



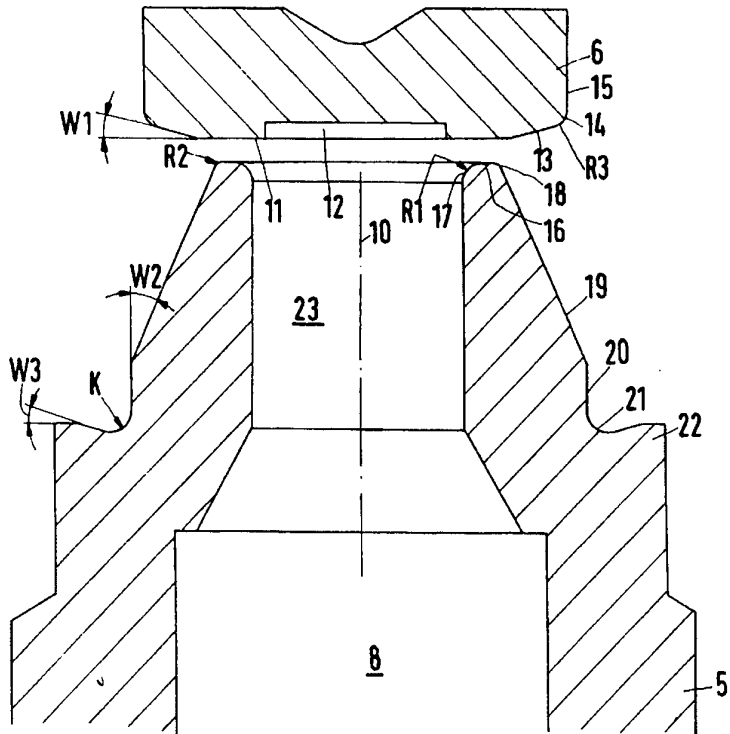
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: VALVE

(57) Abstract

A valve with an inlet and an outlet is disclosed, between which there are arranged a valve seat element (5), which surrounds a duct (8), and a closure element (6), which is arranged to be loaded with a controlling force in the direction in which it engages with the valve seat element (5). It is desirable for such a valve to be used also for fluids having a relatively low boiling temperature, for example, water, and to be able to withstand high pressures and high flow speeds. To that end, the closure element (6) has a closure face (11) running substantially at right angles to the direction of flow, which face lies in a contact zone adjacent to the valve seat element (5), the closure element (6) beyond the closure face (11) having a bevelled sloping face (13) which forms a predetermined first angle (W1) with the closure face (11), and the valve seat element (5) beyond the contact zone having a bevelled lateral face (19) which forms a predetermined second angle (W2) with the axis (10) of the duct.



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- 1 -

Valve

The invention relates to a valve with an inlet and an outlet, between which there are arranged a valve seat element, which surrounds a duct, and a closure element, which is arranged to be loaded with a controlling force in the direction in which it engages with the valve seat element.

Such valves are used, for example, as overflow valves in order to limit the pressure in a hydraulic system or sub-system to a predetermined maximum value. In this case, the controlling force is frequently produced by a spring. As soon as the pressure rises above this value, the overflow valve opens and releases some of the fluid from the system, so that the pressure is able to drop again. In other valves, the controlling force that is necessary to hold or move the closure element is applied by an internal or external actuating element.

In the case of overflow valves it is a problem, for example, that a pressure difference ranging from the highest admissible pressure to a very low pressure, normally the tank pressure, has to be accommodated. This is particularly critical when, in addition to this large pressure difference, a relatively large through-flowing quantity of fluid has to be dealt with. In that case, cavitation phenomena readily occur. The cavitation phenomena are all the more serious, the lower is the boiling temperature of the hydraulic fluid. If, for example, water is used instead of hydraulic oil, the same material disintegration can be

- 2 -

observed at a fraction of the pressure customary with oil.

