(12) STANDARD PATENT (11) Application No. **AU 2001290384 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Relief valve

(51) International Patent Classification(s)
F16K 17/04 (2006.01)

(21) Application No: **2001290384** (22) Date of Filing: **2001.09.21**

(87) WIPO No: **WO02/25150**

(30) Priority Data

(31) Number	(32) Date	(33) Country
507125	**2000.09.22**	**NZ**

(43) Publication Date: **2002.04.02**
(43) Publication Journal Date: **2002.06.20**
(44) Accepted Journal Date: **2006.06.01**

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(56) Related Art
US4799506
GB1532215

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2002 (28.03.2002)

PCT

(10) International Publication Number
WO 02/25150 A1

(51) International Patent Classification[7]: F16K 17/02, 17/04, 17/06, 17/36, 17/38, 24/04, 1/30, 1/46, 1/32, 27/08, F16J 15/32, 15/46, 15/48, 15/56

(21) International Application Number: PCT/NZ01/00196

(22) International Filing Date:
21 September 2001 (21.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
507125 22 September 2000 (22.09.2000) NZ

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EC, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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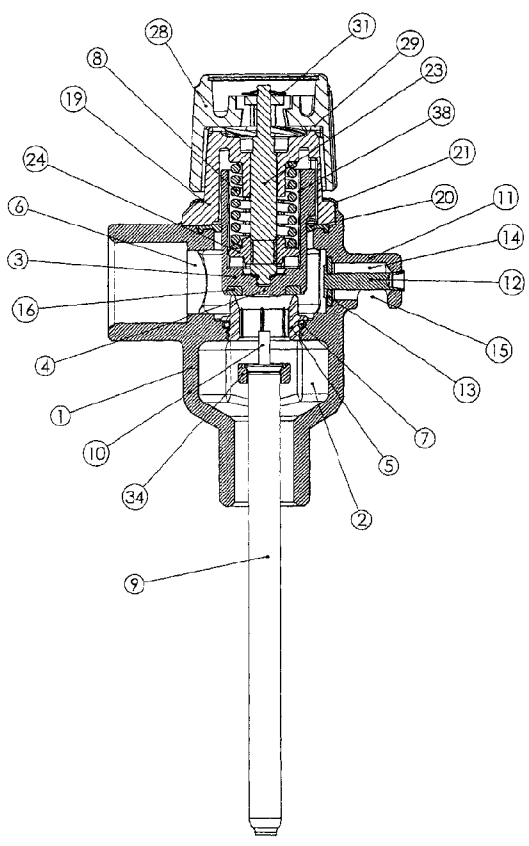
(54) Title: RELIEF VALVE



(57) Abstract: A relief valve assembly is disclosed including a housing (1) having an inlet (2), an outlet (6) and, passageway interconnecting the inlet (2) and outlet (6) and a valve seat (5). A moulded jumper (3) including a valve seal (16) is moveable to engage and disengage the valve seal (16) with the valve seat (5), thereby respectively closing or opening the passageway. The jumper (3) presents a continuous integral surface at least across said valve seat (5) when engaged the valve seat (5). In another embodiment the valve seal (16) is engaged with the jumper (3) in such a manner that the jumper (3) exerts substantially no compressive force on the valve seal (16) when the valve seal (16) is disengaged from the valve seat (5).

WO 02/25150 A1

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Relief Valve

Technical Field

This invention relates to a relief valve and in particular, but not exclusively to a pressure relief valve assembly including an improved jumper, diaphragm and valve adjustment assembly.

Background

Relief valves in the form of pressure and temperature relief valves (PTR valves) are widely used to protect against over pressure or high temperatures occurring within a pipeline or reservoir containing a fluid. A typical application of PTR valves is in safety protection for the temperature and pressure within hot water cylinders.

PTR valves relieve excess pressure from the hot water cylinder once the pressure exceeds a predetermined threshold. As the water in the hot water cylinder is heated, it expands due to thermal expansion. If the hot water system is closed, the pressure of the whole system will increase. Typical PTR valves that include a pressure relief function have a valve assembly known as a jumper pressed against a valve seat by a compression spring to form a seal between the jumper and valve seat. Should the pressure applied to the jumper exceed the opposing force applied by the compression spring, the jumper assembly is disengaged from the valve seat and the pressure is relieved through an outlet. Once the pressure drops sufficiently so that the compression spring can force the jumper back onto the valve seat, the valve closes preventing the flow of fluid from its inlet to the outlet. A temperature relief function may be provided by locating a temperature-dependent expandable material adjacent to the jumper so that when the material expands at higher temperatures, it pushes the jumper away from the valve seat, opening the valve.

The jumper in PTR valves at present provides a potential point of leakage. Although a washer is typically provided to press against the valve seat, leakage may still

occur. Furthermore, the jumper can be time consuming and complex to assemble, increasing the cost of manufacture.

Previous valves have used jumpers with rubber washers or other sealing means held in position by clamping means such as metal washers and screws. The compressive force applied to the rubber washer by the clamping means may be added to by the force of the compression spring holding the jumper on to the valve seat. This may lead to compression failure of the washer.

During flushing of PTR valves, the jumper is typically manually lifted in order to allow fluid to flow through the valve. This creates additional stresses on the jumper, increasing the risk of failure and/or requiring more resilient and typically more expensive materials to be used in jumper construction.

In order to prevent fluid ingressing into the valve past the jumper, a seal is typically provided against the outer periphery of the jumper. The friction of the seal against the jumper can cause hysteresis in the valve operation, reducing its accuracy. Furthermore, the sliding of the jumper along the seal reduces the lifespan of the seal.

