



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.06.2008 Bulletin 2008/25

(51) Int Cl.:
F15B 1/16 (2006.01) F15B 1/22 (2006.01)

(21) Application number: **06425837.9**

(22) Date of filing: **14.12.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(72) Inventor: **Sanfratello, Giuseppe**
20077 Melegnano MI (IT)

(74) Representative: **Concone, Emanuele et al**
Società Italiana Brevetti S.p.A.
Via Carducci 8
20123 Milano (IT)

(71) Applicant: **Sanfratello, Giuseppe**
20077 Melegnano MI (IT)

(54) **Hydropneumatic accumulator with shut-off valve**

(57) A hydropneumatic accumulator comprises a container (1), provided with a connecting pipe (2) suitable for mounting in fluid communication on a line pipe of a hydraulic circuit, a bladder (3) containing a gas and suitable to be compressed or expanded to store or release the fluid of said hydraulic circuit, and a shut-off valve (4) mounted at the end of the connecting pipe (2) fixed to the container (1), the valve (4) being axially movable with respect to the connecting pipe (2) and suitable to abut upon a matching seat (8) so as to close the end of the connecting pipe (2) in conditions of minimum fluid pressure. The shut-off valve (4) comprises a plurality of stems

(5) arranged along the periphery of its head (6) and axially slidable in the connecting pipe (2) in guides (7) formed outside the cross-section of the fluid passage. The lift of the shut-off valve (4) defines an area of the fluid passage between its head (6) and its seat (8) that is larger than the cross-section of the fluid passage defined by the connecting pipe (2) at the entrance into the container (1). The valve according to the present invention is designed not to cause any restriction to the flow rate of the fluid to and from the line pipe, and to completely eliminate the drawback of the concentrated pressure losses, which is typical of the valves of prior art accumulators.

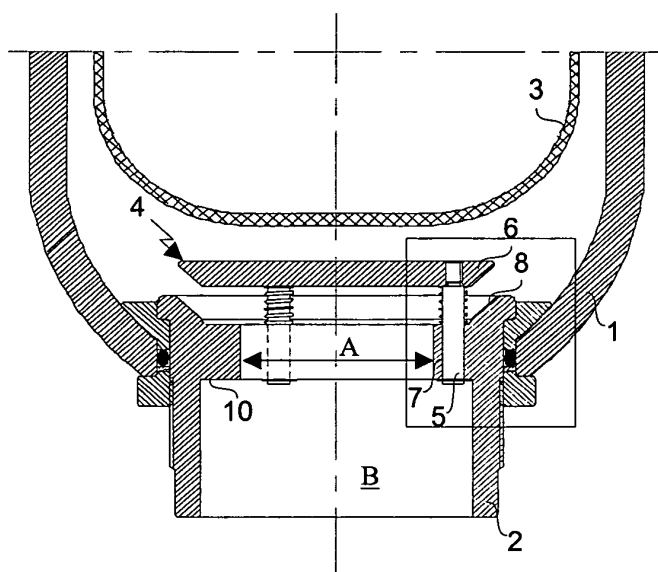


Fig. 1

Description

[0001] The present invention relates to a hydropneumatic accumulator and particularly to a bladder hydropneumatic accumulator provided with a shut-off valve.

[0002] Hydropneumatic accumulators are devices which are capable of storing and releasing pressure energy in hydraulic circuits by utilizing the compressibility of a gas contained therein. They are widely used, for instance, in the food industry, chemical industry and pharmaceutical industry and are also used for hydraulic applications such as, for example, in the hydraulic circuits of machine tools.

[0003] A hydropneumatic accumulator generally comprises a metal container in fluid communication with the plant piping through a connecting pipe. In the container there is arranged a bladder separating the plant fluid from an inert gas, usually nitrogen, which is at a predefined pressure in the accumulator chamber and occupies the whole internal volume thereof.

[0004] When the pressure in the plant exceeds the pressure of the gas contained in the accumulator, the bladder is displaced thus reducing the volume which is occupied by the gas and consequently the gas pressure increases until it balances the pressure of the fluid. When the pressure in the plant decreases, the bladder is displaced in the opposite direction and the gas expands until it balances the new pressure of the fluid. The bladder displacement thus allows to accumulate fluid when the pressure in the plant increases and to release fluid when the pressure in the plant decreases.

[0005] When the pressure in the plant is minimum or even null, the bladder substantially occupies the whole volume of the container. In order to avoid that the bladder is extruded in the connecting pipe as an effect of the pressure of the gas contained therein, and that it is consequently damaged even in an irreparable manner, it is known to use anti-extrusion bottom plates, which are applied on the bladders at their bottom portion, for example during the bladder vulcanization process. When the bladder is expanded occupying the whole internal volume of the container, the bottom plate abuts on a suitable seat formed at the end of the connecting pipe, thus closing it and preventing a further advancing of the bladder. As soon as the pressure in the plant increases, the fluid pushes onto the bottom plate, that is lifted allowing the fluid to enter again.

