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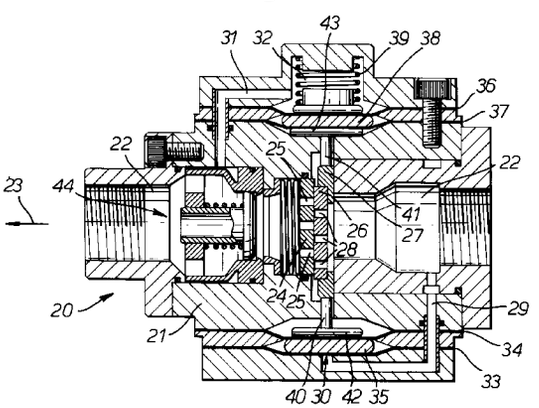
(54) Non-return valves.

(57) A valve (20) comprises a valve body (21), a stationary disc (24) positioned in the valve body transverse to fluid flow through the valve body, there being at least one aperture (25) in the stationary disc, and a moveable disc (26) positioned such that one face of the moveable disc closely abuts and is slidable across one face of the stationary disc, wherein the moveable disc has at least one aperture (28) therethrough, the moveable disc being slidable, in response to the difference between a first pressure in the fluid flow on one side of the valve and a second pressure in the fluid flow on the other side of the valve, between a first position in which the at least one aperture (28) of the moveable disc (26) is aligned with the at least one aperture (25) of the stationary disc (24) and a second position in which the apertures are obstructed, and fluid flow is prevented.

Fig. 2.



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This invention relates to non-return valves for use in fluid flow systems. More particularly, this invention has been developed to provide improved backflow prevention devices for use in water supply systems and the like, but the devices can also be used in other systems.

The current U.K. legislation under existing Byelaws requires that, in water supply systems and the like, measures are taken to protect both the individual consumer and the general public from the effects of backflow, but policing these measures is difficult. There are two known types of protection systems: those which involve an air gap for prevention of contamination, and those which employ mechanical moving parts.

At present, simple mechanical preventers are acceptable under the Byelaws as an alternative to air gap systems. These mechanical devices are however, less reliable, and some incidence of backflow through these devices is likely.

Impending legislation may well require more stringent protection against possible backflow contamination conditions. In a recent draft European Standard for water supply, it was proposed that all consumer clean water outlets should be of a type which will avoid causing contamination to the water supply due to backflow.

Backflow incidents where public health has proven to be affected are rare, but in any case some undertakings may wish to provide their own serviceable protection devices at curtilages to prevent such contamination.

In addition to the above, there are a number of problems which exist with present mechanical protection devices. In particular, identical check valve mechanisms plumbed in series have a high probability of failing simultaneously due to a common cause. Such mechanical devices that vent to atmosphere provide a pathway for contaminants to pollute the supply. Moreover, devices with moving parts can jam or fail to seal because of scale or corrosion.

From U.S. patent 3,955,591 and European published application EP-A-0140314 it is known to provide a valve which relies on interaction between a stationary and a moveable disc each of which contain a series of slots which, when aligned, enable water to flow through the valve at a low head loss. When the slots in the moving disc are misaligned with the slots in the stationary disc, flow is prevented.

The present invention provides a self-exercising check valve that actuates in response to flow demand and pressure changes in the fluid supply system.

According to one aspect of the present invention there is provided a valve comprising a valve body, a stationary disc positioned in the valve body transverse to fluid flow through the valve body, there being at least one aperture in the stationary disc, and a moveable disc positioned such that one face of the moveable disc closely abuts and is slidable across one face of the stationary disc, wherein the moveable disc has at least one aperture therethrough, the moveable disc being slidable, in response to the difference between a first pressure in the fluid flow on one side of the valve and a second pressure in the fluid flow on the other side of the valve, between a first position in which the at least one aperture of the moveable disc is aligned with the at least one aperture of the stationary disc and a second position in which the apertures are obstructed, and fluid flow is prevented.

Preferably, the moveable disc is operated directly by pressure responsive means, the first pressure being applied to one side of the pressure responsive means, and the second pressure being applied to an opposing side of the pressure responsive means.

In a preferred embodiment of the present invention the pressure responsive means comprises at least one diaphragm.

In a particularly preferred embodiment the pressure responsive means comprises a first double diaphragm assembly operably connected to the moveable disc, and a second double diaphragm assembly operably connected to the moveable disc in diametrically opposed relation to the first double diaphragm assembly. The double diaphragm assemblies each provide an air gap for prevention of contamination.

Alternatively, the pressure responsive means may comprise differential pistons, or the moveable disc may be rotatably slidable with respect to the stationary disc by means of a rack and pinion arrangement, the rack being provided on the pressure responsive means and the pinion being operable to rotate the moveable disc.

Preferably, the moveable disc is biassed towards the second position in which fluid flow is prevented, such that in the absence of fluid flow the valve closes.

The stationary and moveable discs are preferably formed from ceramic material to reduce wear.