Object of the Invention

Thus, it is an object of the present invention to provide a relief valve which overcomes or at least alleviates problems in relief valves at present, or at least one which provides the public with a useful choice.

Other objects of the present invention may become apparent from the following description, which is given by way of example only.

Summary of the Invention

According to a first aspect of the invention, there is provided a jumper for a valve assembly, wherein the jumper includes an integral moulded body including a channel or groove in which a valve seal has been moulded.

Preferably, the valve seal may be chemically bonded to the moulded body.

According to a second aspect of the present invention, there is provided a relief valve assembly including a housing having an inlet, an outlet and a passageway interconnecting the inlet and outlet, a valve seat, and a jumper as described in the immediately preceding paragraphs, wherein the jumper is moveable to engage and disengage the valve seal with the valve seat, thereby respectively closing or opening the passageway.

According to a third aspect of the present invention there is provided a relief valve assembly including a housing having an inlet, an outlet and a passageway interconnecting the inlet and outlet, a valve seat and a jumper including a moulded body including a channel or groove in which a valve seal has been moulded, wherein the jumper is moveable to engage and disengage the valve seal with the valve seat thereby respectively closing or opening the passageway.

Preferably, the jumper may be constructed from a plastic or resin material.

Preferably, the valve seal may be moulded into a channel or groove within the jumper.

Preferably, the valve seal may be chemically bonded to said jumper.

Preferably, the valve assembly may include a sealing means sealingly engaged between an internal surface of the housing and an outer surface of the jumper, the sealing means including an outer peripheral portion engaged with the housing and an inner peripheral portion engaged with the jumper and wherein the sealing means includes a flexible portion between said inner and outer peripheral portions to facilitate relative movement between the inner and outer peripheral portions parallel to the movement of the jumper in use to engage and disengage the valve seal from the valve seat.

Preferably, the width of the flexible portion of the sealing means may be sufficient to allow the inner and outer peripheral portions to move relative to each other to an extent substantially equivalent to the movement of the jumper relative to the housing in use.

Preferably, the width of the flexible portion may be substantially the minimum required to allow relative movement of the inner and outer peripheral portions to substantially the same extent as the relative movement of the jumper and housing in use.

Preferably, the outer peripheral portion of the sealing means may be secured to the housing and the inner peripheral portion frictionally engages with the jumper.

Preferably, the inner and outer peripheral portions of the sealing means may include a boss extending around the periphery of said sealing means.

Preferably, the outer portion of the sealing means may be engaged between two portions of the housing.

Preferably, the jumper may form part of a jumper assembly including the jumper, a spindle engageable with the jumper and an adjusting nut including a thread engaged with a corresponding thread on the spindle, wherein the adjusting nut is slideably engageable with the jumper thereby allowing movement of the adjusting nut along the axis of the spindle and preventing rotational movement of the adjusting nut in use and wherein the jumper is adapted to engage with the housing of the relief valve in a manner preventing rotational movement of the jumper.

Preferably, the spindle may engage with the jumper at least partially through a washer engaged with the spindle, wherein the jumper includes a tapered surface adapted to receive the washer.

Preferably, the tapered surface may have a conical or annular vertical section.

Preferably, the jumper may include at least one protrusion extending from an outer surface thereof and the housing includes one or more receptacles to accommodate the protrusion so as to constrain the jumper to move substantially linearly substantially along one axis.

Preferably, the relief valve assembly may further include a sealing means for sealingly engaging between an internal surface of a housing of the relief valve assembly and the jumper, the sealing means including an outer peripheral portion suitable for engagement with an internal surface of the housing and an inner peripheral portion adapted to engage with the outer periphery of the jumper and wherein the inner and outer peripheral portions are separated by a flexible portion facilitating relative movement of the inner and outer peripheral portions substantially transverse to a plane defined by said inner and outer peripheral portions.

Preferably, the inner and/or outer portions of said sealing means may include a boss around the perimeter of the sealing means.

Preferably, the inner peripheral portion may include a boss of substantially circular cross-section.

Preferably, the outer peripheral portion may include a boss of substantially U-shaped cross-section.

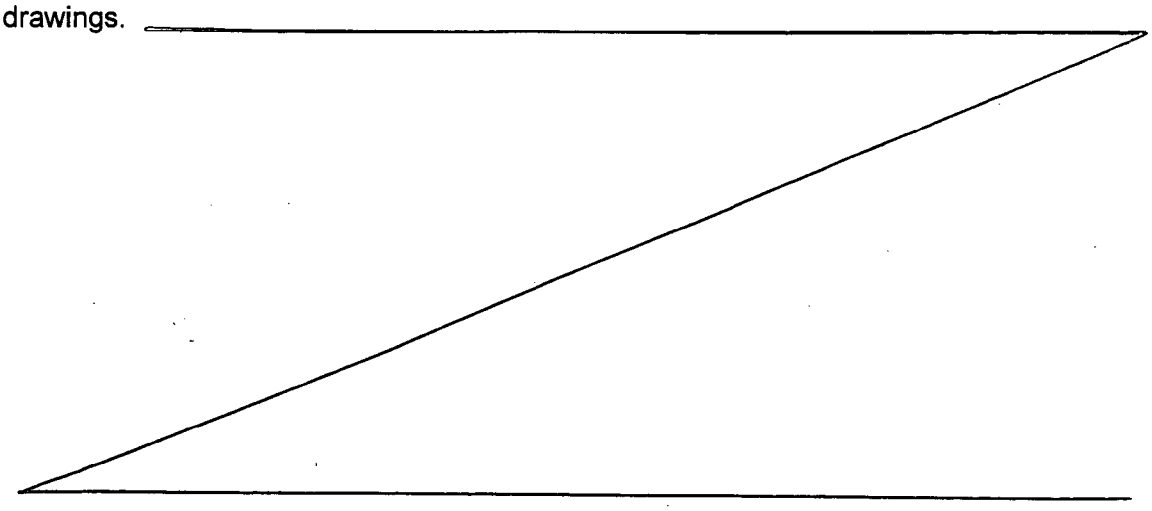
Preferably, the width of the flexible portion may be sufficient to allow the inner and outer peripheral portions to move relative to each other to an extent substantially equivalent to the expected movement of the jumper during use thereof.