US 4 679 592 discloses a valve which has a conical valve seat and a correspondingly conical valve rod as its closure element. The valve seat has a series of radial holes. The flow path through the valve is from the outside inwards. The expansion of the hydraulic fluid that occurs after it has passed through the narrow gap between the valve seat and the closure element, is effected such that the action of coinciding flows from holes distributed in the circumferential direction is mutually cancelled out or weakened. Such a valve can be used as a control valve. Because of the valve characteristic, in many cases it is impossible, however, to use such a valve as an overflow valve.

Another valve is known from DE 40 25 727 C2. Here, the relatively large pressure drop already mentioned is divided into relatively small partial stages. In one embodiment, for that purpose the series connection of two valve sections is disclosed. The valve construction is relatively complicated.

The invention is based on the problem of providing a valve which withstands a relatively large pressure difference even with relatively large amounts of fluid flowing through and even with hydraulic fluids having low boiling temperatures, such as water, for example.

This problem is solved in the case of a valve of the kind mentioned in the introduction in that the closure element has a closure face running substantially at right angles to the direction of flow, which face lies in a contact zone adjacent to the valve seat element, the closure element beyond the closure face having a bevelled sloping face which forms a predetermined first angle with the closure face, and the valve seat element beyond the contact zone having a

- 3 -

bevelled lateral face which forms a predetermined second angle with the axis of the duct.

Through this construction an excellent flow behaviour is obtained, in many cases even a virtually laminar flow between the valve seat and the closure element in the contact zone when the valve is open, that is the closure element has lifted away from the valve seat element. Bevelling of the sloping face on the closure element on the one hand and of the lateral face on the valve seat element on the other hand creates a gradually opening space in the direction of flow behind the gap formed in the region of the contact zone. With a suitable choice of angle, which is discussed hereinafter, cavitation can be kept extremely low.

The sloping face preferably commences further towards the outside than the lateral face. "Outside" here means the direction away from the duct at right angles to the duct. Because of this construction, the closure face in practice extends so far that it projects a little way outwards beyond the lateral face. This produces an improved flow characteristic.

In a preferred embodiment, it is further provided that on the valve seat element the transition from the duct to the contact zone is effected by way of a first curve and the transition from the contact zone to the lateral face is effected by way of a second curve. By curving the edges, the flow is improved, with the formation of fewer eddies. No appreciable reduced pressures, which could lead to cavitation, are therefore formed locally.

The radius of the first curve is in this case preferably larger than the radius of the second curve, a flat face running parallel to the closure face being provided between the two curves. In the area of the contact zone a gap which is defined by two parallel

- 4 -

sides is therefore created. Formation of a laminar flow is promoted by that construction.

In an alternative construction, the radii of the first and second curves are identical and both curves merge into one another. In that case, a curve lies opposite a flat face, the closure face. This construction also provides good results.

The sloping face preferably has an outer portion which forms an angle with the closure face which is smaller than the first angle. This arrangement enlarges the opening forces on the closure body as flow-through increases. The valve characteristic is improved, that is, both the opening and the closing of the valve are able to adhere more accurately to the preset values.

It is especially preferred for the outer portion to form the underside of a circumferential collar arranged on the closure element. The opening forces are in that case formed not only by the compressive forces on the underside, that is to say, the side of the collar facing the valve seat element, but also by suction forces or reduced pressure forces which act on the top side, that is, the side of the collar facing away from the valve seat element.

The sloping face preferably merges by way of a third curve into a circumferential face of the closure element. This also means that the hydraulic fluid is able to flow smoothly against the closure element without interruption and consequent local reduced pressures.

The closure element preferably has a rebate bounded by the closure face. By this means, the fluid builds up a pressure concentration across the rebate and fluid flowing through the valve is deflected at this pressure concentration towards the gap in the contact zone without noticeable eddying occurring here.

- 5 -

Experiments have shown that the first angle preferably has a magnitude in the range from 5° to 30°, especially from 10° to 20°, and preferably from 14° to 16°. The closer the angle to the value of 15°, the better the results, in particular in respect of the cavitation behaviour.