In use, flow induced pressure changes continually exercise the disc sealing faces of the valve, thereby reducing the possibility of lime-scale encrustation on the seal.

A stop cock may be provided to manually override the pressure responsive setting of the valve.

In a particularly preferred arrangement, the disc valve of the first aspect of this invention may be placed in series with a spring-operated check valve or, alternatively, a spring-operated check valve may be incorporated within the valve body. This provides a fail safe device.

Where a spring-operated check valve is positioned on a first side of the disc valve, a relief valve may then be added to the arrangement, to provide a "reduced pressure zone" device. The relief valve preferably comprises a spring-loaded plunger, operably moveable within a branch passage extending from

the valve body, one side of the plunger being responsive to pressure on a second side of the disc valve, and the other side of the plunger being responsive to pressure on the first side of the disc valve, between the disc valve and the spring-operated check valve.

According to a second aspect of the present invention there is provided a valve comprising a valve body, a perforated, substantially conical member supported within the valve body, and a diaphragm adapted to seat within the conical member and comprising a flexible conical skirt, wherein the skirt is moveable to allow fluid to flow in one direction through the valve via the perforations in the conical member, and wherein the skirt seals against the conical member to prevent flow through the valve when the direction of fluid flow is reversed.

In a particularly preferred arrangement, the valve of the second aspect of the present invention may be placed in series with a spring-operated check valve, or such a check valve may be incorporated within the valve body of the invention. This provides a fail safe device.

The present invention will now be described in more detail with reference to the accompanying drawings, in which:

Figure 1 illustrates diagrammatically the principle of operation of a first aspect of the present invention;

Figure 2 shows in longitudinal section a preferred embodiment of the first aspect of the invention;

Figure 3 shows in longitudinal section an alternative embodiment of the first aspect of the invention;

Figure 4 shows in axial cross-section another embodiment of the first aspect of the invention;

Figure 5 illustrates an arrangement whereby the valve of the first aspect of the invention is combined with a relief valve; and

Figure 6 shows one embodiment of a second aspect of the present invention.

Referring first to Figure 1, there is provided a supply pipe 1 in which the normal direction of fluid flow is as shown by arrow 2. A sliding disc valve 3 in accordance with the first aspect of this invention is placed in the supply pipe 1. A connecting passage or line 4 links a pressure responsive device 5 with the supply pipe upstream of the valve 3, and a connecting passage or line 6 links a further pressure responsive device 7 with the supply pipe downstream of the valve 3.

The pressure responsive device 5 incorporates a pressure responsive member which is shown in Figure 1 as a diaphragm 8. One side of the diaphragm 8 is exposed to the pressure in the supply pipe upstream of the valve 3 by means of the connecting line 4, the diaphragm being biassed against the upstream pressure by means of a compression spring 9. The further pressure responsive device 7 incorporates a pressure responsive member which is shown in Figure 1 as a diaphragm 10. One side of the diaphragm 10 is exposed to the pressure in the supply pipe downstream of the valve 3 by means of the connecting line 6. A connecting member 11 connects diaphragm 8 with diaphragm 10, and the connecting member 11 is moveable to actuate means 12 to open and close the valve 3. If there is no flow through the supply pipe, then the spring 9 acts to move means 12 to close the valve 3. Clearly, the compression spring 9 shown in Figure 1 could be replaced by any other suitable biassing means in either pressure responsive device 5 or pressure responsive device 7.

When the flow in the supply pipe is in the direction of arrow 2, if P_1 is the upstream pressure and P_2 is the downstream pressure, A_1 is the area of diaphragm 8 and A_2 is the area of diaphragm 10, and S is the force supplied by the spring 9, then if P_1A_1 is greater than the sum of P_2A_2 and S, the connecting member 11 will move to actuate means 12 to open the valve 3.

Thus, if the force P_2A_2 becomes too similar in magnitude to the force P_1A_1, then the spring force S will act to close the valve 3. To prevent backflow, the spring force S and the areas A_1 and A_2 are selected such that the valve will close before P_2 equals P_1. Preferably, the spring force S and the areas A_1 and A_2 are selected such that the valve will close when the amount by which P_1 is greater than P_2 drops to about 0.5 to 1 bar.

Clearly, if the flow in the supply pipe is reversed (in the direction opposite to arrow 2), then P_2 is greater than P_1 and valve 3 closes. Thus, pressure upstream and downstream of the valve is sensed by the diaphragms 8, 10 and, if the downstream pressure becomes too close in magnitude to the upstream pressure, the valve automatically closes.

A preferred embodiment of the present invention, operating on the principle described with respect to Figure 1, is shown in more detail in Figure 2. A valve 20 comprises a valve body 21 having a through bore 22 adapted to be connected into a supply line (not shown) such that, when fluid is flowing in the normal direction of supply in the line, the direction of flow in the through bore 22 is as shown by arrow 23.