Preferably, the valve seal is engaged with the jumper in such a manner that the jumper exerts substantially no compressive force on the valve seal when the valve seal is disengaged from the valve seat.

According to a fifth aspect of the invention, there is provided a method of constructing a jumper for a valve, the method including moulding a jumper body having a channel or groove in an integral sealing surface of the jumper and then moulding a valve seal into said channel or groove.

Preferably, the method may include chemically bonding the valve seal to the jumper body.

Further aspects of the present invention may become apparent from the following description, which is given by way of example only and in reference to the accompanying drawings.



Brief Description of the Drawings

Figure 1: shows a cut-away view of a pressure and temperature relief valve according to one embodiment of the present invention;

Figure 2: shows a cut-away perspective view of a jumper of the relief valve shown in Figure 1;

Figure 3: shows an exploded view of the jumper assembly of the relief valve of Figure 1; and

Figure 4: shows a cut-away perspective view of an alternative embodiment of the jumper of the relief valve shown in Figure 1.

Detailed Description of the Invention

Referring first to Figure 1, a cut-away view of a pressure and temperature relief valve according to one aspect of the present invention is shown. The relief valve of Figure 1 has been designed to conform to the Australian Standard 1357.1, which is hereby incorporated by reference in its entirety where appropriate. Therefore, the valve body 1 including an inlet chamber 2 and outlet chamber 6 have substantial similarities to the design in the Australian standard.

One distinguishing feature of the valve of the present invention is the auxiliary relief device 11, which is formed integrally with the valve body 1. As the auxiliary relief device 11 is not a separate component, the risk of a leak occurring through any engagement portions between a separate relief device with the body of the valve is avoided. Furthermore, the number of components to assemble is reduced, resulting in efficiencies in assembly and in the cost of manufacture.

The auxiliary relief device 11 includes an internal bore 14 to accommodate a spindle 12 and a washer 13. If the internal pressure within the outlet chamber 6 exceeds the resilience of the washer 13, which may occur should the outlet 6 become

blocked, the washer 13 deflects, allowing the spindle 12 and washer 13 to move into the bore 14 and open a passage from the inlet 2 to the vent hole 15.

To form the internal bore 14 and outlet 6, a machine tool may be applied from the opposite side of the relief valve through the end of outlet 6. This allows both the outlet 6 and bore 14 to be formed within the valve body 1 from one side of the valve, resulting in efficiency gains in production.

A valve member or jumper 3 is provided as part of a jumper assembly 4. The jumper 3 engages with a valve seat 5 to close the passageway between the inlet 2 and outlet 6. The jumper 3 is able to move linearly along its axis to engage and disengage the seal 16 with the valve seat 5. The valve seat 5 is sealingly engaged with the inner peripheral wall of the valve body 1, the sealing function assisted by a valve seat seal 7.

The jumper 3 is an integrally formed component and therefore leaks through the jumper 3 are avoided. The integral and continuous surface across the valve seat 5 prevents any leaks through the jumper 3. Also, the number of components of the valve are reduced by having an integrally formed jumper 3, reducing cost and simplifying assembly. The jumper 3 is formed by moulding a plastics or resin material into the required shape, which may include a channel or groove to accommodate the seal 16. The seal 16 is formed by moulding rubber or other flexible material directly into the jumper channel or groove. This seal 16 may be chemically bonded to the jumper 3 or bonded using any other appropriate technique known in the art, for example through the use of an adhesive or frictional or interlocking engagement.

Those skilled in the art may recognise that by bonding the seal 16 to the jumper 3, the seal 16 may be installed in a substantially unstressed state. In this way the only stress applied to the seal 16 is that induced by the compression spring 8 in forcing the seal 16 onto the valve seat 5. This stress reduction may reduce the instances of compression failure of the seal 16 compared to the valves of the prior art. The seal 16 may be bonded to the jumper using a suitable adhesive such as an alcohol based adhesive.

Typically, existing jumper assemblies comprise many components including a rubber washer. The components are riveted or screwed together. The compression applied to the washer during the assembly process will compress the rubber into any cavities within the assembly, creating the necessary water-tightness for valves correct function. If the cavities are not completely filled, or the rubber washer can deflect under water pressure, a leak will ensue.

Rubber can only withstand a certain compression load before yielding to failure. As extra loading is applied to the washer during final valve construction and during valve operation, it could be possible for assemble pre-loading with additional operational loading to exceed the compressive strength of the washer resulting in failure and subsequent leaks.

In the moulded jumper of the present invention, there is no stressing of the rubber washer prior to final valve construction.

Forming the jumper 3 from a plastic or resin may have a number of advantages including reduction in cost and ease of manufacture. A plastic jumper 3 may also prevent the buildup of mineral deposits such as calcium which may otherwise jam the jumper 3 in either an open or closed position.