Similarly, it has been shown that the second angle should advantageously have a magnitude in the range from 0° to 35°, especially from 20° to 30°, and preferably from 23.5° to 24.5°.

The radii of the first and the third curves are advantageously substantially the same. It has been shown that with these configurations, flows that provide a very satisfactory behaviour of the valve are obtained, in particular from the point of view of cavitation.

Preferred values for the radius of the first curve lie in the range from 0.1 to 1.0 mm, preferably in the range from 0.4 to 0.6 mm.

The radius of the second curve is preferably in the range from 0.0 to 1.0 mm and preferably in the range from 0.1 to 0.3 mm.

The invention is described hereinafter with reference to embodiments of an overflow valve, in conjunction with the drawings, in which

- Fig. 1 shows a diagrammatic view of an overflow valve,
- Fig. 2 shows a diagrammatic view of the valve seat element and closure element,
- Fig. 3 shows a further construction of an overflow valve with modified closure element, and
- Fig. 4 is a fragmentary view of a further construction of a valve seat element.

An overflow valve 1 has a housing 2 with an inlet 3 and an outlet 4. Arranged in the inlet 3 is a

- 6 -

valve seat element 5, adjacent which lies a closure element 6 which is held in the closed position by a compression spring 7.

The closure element 6 closes a duct 8 formed in the valve seat element 5. When the pressure in the inlet 3 and consequently in the duct 8 exceeds a predetermined value, the force resulting from the pressure and acting on the closure element overcomes the force of the compression spring 7, and the closure element 6 lifts away from the valve seat element 5 and opens a fluid path from the duct 8 into a chamber 9 formed in the housing which surrounds the closure element annularly and is connected to the outlet 4.

The more detailed construction of the valve seat element 5 and closure element 6 is explained in conjunction with Fig. 2. For reasons of clarity, the closure element 6 has here been illustrated lifted away from the closure element 6. For the purpose of the explanation, a duct axis 10 has additionally been drawn in. For ease of understanding it is assumed in the following that both the valve seat element 5 and the closure element 6 are of rotationally symmetrical construction, that is, sections appear as rings or circles. This is, however, only by way of example. The construction of the valve is not restricted to such rotational symmetry.

The closure element 6 has a closure face 11 which runs substantially at right angles to the duct axis 10. The closure face 11 annularly surrounds a recess or a rebate 12. A concentration of pressure is able to build up here during operation of the valve.

Towards the outside, that is, as the distance from the duct axis 10 increases radially, adjoining the closure face 11 there is a sloping face 13, which forms an angle $W1$ with the closure face 11. The angle $W1$ is 15° in this particular case. The sloping face 13 merges by way of a curve 14 into a circumferential face

- 7 -

15 of the closure element 6. The radius of this curve 14 is about 0.5 mm. The axial length of the circumferential face 15 with a duct diameter of 7 mm is at least 3 mm.

The valve seat element 5 has a valve seat 16 parallel to the closure face 11. The region in which the closure face 11 rests against the valve seat 16 in the closed state of the valve is referred to hereinafter as the "rest region". The rest region is smaller than the closure face 11 of the closure element 6. It coincides substantially with the size of the valve seat 16.

The duct 8 merges by way of a first curve 17 into the valve seat 16. The valve seat 16 merges by way of a second curve 18 into a lateral face 19. The lateral face 19 of the valve seat element 5 forms with the duct axis 10, or a line parallel thereto, a second angle W_2 , here 24° . The second angle W_2 is therefore larger than the first angle W_1 .

The first curve 17 has a radius R_1 of 0.5 mm, the second curve 18 has a radius R_2 of 0.2 mm and the third curve 14 has a radius R_3 of 0.5 mm. These values were found to be the ideal values where the diameter of a narrow part 23 of the duct 8 before the start of the first curve 17 is 7 mm.