A stationary disc 24 is positioned and held in the through bore transverse to the fluid flow. The disc 24 has a number of apertures 25 therethrough. A moveable disc 26 is supported in sliding face to face abutment with the stationary disc 24, by means of a supporting member 27. The moveable disc has a number of apertures 28 therethrough corresponding to the number of apertures 25.

A through passage 29 connects the upstream side of the discs 24, 26 with a chamber 30, and a further through passage 31 connects the downstream side of the discs 24, 26 with a chamber 32. The chamber 30 houses a pressure responsive member which,

as shown in Figure 2, comprises two diaphragms 33, 34 separated by an intermediate support 35. The chamber 32 houses a similar pressure responsive member which, as shown in Figure 2, comprises two diaphragms 36, 37 separated by an intermediate support 38. The chamber 32 also houses a spring 39 which acts on the exterior face of the double diaphragm 36, 37 to bias it downwards, as shown in Figure 2.

Rods 40, 41 extend from the supporting member 27 and contact the interior faces of the double diaphragms 33, 34 and 36, 37 via heads 42, 43. Accordingly, movement of the diaphragms is transmitted via the rods 40, 41 and the supporting member 27 to the moveable disc 26.

The exterior face of double diaphragm 33, 34 is exposed to the pressure upstream of the valve by means of through passage 29, and the exterior face of double diaphragm 36, 37 is exposed to the pressure downstream of the valve by means of through passage 31.

Thus, when there is no flow through the valve, the spring 39 biasses the diaphragms and the supporting member downwards, and the moveable disc 26 is held in the position shown in Figure 2, where the apertures 28 are out of alignment with apertures 25 in the stationary disc, and the valve is closed.

When fluid is passed through the bore 22 in the direction of arrow 23, the pressure downstream of the discs 24, 26 will be lower than the pressure upstream of the discs. If the difference between the upstream and downstream pressures is sufficient to overcome the biassing force of the spring 39, then the diaphragms and the supporting member 27 will be moved upwards, and the moveable disc will slide upwards with the supporting member until its apertures 28 are aligned with the apertures 25 in the stationary disc, and fluid will flow through the valve with low head loss.

If fluid flow through the valve is reversed the pressure in passage 31 is greater than the pressure in passage 29, and the pressure difference combined with the biassing force of spring 39 acts to return the valve to its closed position shown in Figure 2.

Preferably the discs 24, 25 are made of a ceramic material so as to be resistant to wear, but any other suitable material may be used.

A conventional spring-operated check valve 44 is incorporated within the valve body 21 as a fail safe device and to provide a combination of different check valve devices, thereby reducing the risk of simultaneous failure.

The double diaphragms 33, 34 and 36, 37 provide an effective seal between the passages 29 and 31 and the interior faces of the double diaphragms, eliminating the requirement for O-ring seals and the like. The double diaphragms also create an air gap between the two diaphragms and, in particular, an air gap between diaphragms 36 and 37 which acts as a safety means to prevent any contamination of the upstream fluid with the monitored sample of the downstream fluid in passage 31.

The embodiment shown in Figure 3 is substantially the same as that shown in Figure 2, and like numerals have been used for like parts. However, the double diaphragms used in the Figure 2 embodiment have been replaced by pressure responsive pistons 50 and 51 operably connected to the moveable disc 26, to slide the moveable disc 26 transverse to the stationary disc 24 to open and close the valve in response to a difference in pressure across the valve.

In Figure 4, the embodiment of Figure 3 has been modified such that the moveable disc 26 is rotatable about its central axis instead of being transversely slidable. By rotating the moveable disc 26 the apertures in the moveable disc are rotated into or out of alignment with apertures in the stationary disc. The rotation is achieved by means of a rack and pinion arrangement. The pistons 50 and 51 are connected via a rod 52 on which is provided a rack 53. The rack engages with a pinion 54 such that, as the rack 53 is moved up and down with the rod 52 in response to pressure differences across the valve, the pinion 54 is rotated. A gear 55 is fixed to the pinion to rotate with the pinion, and the gear 55 engages a toothed edge 56 on the moveable disc 26. The disc 26 is thus rotated in response to pressure difference across the valve.

A manually operated stop cock may optionally be incorporated in any of the valves shown in Figures 2 to 4, such that the position of the moveable disc can be set manually by overriding the pressure responsive setting of the valve.