Figure 4 shows a sectional view of an alternative embodiment of the jumper 3. In this embodiment the jumper 3' is has a groove 41 adapted to mechanically secure a seal 16'. The groove 41 may be shaped to retain the seal 16' without the need for an adhesive, for example by interlocking of the seal 16' and the jumper 3', although adhesive may be used to provide additional resistance to separation of the seal 16' from the jumper 3' and/or to prevent leakage past the seal 16' into the body of the valve. The jumper in Figure 4 has the disadvantage of providing a possible leak path around the seal 16'. This is in contrast to a moulded jumper such as the jumper 3 that presents a continuous integral surface across the valve seat.

In order to provide a closing force to seat the jumper 3 onto the valve seat 5, a compression spring 8 is provided between a cover 19 and an adjusting nut 24 engaged with a spindle 23. Thus, the compression spring 8 generates a downward force onto

the adjusting nut 24, which pushes the spindle 23 down onto the washer 32 (see Figure 3) and jumper 3, pressing it against the valve seat 5. Should the pressure at the inlet 2 exceed the force applied by the compression spring 8, then the jumper 3 will be forced upwards, allowing fluid to traverse from the inlet 2 to the outlet 6.

The adjusting nut is engaged with the jumper 3 so that rotation of the adjusting nut 24 upon rotation of the spindle 23 is prevented (see Figures 2 and 3). Therefore, the spring 8 is not rotated during adjustment, as the adjusting nut 24 moves axially without rotating. This avoids the problem of the spring binding or digging into the cover 19 and/or adjusting nut 24. In prior art relief valves, a washer is typically provided to overcome this problem and thus the valve of the present invention has a reduced number of components, reducing the cost of manufacture and assembly of the relief valve.

The adjustment of the relief valve should be completed during manufacture and the valve designed so that the user can not easily vary this once assembly has been completed. Therefore once the cap 28 has been placed over the cover 19, the spindle 23 is not accessible by a user without first disassembling the valve. Rotation of the cap 28 does not rotate the spindle 23 since it is free to rotate relative to the spindle 23. Washer 32 is provided to allow the rotation of the spindle 23 relative to the jumper 3. The washer 32 also provides the function of distributing the load applied by the spindle 23 over a larger area of the jumper 3. This allows the jumper 3 to be manufactured from less resilient material, in particular, a moulded plastic or resin material. This represents an opportunity for cost saving over the metal alloys typically used in prior art relief valves and the valves.

The washer 31 allows the spindle 23 to be raised together with the raising of the cap 28. To facilitate this, ramps 29, 30 are distributed around the perimeter of the cap 28 and cover 19 so that when it is rotated, the cap 28 moves upwards, pulling the spindle 23 upwards with it. The jumper 3 is therefore also allowed to move upwards, opening the valve to allow fluid to pass from the inlet 2 to the outlet 6. The washer 32 (see figure 3) may assist to pull the jumper 3 upwards when the pressure at the inlet 2 is insufficient to push the jumper 3 up. Thus, rotation of the cap 28 allows the relief valve to be flushed. As the compression spring 8 does not rest directly onto the jumper

3, the force applied to the jumper 3 is not increased during flushing as the additional force resulting from further compression of the spring is applied only to the adjusting nut 24. This is in contrast with prior art valves where the spring is applied directly onto the jumper 3. Therefore, the stresses applied to the jumper 3 are reduced.

A seal 20 is provided between the wall of the valve body 1 and the jumper 3. The seal 20 prevents fluid from traversing from the outlet 6 to contact the compression spring 8 and surrounding components. The seal 20 includes an inner peripheral portion 37 and an outer peripheral portion 36 (see Figure 3), both including thickened portions or bosses. The seal 20 includes a flexible portion between the inner and outer peripheral portions 37, 36, allowing relative movement between the inner and outer peripheral portions 37, 36. Thus, when the jumper 3 moves upwards, the inner peripheral portion of the valve 20 also moves upwards with it at least to a certain extent. This prevents or reduces dragging of the seal 20 along the outer surface of the jumper 3. As well as increasing the life of the seal 20, this action may also reduce inaccuracies in the valve caused by hysteresis, due to the reduction of drag applied to the jumper 3. Preferably, the width of the flexible portion between the inner and outer peripheral portions 37, 36 may be substantially the minimum to allow for movement of the jumper 3 during normal or typical use without the inner peripheral portion 37 sliding along the outer surface of the jumper 3.

The outer peripheral portion 36 is secured between the valve body 1 and the cover 19. Therefore, a single seal 20 provides the dual function of preventing fluid from traversing up the outer periphery of the jumper 3 and also seals against fluids escaping from the valve through the gap between the valve body 1 and cover 19. Preferably, the inner portion 37 of the seal 20 has a substantially annular cross-section, wherein the outer portion 36 has a substantially U-shaped cross-section as shown in Figure 3. In an alternative less preferred embodiment, the inner peripheral portion 37 may be secured to the jumper 3, with the outer peripheral portion frictionally engaging with the inner wall of the valve body 1.

In addition to the aforementioned pressure relief functions, the relief valve may also include a temperature relief function. This is accommodated using a standard temperature probe 9, which contains and expandable material such as wax, which

expands at higher temperatures, forcing a pin 10 within the temperature probe to move upwards. If the water temperature exceeds the set point of the probe, the pin 10 touches the bottom of the jumper assembly 4, causing the jumper assembly 4 to lift off the valve seat 5. This allows hot water to travel from the inlet 2 to the outlet 6. The probe 9 is supported in the valve by a cantilever 34 that protrudes from the inside wall of the inlet 2.