In this construction, a substantially laminar flow forms between the valve seat 16 and the closure face 11. In the direction of flow behind the valve seat 16 the fluid is able to spread out in the chamber 9. The special construction of the valve seat element 5 and the closure element 6 enable a flow to form which lies for a greater distance adjacent to both parts 5, 6. Here, a curve can, of course, be provided not only between the closure face 11 and the sloping face 13, but also between the lateral face 19 and the outer face 20. Pressure relief of the fluid flowing through is here effected such that either virtually no local

- 8 -

reduced pressures occur, and thus no cavitation, or such that when local reduced pressures do occur with resultant cavitation, the cavitation takes place in the fluid itself, that is, not in the housing 2. The valve seat 16 and the closure face 11 are not affected hereby. The service life of the valve can therefore be considerably increased despite the use of "hard" hydraulic fluids, such as, for example, water, pressure differences and high flow-through rates.

Fig. 3 shows an alternative construction, in which identical parts have been provided with the same reference numbers.

Compared with the construction according to Figs 1 and 2, the closure element 24 has been modified and now has a circumferential collar 25. The collar 25 has an underside 26 which adjoins the sloping face 13. The underside in this case faces towards the valve seat element 5. The underside 26 forms with the plane of the closure face 11 an angle which is smaller than the first angle W_1 . In an extreme case, the underside 26 can run parallel to the closure face 11 or even form a "negative" angle with the closure face 11.

The construction of the closure element 24 with the collar 25 improves the valve characteristic, that is, the dependency of the opening or closing pressure on the flow-through can be reduced by this measure.

Fig. 4 shows an alternative construction of the valve seat 16', in which the first curve 17 and the second curve 18 have the same radius R_1 and merge without transition into one another. Unlike the valve seat 16 according to Fig. 2, the valve seat 16' has no part aligned parallel to the closure face 11. The engagement of the closure element 6 on the valve seat element 5 is therefore effected here only within a virtually line-contact or very narrow region.

Patent Claims

1. A valve with an inlet and an outlet, between which there are arranged a valve seat element, which surrounds a duct, and a closure element, which is arranged to be loaded with a controlling force in the direction in which it engages with the valve seat element, characterized in that the closure element (6, 24) has a closure face (11) running substantially at right angles to the direction of flow, which face lies in a contact zone adjacent to the valve seat element (5), the closure element (6, 24) beyond the closure face (11) having a bevelled sloping face (13) which forms a predetermined first angle (W1) with the closure face (11), and the valve seat element (5) beyond the contact zone having a bevelled lateral face (19) which forms a predetermined second angle (W2) with the axis (10) of the duct.
2. A valve according to claim 1, characterized in that the sloping face (13) commences further towards the outside than the lateral face (19).
3. A valve according to claim 1 or 2, characterized in that on the valve seat element (5) the transition from the duct (8) to the contact zone is effected by way of a first curve (17) and the transition from the contact zone to the lateral face (19) is effected by way of a second curve (18).
4. A valve according to claim 3, characterized in that the radius (R1) of the first curve (17) is larger than the radius (R2) of the second curve (18), a flat face (16) running parallel to the closure face (11) being provided between the two curves (17, 18).

- 10 -

5. A valve according to claim 3, characterized in that the radii of the first and second curves (17, 18) are identical and both curves (17, 18) merge into one another.

6. A valve according to one of claims 1 to 5, characterized in that the sloping face (13) has an outer portion (26) which forms an angle with the closure face (11) which is smaller than the first angle (W1).

7. A valve according to claim 6, characterized in that the outer portion forms the underside (26) of a circumferential collar (25) arranged on the closure element (24).

8. A valve according to one of claims 1 to 7, characterized in that the sloping face (13) merges by way of a third curve (14) into a circumferential face (15) of the closure element (6).

9. A valve according to one of claims 1 to 8, characterized in that the closure element (6) has a rebate (12) bounded by the closure face (11).