Figure 5 shows a fluid supply line 80 in which the normal direction of fluid flow is shown by arrow 81. A sliding disc valve in accordance with any of the embodiments shown in Figures 2 to 4 is fitted in the supply line 80, and is shown diagrammatically at 82 in Figure 5. A conventional spring-operated check valve is also provided in the supply line downstream of the sliding disc valve 82. A relief valve shown generally at 83 is fitted to one side of the supply line. The relief valve has a valve body 85, and an aperture 84 in the supply line connects the fluid flow through the supply line with a branch passage 86 through the body 85 of the relief valve. The aperture 84 lies between the disc valve 82 and the check valve 44. A further aperture 87 is formed in the side of the supply line upstream of the disc valve 82. The aperture 87 connects with a through passage 88 in the relief valve body. The relief valve body incorporates an outlet passage 89, and a valve member 90 is movable between a first position (shown in Figure 5) in which the branch passage 86 is shut off from the outlet passage 89, and a second position in which the branch passage 86 connects with the outlet passage 89 to allow fluid flow in

the direction of arrow 91. In the Figure 5 embodiment, the valve member 90 comprises a plunger 92 having at one end a head 93 adapted to close the opening between the branch passage 86 and the outlet passage 89. The other end of the plunger is connected to one side of a pressure responsive member such as a diaphragm 94. The plunger 92 is biassed to the second, open position by means of a spring such as a compression spring 95. The other side of the diaphragm 94 is exposed to the pressure upstream of the sliding disc valve 82 by means of aperture 87 and through passage 88.

When fluid is flowing in the direction of arrow 81, the diaphragm 94 responds to the upstream pressure forcing the spring loaded plunger 92 to close against the force of the spring 95. The branch passage 86 is thus isolated from the outlet passage 89, as shown in Figure 5.

If upstream pressure is lost, such that there is a risk of backflow occurring, the spring 95 forces the plunger 92 of the relief valve to open, connecting the branch passage 86 with the outlet passage 89, creating a reduced pressure region 95 and allowing the fluid to drain from the region 95 between the disc valve 82 and the check valve 44. As discussed above, when the upstream pressure drops, the disc valve 82 and the check valve 44 are closed. Accordingly, once the fluid has drained through outlet passage 89, a safety airgap is produced in the region 95 between the potential contaminant and the fluid supply.

For convenience, the relief valve 83 may be bolted on to the supply line, or connected in any other suitable way.

Figure 6 shows a valve 60 in accordance with the second aspect of the invention, fitted between a manifold 61 and a meter 62. The valve comprises a valve body 63 having an annular inlet passage 64 separated from a central outlet passage 65, by means of a sleeve 66. A frusto-conical member 67 made preferably of metal is supported within the sleeve by any suitable arrangement. In the particular embodiment shown in Figure 6, the sleeve 66 is formed from an upper portion 68 and a lower portion 69, and a flange 70 on the member 67 is clamped between the upper and lower portions of the sleeve.

The frusto-conical member 67 thus lies in the flow through the outlet passage 65, and the taper of the frusto-conical member expands outwardly in the normal direction of flow through the outlet passage. A number of perforations 71 are provided in the frusto-conical member 67. A flexible diaphragm 72, made of an elastomeric material such as rubber, and having a frusto-conical skirt 73, is seated within the member 67. When fluid flows in the normal direction through the valve (as shown by the arrows), the skirt 73 is lifted away from the member 67 by fluid passing through the perforations 71 and the fluid can flow readily through the valve. However, when fluid flow through the manifold is reversed, the fluid pressure expands the skirt 73 to seal against the member 67 and prevent reverse flow through the valve.

A conventional spring-operated check valve 74 is also incorporated within the valve body 63 for additional safety.

The embodiment shown in Figure 6 has the advantage that it can be added to existing domestic installations without difficulty and without significant alterations to the existing installations being required. It is particularly useful as a non-return valve for connecting a domestic water meter to a supply manifold.

Although the specific embodiments of the present invention have been described with respect to backflow preventers for water supply systems, clearly the valves of the present invention may be used in any other areas of fluid flow control, where non-return valves are required.

Claims

1. A valve comprising a valve body (21), a stationary disc (24) positioned in the valve body transverse to fluid flow through the valve body, there being at least one aperture (25) in the stationary disc, and a moveable disc (26) positioned such that one face of the moveable disc closely abuts and is slidable across one face of the stationary disc, wherein the moveable disc has at least one aperture (28) therethrough, the moveable disc being slidable, in response to the difference between a first pressure in the fluid flow on one side of the valve and a second pressure in the fluid flow on the other side of the valve, between a first position in which the at least one aperture (28) of the moveable disc (26) is aligned with the at least one aperture (25) of the stationary disc (24) and a second position in which the apertures are obstructed, and fluid flow is prevented.

2. A valve according to claim 1, characterised in that the moveable disc is operated directly by pressure responsive means (33, 34, 36, 37), the first pressure being applied to one side of the pressure responsive means, and the second pressure being applied to an opposing side of the pressure responsive means.

3. A valve according to claim 2, characterised in that the pressure responsive means comprises at least one diaphragm.

4. A valve according to claim 3, characterised in that the pressure responsive means comprises a first double diaphragm assembly (33, 34) operably connected to the moveable disc (26), and a second double diaphragm assembly (36, 37) oper-

ably connected to the moveable disc (26) in diametrically opposed relation to the first double diaphragm assembly.

5. A valve according to claim 2, characterised in that the pressure responsive means comprises differential pistons (50, 51).