To assemble the valve, the jumper 3, spindle 23, compression spring 8, adjusting nut 24 and cover 19 are first assembled and then inserted over the valve body 1. A flange 21 of the valve body 1 is then swaged over so as to engage the cover 19. The spindle 23 is then rotated to adjust the set pressure of the valve, after which the cap 28 and washer 31 are secured to the spindle 23.

Referring to Figure 2, an enlarged cut-away perspective view of the jumper 3 and washer 16 is shown. The jumper 3 includes a number of channels or grooves 25, in this case six, around its inner periphery. These receive corners of the adjusting nut 24, allowing it to linearly move up and down the jumper 3, but not rotate relative to the jumper 3. Protrusions in the forms of fins 17 are provided around the outer periphery of the jumper 3, which are accommodated by corresponding channels or grooves 18 in the cover 19 to prevent rotational movement of the jumper 3. Therefore, since neither the adjusting nut 24 nor jumper 3 can rotate, the compression spring 8 can also not be rotated due to rotation of the spindle 23.

A washer 32 is provided to engage with the protrusions 39 in an interlocking manner. The lower internal surface 33 of the jumper 3 has a tapered surface to support the washer 32 and distribute the load applied by the spindle 23, allowing less resilient materials to be used to manufacture. In a preferred embodiment as presently contemplated the lower surface has a substantially conic-shaped vertical section.

Figure 3 shows an exploded view of a portion of the relief valve. The cover 19 includes channels or grooves 18 to receive the fins 17 of the jumper 3. Bosses 26 and 27 are provided on the cover 19 and adjusting nut 24 to support the compression spring 8 in place. This prevents the compression spring 8 from moving off axis. In combination with a lack of rotation of the jumper 3, the jumper 3 rests on the valve seat

5 in the same position each time. This allows the valve seat 5 and seal 16 to conform to each others shape, creating a better seal and improving the seal obtained upon reseating.

Two flats 22 are provided on the spindle 23 to allow for adjustment during assembly of the relief valve. A thread 40 is provided to engage with a corresponding thread of the adjustment nut 24 to allow the position of the adjustment nut 24 to be varied by rotating the spindle 23. The adjusting nut 24 includes six faces 35, the corners of which are received by the channels or grooves 25 of the jumper 3 to guide its movement along the spindle 23 and prevent rotational movement.

Thus, there is provided a pressure temperature relief valve having features including a jumper that is integrally formed, which has a moveable seal around the periphery of the jumper, allows adjustment of the valve without rotation of the spring and allows flushing of the valve without applying excess pressure to the jumper.

Where in the foregoing description, reference has been made to specific components or integers of the invention having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be understood that modifications or improvements may be made thereto without departing from the scope of the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A jumper for a valve assembly, wherein the jumper includes an integral moulded body including a channel or groove in which a valve seal has been moulded.

2. The jumper of claim 1, wherein the valve seal is chemically bonded to the moulded body.

3. A relief valve assembly including a housing having an inlet, an outlet and a passageway interconnecting the inlet and outlet, a valve seat, and a jumper according to claim 1 or claim 2, wherein the jumper is moveable to engage and disengage the valve seal with the valve seat, thereby respectively closing or opening the passageway.

4. A relief valve assembly including a housing having an inlet, an outlet and a passageway interconnecting the inlet and outlet, a valve seat and a jumper including a moulded body including a channel or groove in which a valve seal has been moulded, wherein the jumper is moveable to engage and disengage the valve seal with the valve seat thereby respectively closing or opening the passageway.

5. The valve assembly of claim 4 wherein the jumper is constructed from a plastic or resin material.

6. The valve assembly of claim 4 or claim 5 wherein the valve seal has been moulded into a channel or groove within said jumper.

7. The valve assembly of any one of claims 4 to 6 wherein the valve seal is chemically bonded to said jumper.

8. The valve assembly of any one of claims 4 to 7 wherein the valve assembly includes a sealing means sealingly engaged between an internal surface of the housing and an outer surface of the jumper, the sealing means including an outer

peripheral portion engaged with the housing and an inner peripheral portion engaged with the jumper and wherein the sealing means includes a flexible portion between said inner and outer peripheral portions to facilitate relative movement between the inner and outer peripheral portions parallel to the movement of the jumper in use to engage and disengage the valve seal from the valve seat.

9. The valve assembly of claim 8 wherein the width of the flexible portion of the sealing means is sufficient to allow the inner and outer peripheral portions to move relative to each other to an extent substantially equivalent to the movement of the jumper relative to the housing in use.

10. The valve assembly of claim 8 or 9 wherein the width of the flexible portion is substantially the minimum required to allow relative movement of the inner and outer peripheral portions to substantially the same extent as the relative movement of the jumper and housing in use.

11. The valve assembly of any one of claims 8 to 10 wherein the outer peripheral portion of the sealing means is secured to the housing and the inner peripheral portion frictionally engages with the jumper.

12. The valve assembly of any one of claims 8 to 11 wherein the inner and outer peripheral portions of the sealing means include a boss extending around the periphery of said sealing means.

13. The valve assembly of any one of claims 8 to 12 wherein the outer portion of the sealing means is engaged between two portions of the housing.