[0006] The expansion movement of the bladder in the axial direction is strongly influenced by the homogeneity of the thickness of its walls. In small-size accumulators the expansion movement substantially occurs in the axial direction, allowing a correct abutment of the anti-extrusion bottom plate on the end of the connecting pipe. In accumulators of a greater size, e.g. having storing volumes greater than 10 l, the expansion movement can deviate even greatly from the axial direction, therefore it is preferred to substitute the anti-extrusion bottom plate with shut-off valves directly mounted at the end of the

connecting pipe.

[0007] Known shut-off valves are typically poppet valves, whose stem is axially slidable in the connecting pipe. During the normal operation of the plant, the shut-off valve is open, biased in the open position by a spring coaxially mounted to the stem. When the pressure in the plant is minimum or even null the bladder is expanded and pushes the valve overcoming the spring force up to closing the end of the connecting pipe, thus avoiding the extrusion of the bladder.

[0008] However, the use of shut-off valves instead of anti-extrusion bottom plates generates some problems. In fact the guide of the valve is arranged in the connecting pipe, thus occupying a portion of the cross-section of the fluid passage. Consequently, there is a limitation in the flow-rate to and from the line pipe. Moreover, concentrated pressure-losses are generated, due to the presence of both the guide and the elements connecting the guide to the inner walls of the connecting pipe, which negatively affect the flow and in particular the response speed of the accumulator to pressure oscillations in the plant.

[0009] The object of the present invention is thus to provide a hydropneumatic accumulator provided with a shut-off valve that allows to overcome such drawbacks. Said object is achieved by a hydropneumatic accumulator whose main features are specified in claim 1, while other features are specified in the subsequent claims.

[0010] In the accumulator according to the present invention, the valve is provided with a plurality of stems arranged along the circumference of its head and slidable in guides formed outside the cross-section of the fluid passage. Thanks to this arrangement of the stems and the respective guides, the valve of the accumulator according to the present invention does not in any way restrict the flow rate of the fluid to and from the line pipe, and completely eliminates the drawback of the concentrated pressure losses caused by the presence of the valve guide in the connecting pipe.

[0011] The main advantage of the accumulator according to the present invention is that it is possible to set the valve lift so that the cross-section of the fluid passage between the head and the seat is greater than that defined by the connecting pipe, thus obtaining that the control section of the flow is only that of the connecting pipe.

[0012] These and other advantages of the accumulator according to the present invention will be evident to those skilled in the art from the following detailed description of an embodiment thereof with reference to the enclosed drawings, wherein:

Fig. 1 shows a sectional view of an accumulator provided with a shut-off valve according to the present invention;

Fig. 2 shows a detail of the accumulator of Fig. 1; and Fig. 3 shows a front view of a stem of the shut-off valve.

[0013] Fig. 1 shows a hydropneumatic accumulator according to the present invention, conventionally comprising a container 1 in fluid communication with a line pipe (not shown) through a connecting pipe 2. The connecting pipe 2 may be tightly fixed to the line pipe, e.g. by means of a flange and suitable seals (not shown). The accumulator also includes in a known way a bladder 3 which is compressed or expanded in order to store or release fluid from the accumulator from and to the line pipe respectively. A shut-off valve 4 is arranged at the end of the connecting pipe 2 fixed to container 1. The valve 4 is axially movable with respect to the connecting pipe 2 and is suitable to close the end of the connecting pipe 2 under conditions of minimum fluid pressure.

[0014] As shown in the figure, the shut-off valve 4 of the accumulator according to the present invention includes a plurality of stems 5 arranged along the periphery of its head 6 and axially slidable in the connecting pipe 2 in guides 7 formed outside the cross-section of the fluid passage. This allows to leave the cross-section of the fluid passage, which is indicated in the figure by letter A, completely free thus eliminating the pressure losses caused by the guides of the shut-off valves of the accumulators according to the prior art.

[0015] The lift of the shut-off valve 4 is designed so as to define an area of the fluid passage between head 6 and its seat 8 that is larger than the area of cross-section A of the fluid passage defined by the connecting pipe 2 at the entrance of container 1. In this way the flow rate of the fluid is solely controlled by the area of cross-section A of pipe 2, with no interference from the shut-off valve 4 and/or its guiding structure, thus providing the accumulator with improved flow characteristics and with a high speed of response to the pressure variations.