6. A valve according to claim 1, characterised in that the moveable disc is rotatably slidable with respect to the stationary disc by means of a rack and pinion arrangement (53, 54), the rack (53) being provided on the pressure responsive means and the pinion (54) being operable to rotate the moveable disc.

7. A valve according to any preceding claim, characterised in that biassing means (39) bias the moveable disc towards the second position in which fluid flow is prevented, such that in the absence of fluid flow the valve closes.

8. A valve according to any preceding claim, characterised in that the stationary and moveable discs are formed from ceramic material.

9. A valve according to any preceding claim, characterised in that a stop cock is provided to manually override the pressure responsive setting of the valve.

10. A valve comprising a valve body (63), a perforated, substantially conical member (67) supported within the valve body, and a diaphragm (72) adapted to seat within the conical member and comprising a flexible conical skirt (73), wherein the skirt is moveable to allow fluid to flow in one direction through the valve via the perforations (71) in the conical member, and wherein the skirt seals against the conical member to prevent flow through the valve when the direction of fluid flow is reversed.

Fig. 1.

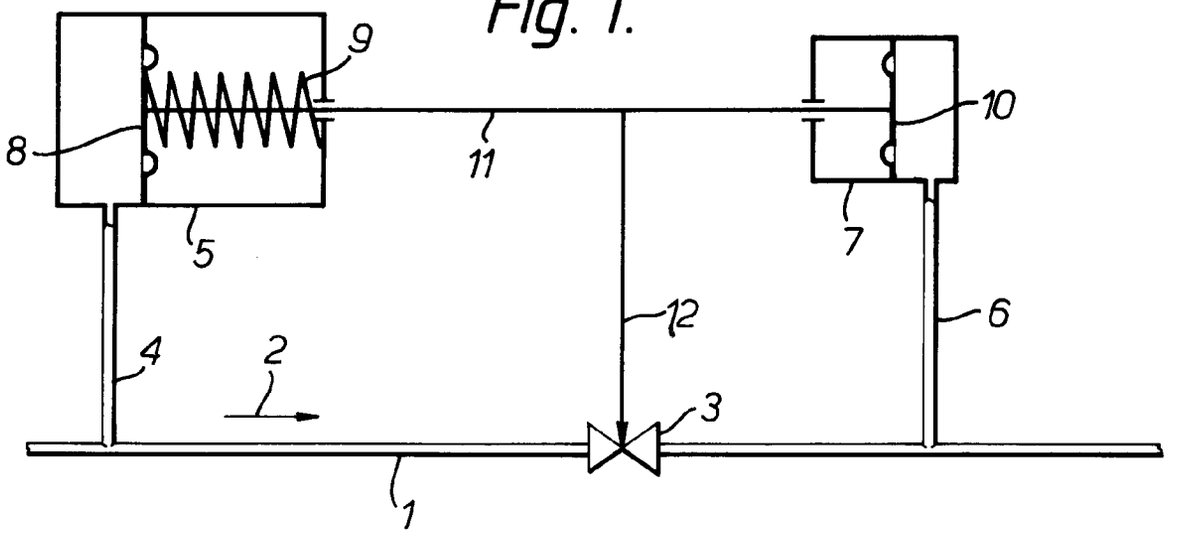
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Fig. 2.

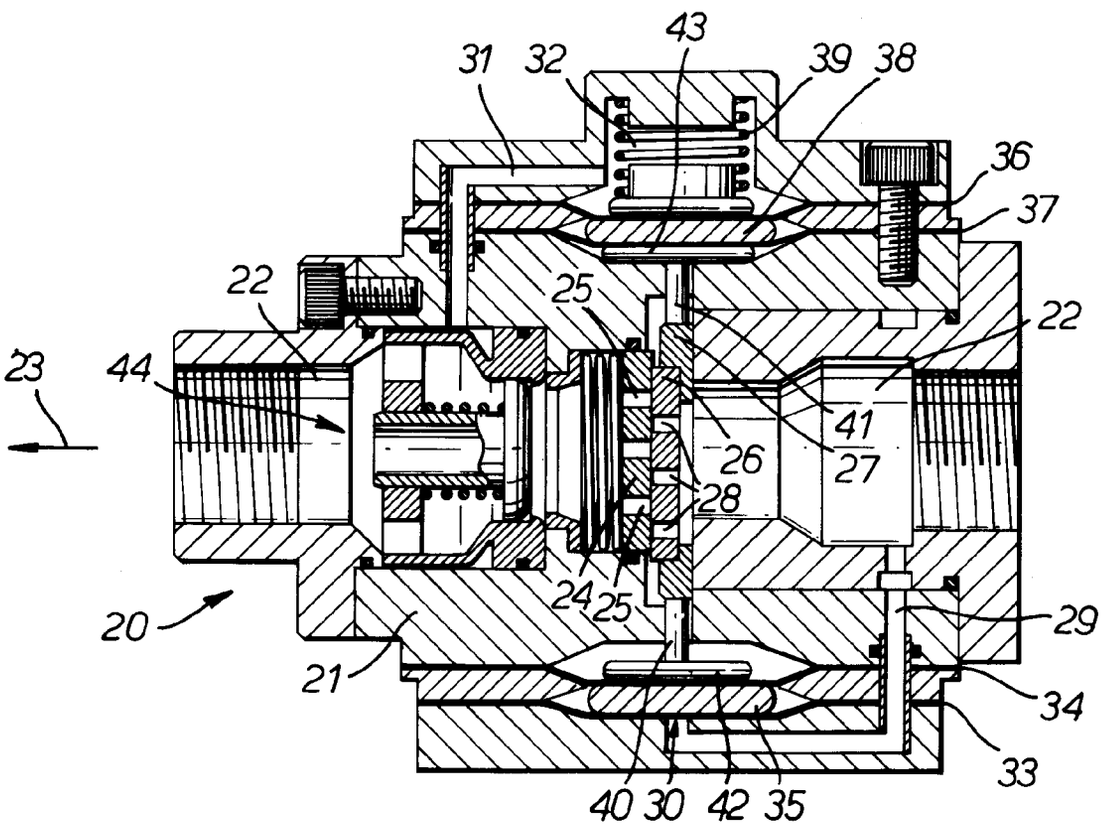
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Fig. 3.