14. The valve assembly of any one of the preceding claims wherein the jumper forms part of a jumper assembly including the jumper, a spindle engageable with the jumper and an adjusting nut including a thread engaged with a corresponding thread on the spindle, wherein the adjusting nut is slideably engageable with the jumper thereby allowing movement of the adjusting nut along the axis of the spindle and preventing rotational movement of the adjusting nut in use and wherein the jumper is adapted to engage with the housing of the relief valve in a manner preventing rotational movement of the jumper.

15. The valve assembly of claim 14 wherein the spindle engages with the jumper at least partially through a washer engaged with the spindle, wherein the jumper includes a tapered surface adapted to receive the washer.

16. The valve assembly of claim 15 wherein the tapered surface has a conical or annular vertical section.

17. The valve assembly of any one of claims 14 to 16 wherein the jumper includes at least one protrusion extending from an outer surface thereof and the housing includes one or more receptacles to accommodate the protrusion so as to constrain the jumper to move substantially linearly substantially along one axis.

18. A relief valve assembly as claimed in any one of claims 3 to 17, further including a sealing means for sealingly engaging between an internal surface of a housing of the relief valve assembly and the jumper, the sealing means including an outer peripheral portion suitable for engagement with an internal surface of the housing and an inner peripheral portion adapted to engage with the outer periphery of the jumper and wherein the inner and outer peripheral portions are separated by a flexible portion facilitating relative movement of the inner and outer peripheral portions substantially transverse to a plane defined by said inner and outer peripheral portions.

19. The relief valve assembly of claim 18 wherein the inner and/or outer portions of said sealing means include a boss around the perimeter of the sealing means.

20. The relief valve assembly of claim 18 or 19 wherein the inner peripheral portion includes a boss of substantially circular cross-section.

21. The relief valve assembly of any one of claims 18 to 20 wherein the outer peripheral portion includes a boss of substantially U-shaped cross-section.

22. The relief valve assembly of any one of claims 18 to 21 wherein the width of the flexible portion is sufficient to allow the inner and outer peripheral portions to move relative to each other to an extent substantially equivalent to the expected movement of the jumper during use thereof.

23. The relief valve assembly of any one of the preceding claims, wherein the valve seal is engaged with the jumper in such a manner that the jumper exerts substantially no compressive force on the valve seal when the valve seal is disengaged from the valve seat.

24. A method of constructing a jumper for a valve, the method including moulding a jumper body having a channel or groove in an integrally moulded sealing surface of the jumper and then moulding a valve seal into said channel or groove.

25. The method of claim 24 further including chemically bonding the valve seal to the jumper body.

26. A relief valve assembly substantially as herein described with reference to Figures 1, 2 and 3 or Figure 4.

DATED this 21st day of June, 2004
BALDWIN SHELSTON WATERS
Attorneys for: METHVEN LIMITED