[0016] As shown in detail in Figures 2 and 3, stems 5 of the shut-off valve 4 according to the present invention are separable from head 6. This feature is particularly advantageous as it allows to manufacture valve 4 in a simpler and cheaper way, possibly using different materials for stems 5 and head 6 in order to optimize the closing and guiding functions.

[0017] Each stem 5 exhibits a threaded end 5a suitable to be screwed into head 6 of the shut-off valve 4 in a matching threaded hole. In proximity to the end opposite to the threaded one, a circumferential groove 5b is formed that allows to fix an elastic stop ring 9, e.g. a Seeger ring. Once stems 5 are fixed to head 6, the shut-off valve 4 is inserted into its seat 8 by sliding stems 5 in the respective guides 7 formed in the connecting pipe 2.

[0018] The connecting pipe 2 internally exhibits an enlarged portion B, having a larger diameter with respect to cross-section A of the fluid passage and facing the line pipe. Such an enlarged portion B extends at least up to the portion where guides 7 of stems 5 are formed, so that guides 7 can be formed as through holes connecting the valve seat 8 with the enlarged portion B. When valve 4 is completely inserted into its seat 8, the ends of stems 5 protrude from the guides into the enlarged portion B,

thus allowing to fix the stop rings 9 onto the circumferential grooves.

[0019] Therefore, when valve 4 is lifted to allow the fluid to enter the accumulator, stems 5 slide in the respective guides 7 until the stop rings 9 abut upon an annular surface 10 defined at the cross-section variation between the enlarged portion B and cross-section A of the fluid passage towards the accumulator, thus limiting the lift of valve 4 to a prescribed amount.

[0020] In order to keep valve 4 open during the normal operation of the accumulator, a coil spring is provided at each stem 5, restrained between head 6 and seat 8 of valve 4. This solution is particularly advantageous with respect to the state of the art, because at equal technical features of the accumulator the force needed to keep valve 4 open is divided among more coil springs working in parallel. Consequently, it will be possible to use springs of smaller size, which, being less stressed with respect to the only central spring employed for the valves of known accumulators, will guarantee a longer service life to the shut-off valve.

[0021] In a preferred embodiment, the shut-off valve 4 comprises three stems 5 arranged 120° apart in the circumferential direction. This arrangement is particularly advantageous in that it allows to guide the axial movement of valve 4 in a stable way without excessively reducing the cross-section of the fluid passage defined between head 6 and seat 8. Therefore, it is possible to design such a lift as to restrict as much as possible the space taken up by valve 4 inside the accumulator, thus maximizing the volume available for the fluid.

[0022] It is clear that the above disclosed and illustrated embodiment of the accumulator according to the invention is only an example susceptible of numerous variations. In particular, the number of the stems guiding the movement of the shut-off valve could be proportional to the storing volume prescribed for the accumulator, thus allowing to guide valves of a larger size always in an optimal way. Furthermore, stems 5 could be fixed to head 6 of valve 4 in alternative ways with respect to the threaded connection, e.g. by snap or interference fit, or they could be inserted in the respective holes of head 6 and welded therein, thus accomplishing a valve structure of a monolithic type.

Claims

1. A hydropneumatic accumulator comprising a container (1), provided with a connecting pipe (2) suitable for mounting in fluid communication on a line pipe of a hydraulic circuit, a bladder (3) containing a gas and suitable to be compressed or expanded to store or release the fluid of said hydraulic circuit, and a shut-off valve (4) mounted at the end of the connecting pipe (2) fixed to the container (1), said valve (4) being axially movable with respect to the connecting pipe (2) and suitable to abut upon a matching seat

- (8) so as to close the end of the connecting pipe (2) under conditions of minimum fluid pressure, **characterized in that** the shut-off valve (4) comprises a plurality of stems (5) arranged along the periphery of its head (6) and axially slidable in the connecting pipe (2) in guides (7) formed outside the cross-section (A) of the fluid passage.
2. An accumulator according to the previous claim, **characterized in that** the lift of the shut-off valve (4) defines an area of fluid passage between the head (6) and its seat (8) that is larger than the area of the cross-section (A) of the fluid passage defined by the connecting pipe (2) at the entrance of the container (1).
 3. An accumulator according to claim 1 or 2, **characterized in that** the stems (5) of the shut-off valve (4) are separable from the head (6).
 4. An accumulator according to the previous claim, **characterized in that** each stem (5) exhibits one threaded end (5a) suitable to be screwed into the head (6) of the shut-off valve (4) in a matching threaded hole.
 5. An accumulator according to any of the previous claims, **characterized in that** said connecting pipe (2) internally exhibits an enlarged portion (B), having a diameter larger than that of the cross-section (A) of the fluid passage, said enlarged portion (B) facing the line pipe and extending at least up to the portion where the guides (7) of the stems (5) are formed.
 6. An accumulator according to the previous claim, **characterized in that** said guides (7) are through holes connecting the seat (8) of the valve (4) with the enlarged portion (B) of said connecting pipe (2).
 7. An accumulator according to the previous claim, **characterized in that** each stem (5) further exhibits a circumferential groove (5b) in proximity to the end opposite to the threaded one, said groove (5b) allowing to fix an elastic stop ring (9).
 8. An accumulator according to the previous claim, **characterized in that** said stop ring (9) is a stop ring of the Seeger type.
 9. An accumulator according to the previous claim, **characterized in that** during the normal operation of the accumulator, the valve (4) is in the open position and the stop rings (9) mounted on the stems (5) abut upon an annular surface (10) defined at the cross-section variation between the enlarged portion (B) and the cross-section (A) of the fluid passage towards the accumulator.
 10. An accumulator according to any of the previous claims, **characterized in that** at each stem (5) there is provided a coil spring (11) restrained between the head (6) and the seat (8) of the valve (4).
 11. An accumulator according to any of the previous claims, **characterized in that** the shut-off valve (4) comprises three stems (5) arranged 120° apart in the circumferential direction.

