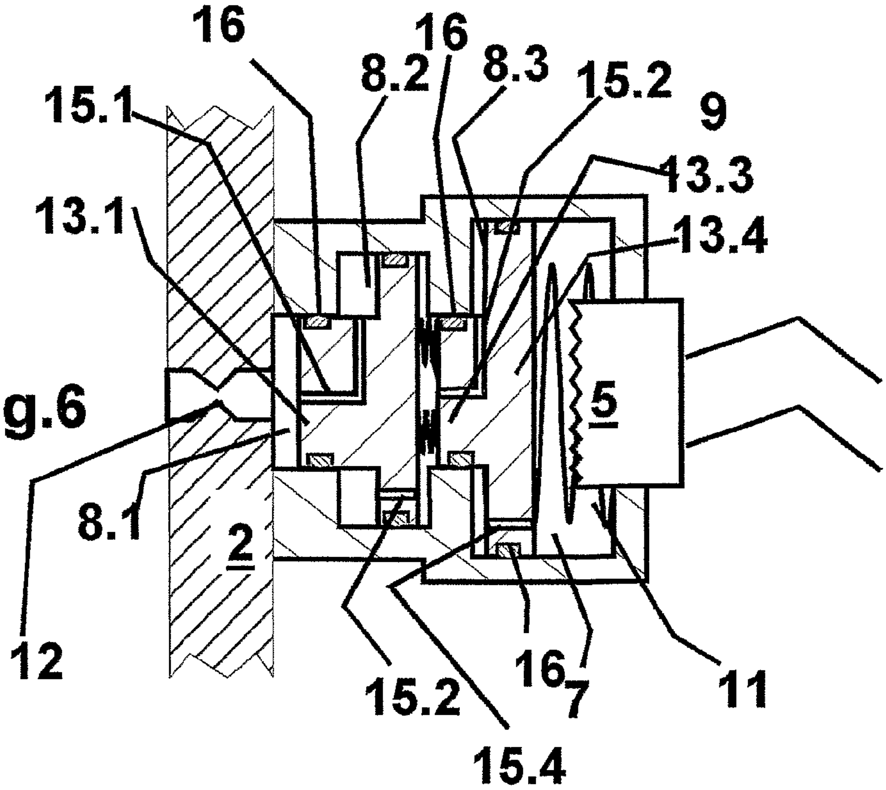
8.1
2
13.3
12
16
7
11
15.2
13.2
15.4

Fig.6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15.2
9
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2
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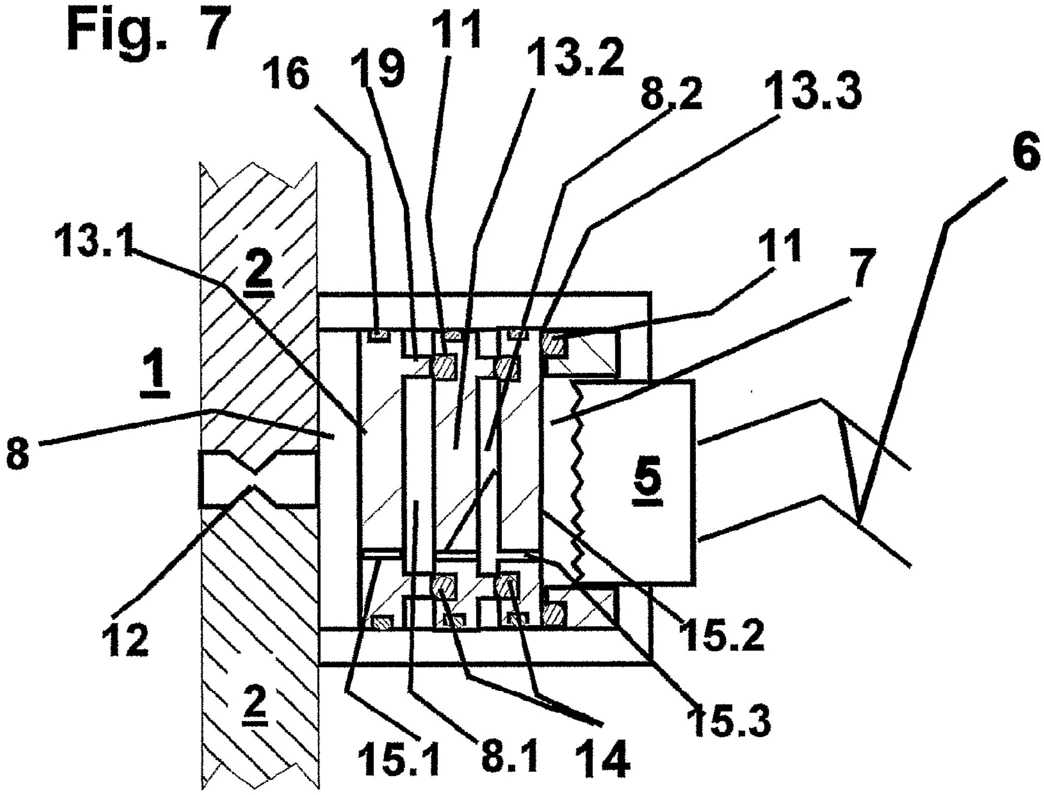
7
11
12
15.2
15.4