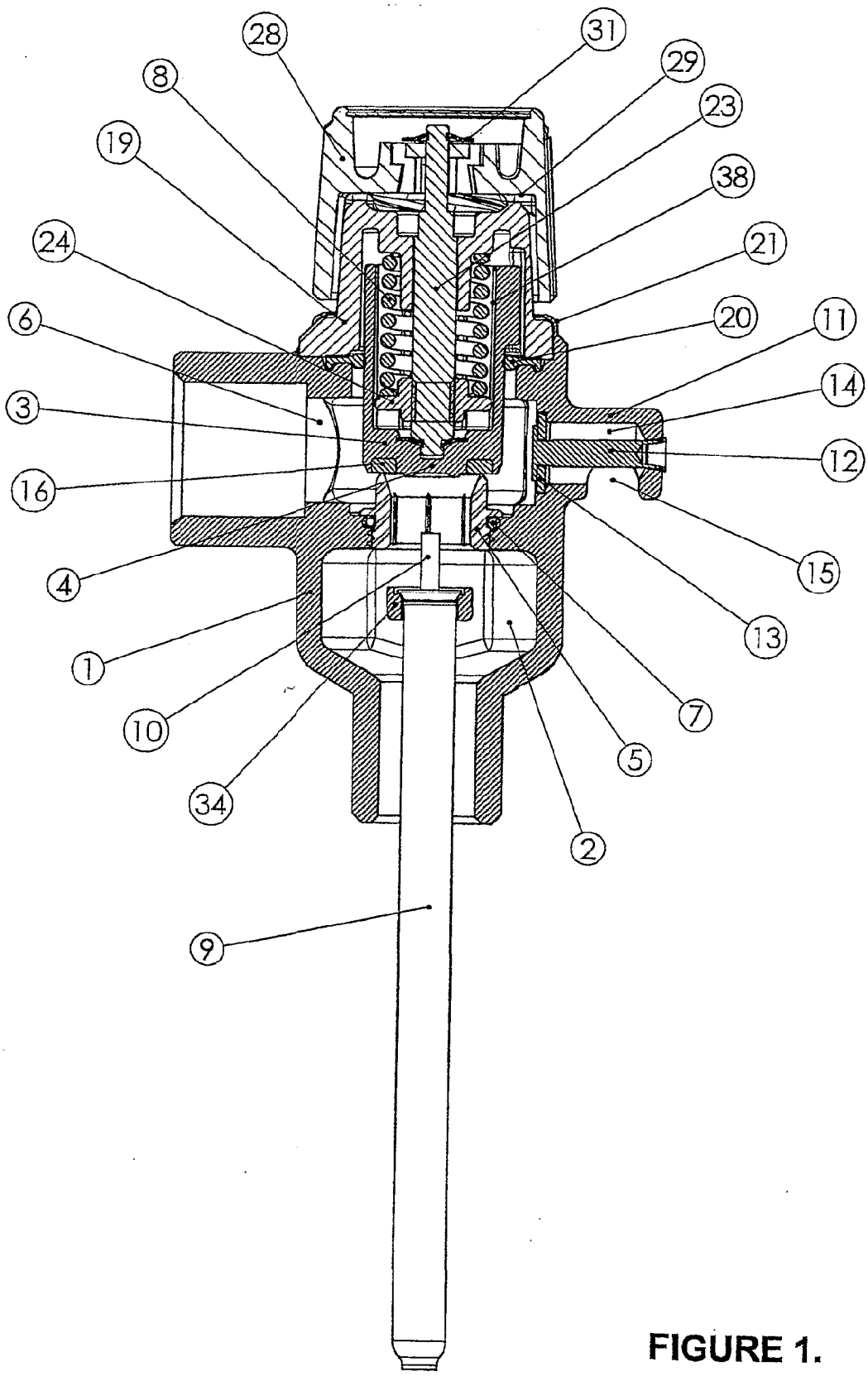


FIGURE 1.

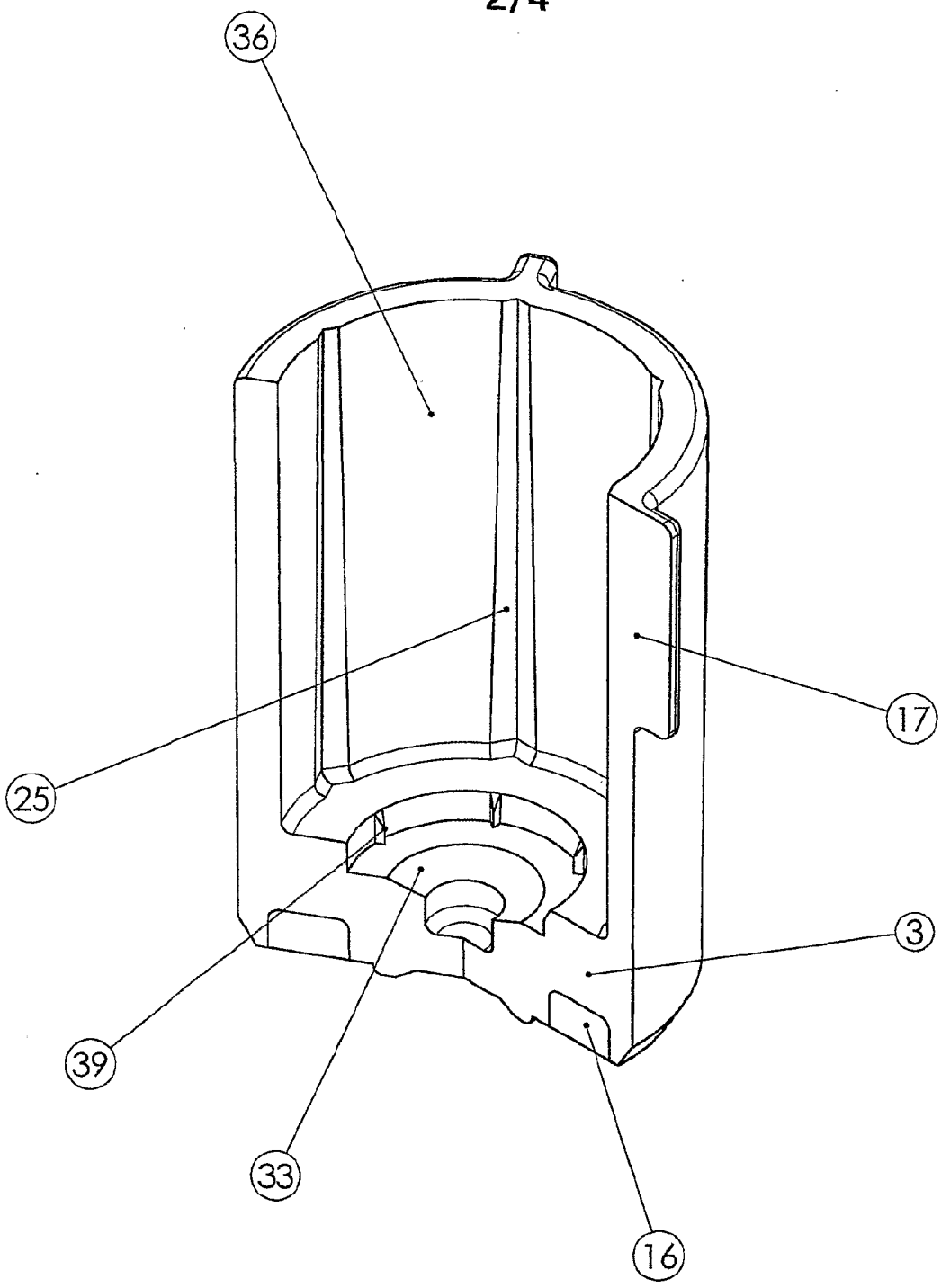


FIGURE 2.