10. A valve according to one of claims 1 to 9, characterized in that the first angle (W1) has a magnitude in the range from 5° to 30°, especially from 10° to 20°, and preferably from 14° to 16°.

11. A valve according to one of claims 1 to 10, characterized in that the second angle (W2) has a magnitude in the range from 0° to 35°, especially from 20° to 30°, and preferably from 23.5° to 24.5°.

12. A valve according to one of claims 8 to 11, characterized in that the radii (R1, R3) of the first

- 11 -

and the third curves (17, 14) are substantially the same.

13. A valve according to one of claims 3 to 12, characterized in that the radius of the first curve (17) lies in the range from 0.1 to 1.0 mm, preferably in the range from 0.4 to 0.6 mm.

14. A valve according to one of claims 3, 4 or 6 to 13, characterized in that the radius of the second curve (18) lies in the range from 0.0 to 1.0 mm and preferably in the range from 0.1 to 0.3 mm.

Fig.1

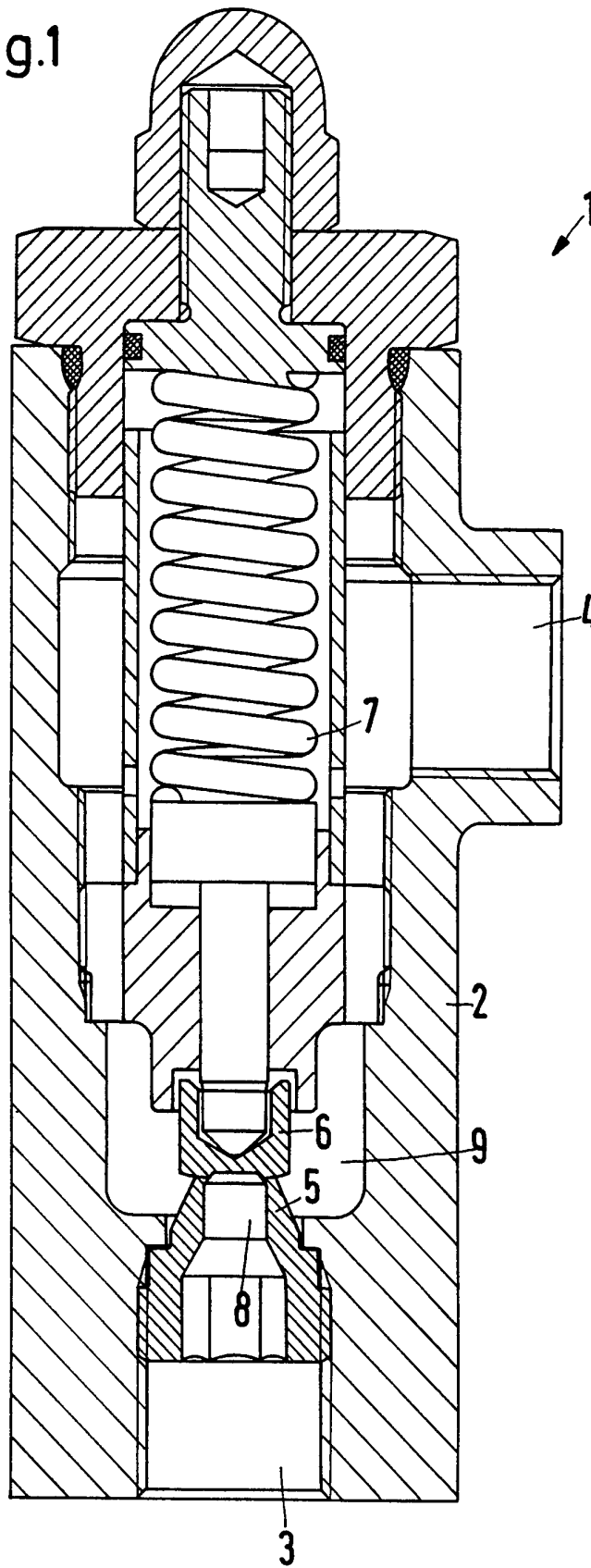


Fig.2

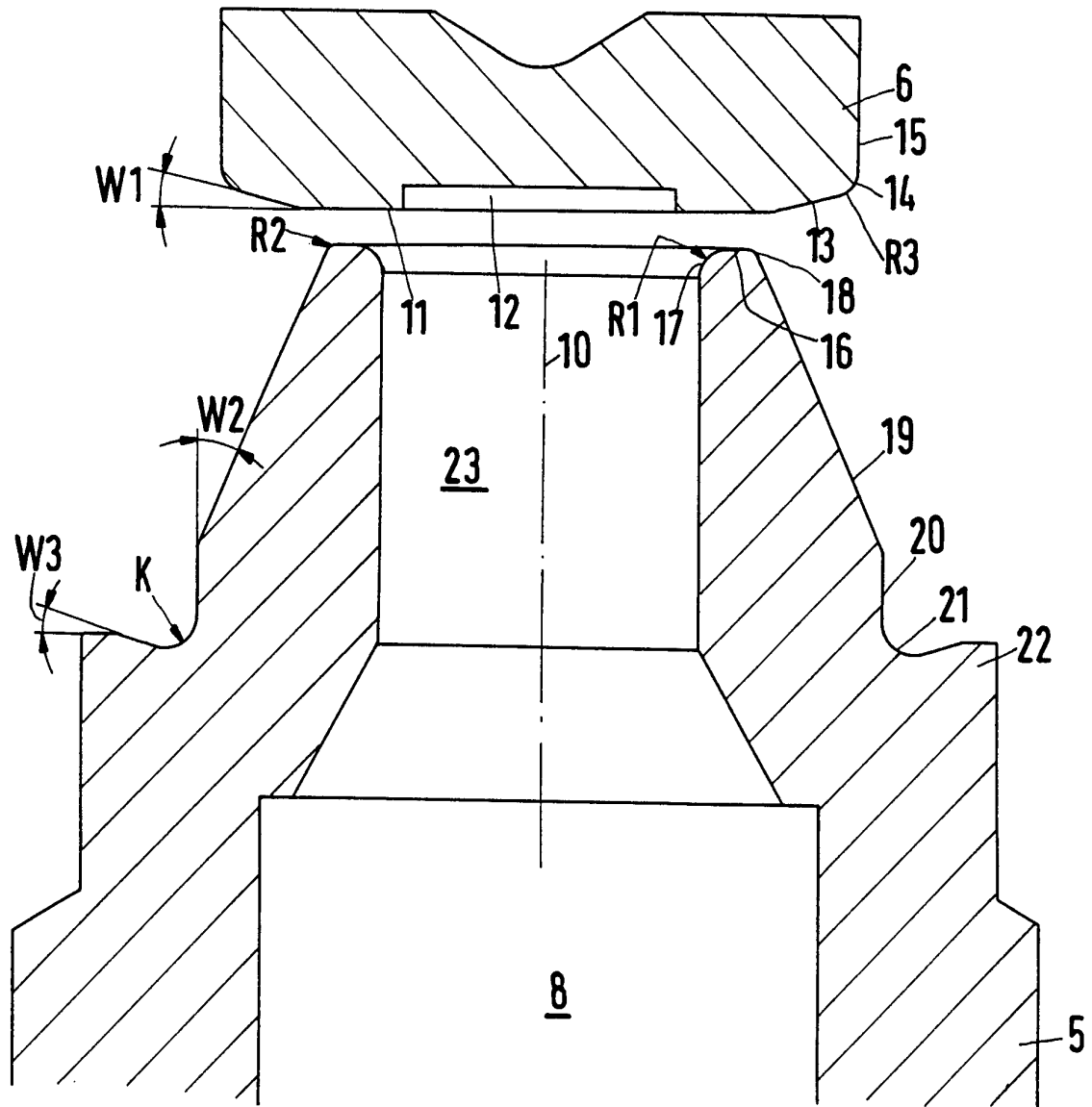


Fig.3

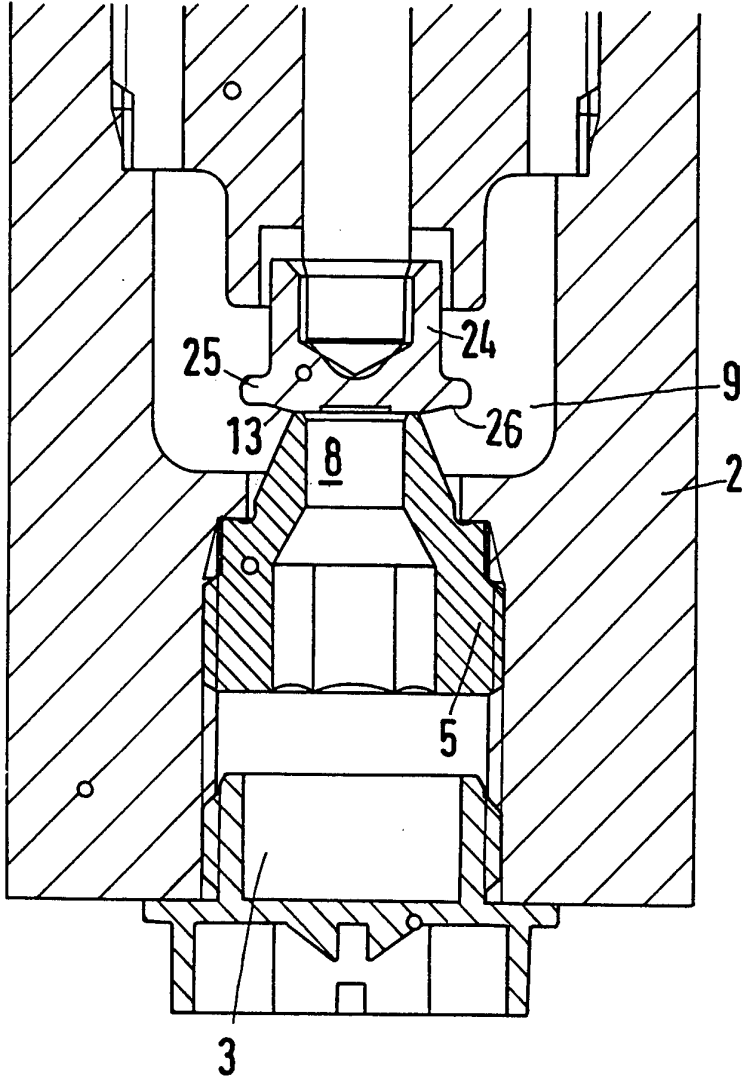
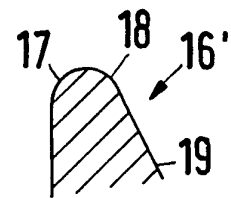


Fig.4



INTERNATIONAL SEARCH REPORT

International application No.

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| A. CLASSIFICATION OF SUBJECT MATTER | | |
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| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | |
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y | FR, A1, 2389815 (PONT-A-MOUSSON S.A.), 1 December 1978 (01.12.78), figures 1,2, claim 1 -- | 1-5 |
| X | FR, A1, 2336614 (CONSOLIDATED VALVE INDUSTRIES, INC.), 22 July 1977 (22.07.77), page 2 - page 3, figure 4 | 1,2 |
| Y | -- ----- | 3-5 |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex. | | |
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INTERNATIONAL SEARCH REPORT

Information on patent family members

09/02/95

International application No.

PCT/DK 94/00441

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---------------------|----------------------------|---------------------|
| FR-A1- 2389815 | 01/12/78 | NONE | |
| FR-A1- 2336614 | 22/07/77 | NONE | |