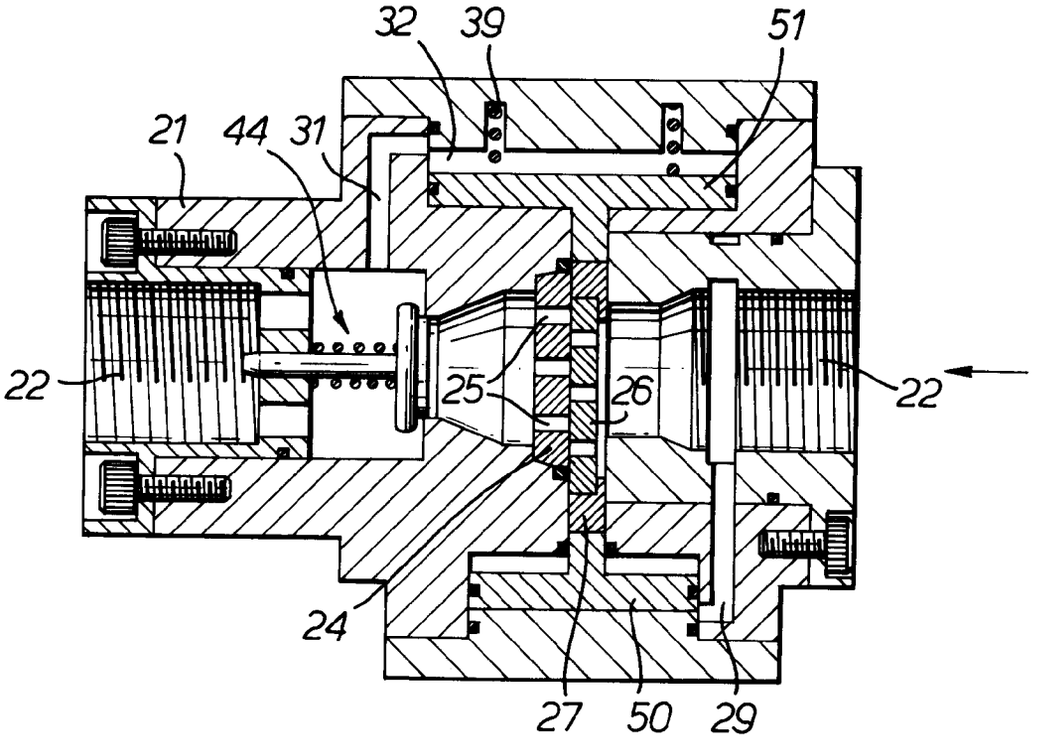
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Fig. 4.