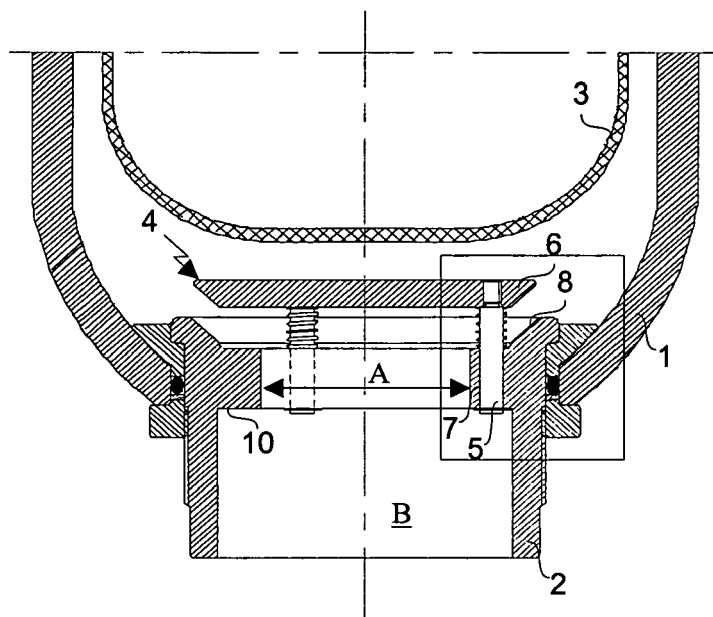


Fig. 1

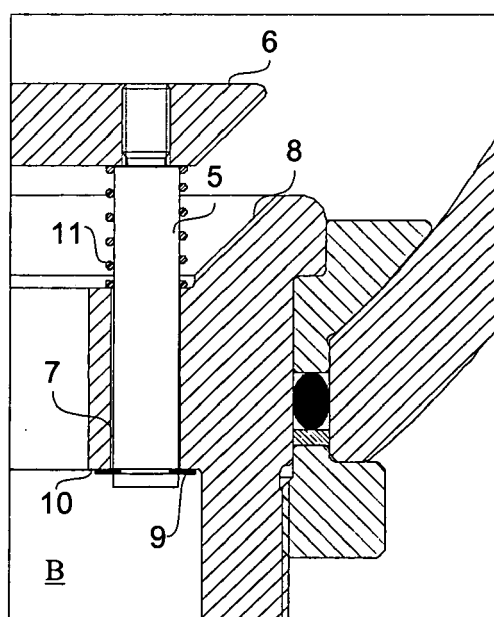


Fig. 2

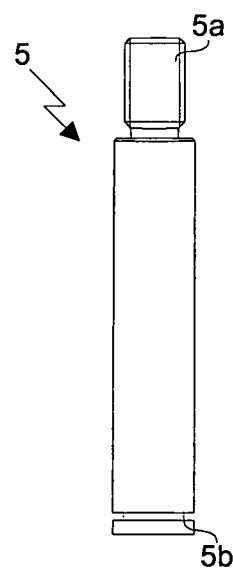


Fig. 3



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5837

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	BE 423 405 A (BERGER M.P.) 30 October 1937 (1937-10-30) * page 4, line 28 - page 5, line 5 * * page 8, line 19 - page 9, line 11; figures 1,6 * -----	1-11	INV. F15B1/16 F15B1/22
			TECHNICAL FIELDS SEARCHED (IPC)
			F15B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 May 2007	Examiner RECHENMACHER, M
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EP 06 42 5837

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
BE 423405	A	NONE	

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