Fig. 7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8
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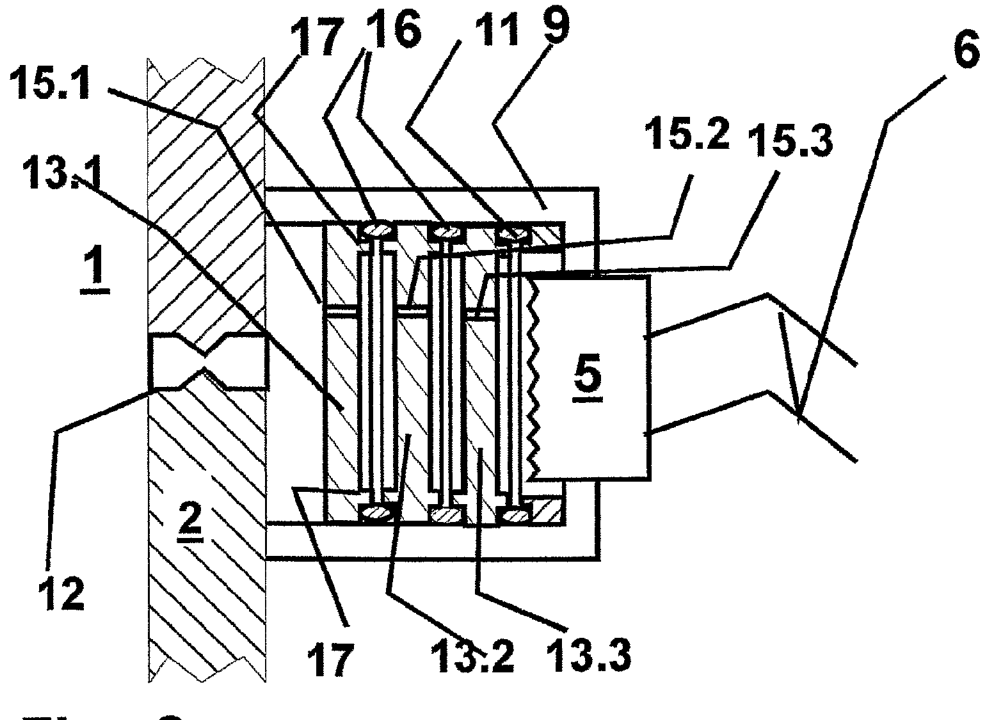
15.2
2
15.3
15.1
8.1
14


17
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6
15.1
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15.3
13.1
1
5
2
12
17
13.2
13.3

Fig. 8