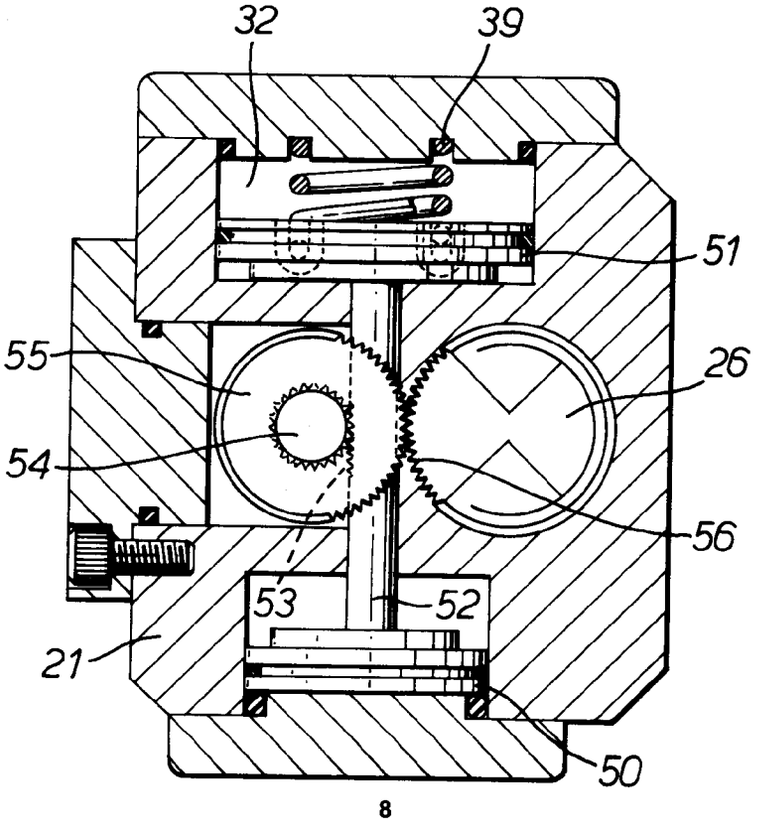
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Fig. 5.