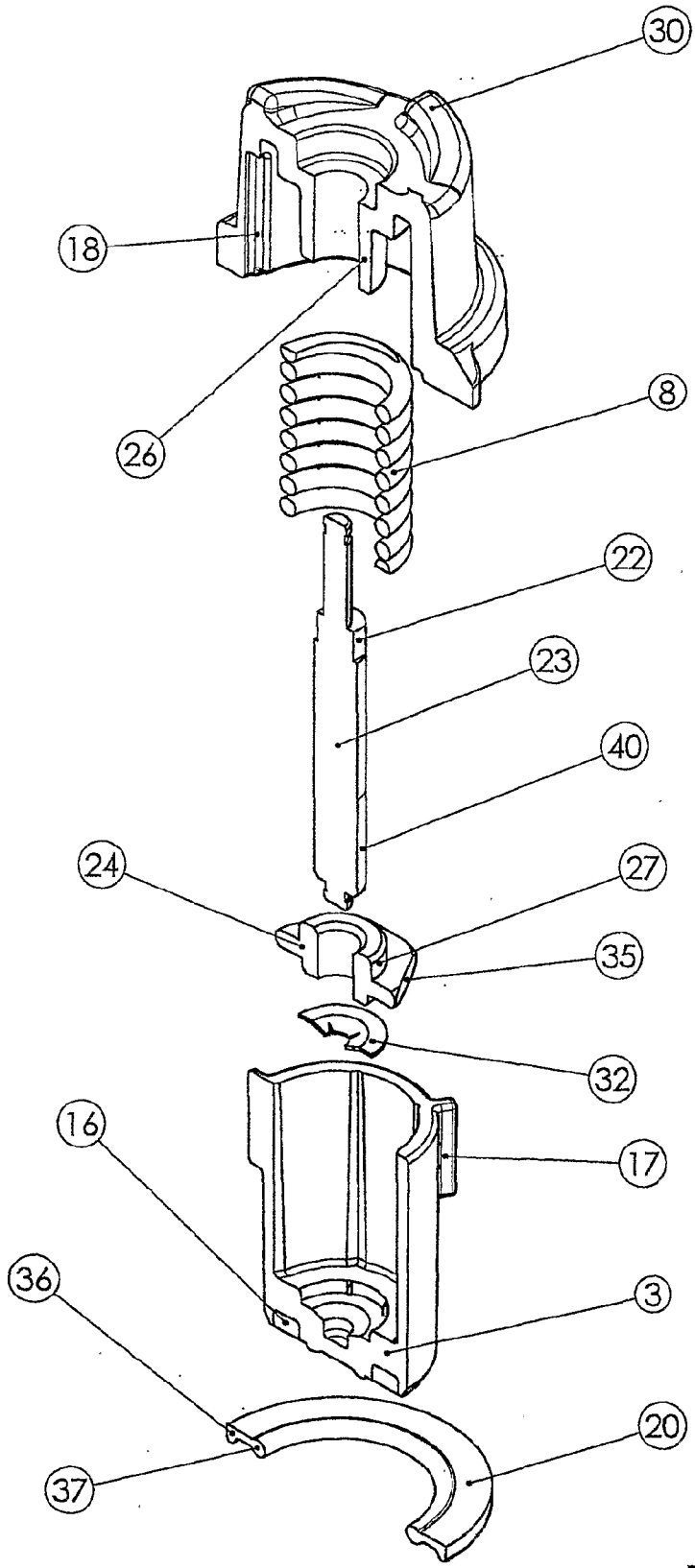


FIGURE 3.

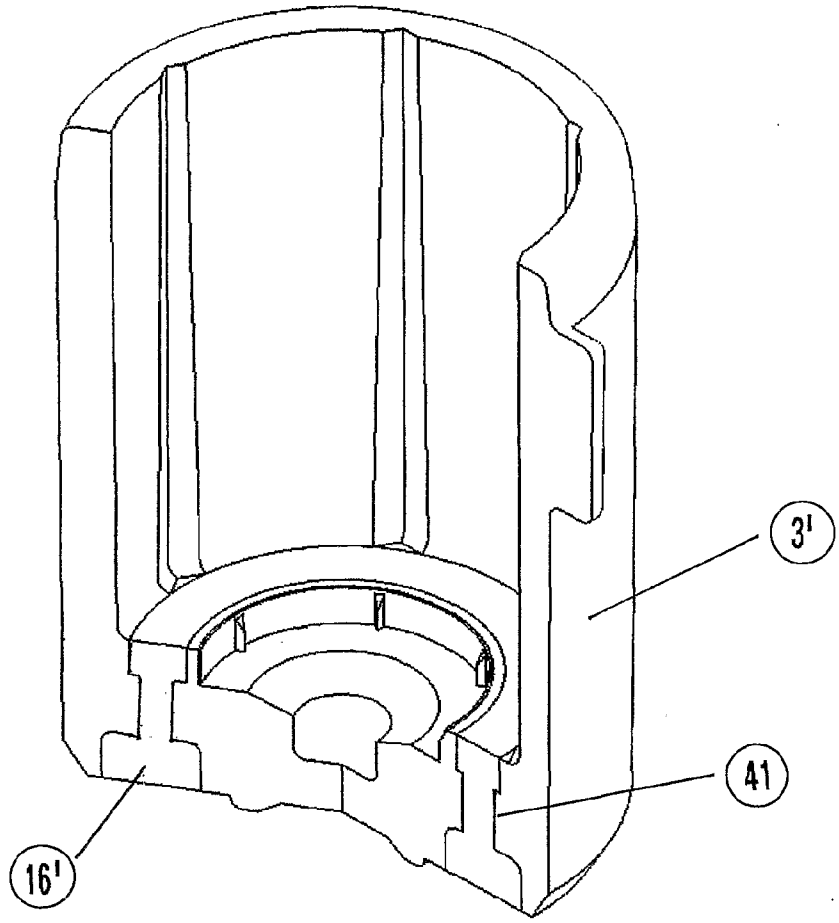


FIGURE 4.