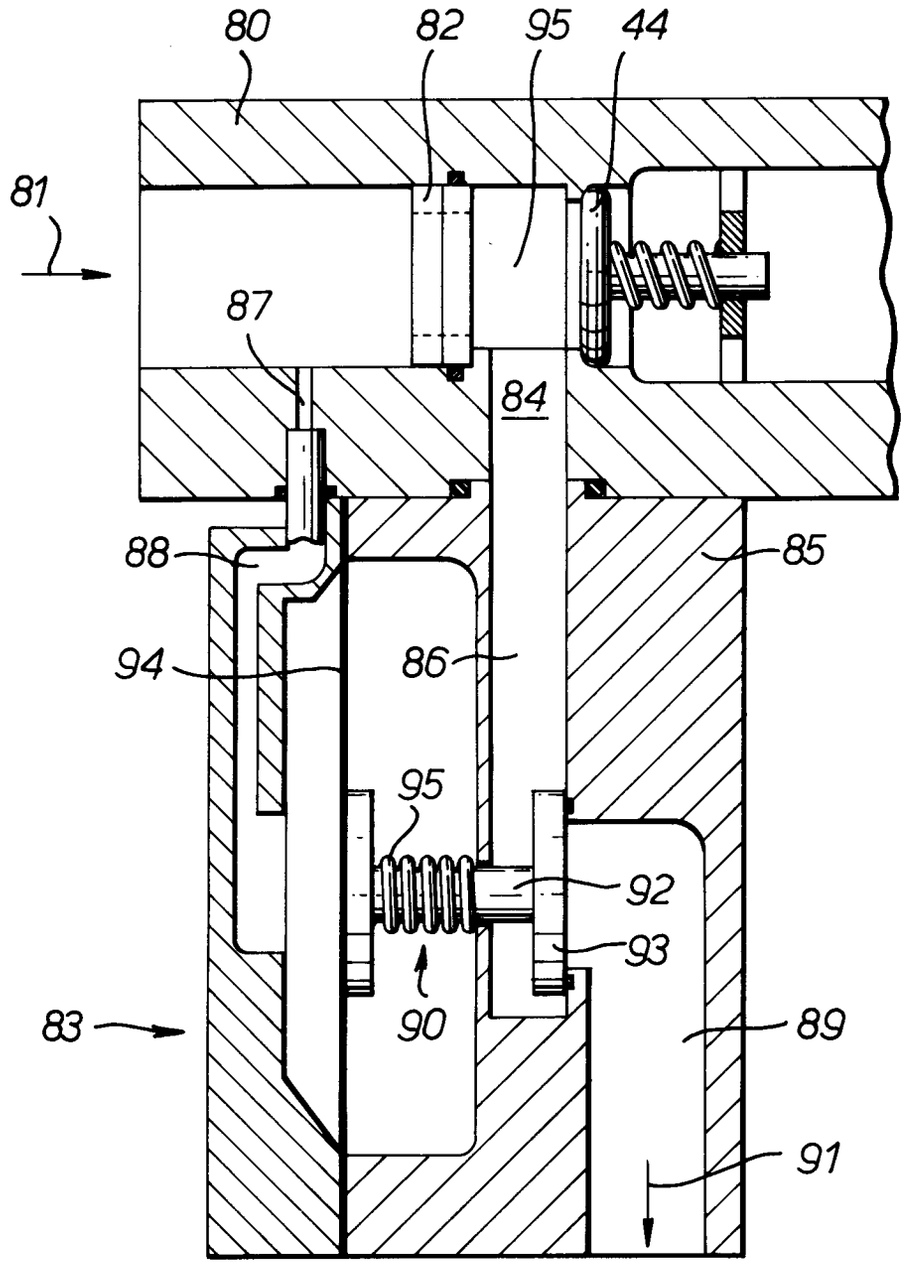
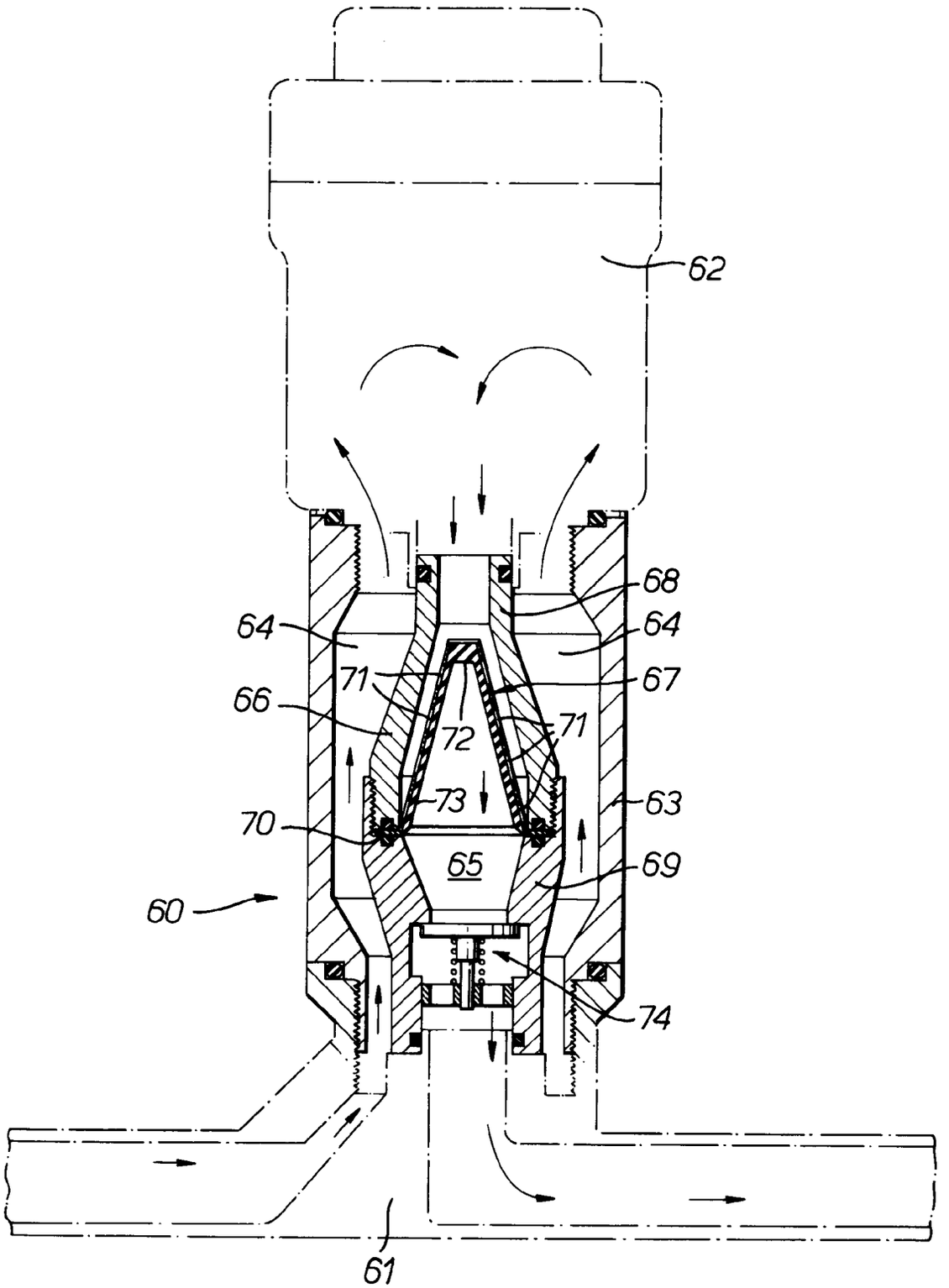


Fig.6.



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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 3083

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-1 310 784 (FERCH & NABBEN) * page 1, right column, paragraph 2 * * page 2, left column, paragraph 7 - right column, paragraph 2; figures *	10	E03C1/10
X	DE-C-218 988 (ZINGLER)	10	
D,Y	US-A-3 955 591 (BAUMANN) * abstract; figures 1,3 *	1,7	
Y	US-A-2 417 357 (GRISWOLD) * column 1, line 47 - column 2, line 11 * * column 5, line 18 - column 6, line 21; figures 1,3 *	1,7	
A		2,3	
A	EP-A-0 351 319 (SOCLA) * column 7, line 40 - column 8, line 5 * * column 14, line 29 - column 15, line 19; figures 25-27 *	1,2,6	
A	GB-A-586 166 (CARLTON ET A.) * page 6, line 20 - line 44; figures *	4	TECHNICAL FIELDS SEARCHED (Int. Cl.5) E03C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 SEPTEMBER 1993	DE COENE P.J.S.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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