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(56) Documents Cited:
GB 2220049 A **US 5113891 A**
US 4848389 A **US 4815491 A**
US 20050092663 A1

(58) Field of Search:
INT CL **E03B, F16K**
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(54) Title of the Invention: **Plumbing protector**
Abstract Title: **Prevention of freezing in plumbing**

(57) A protective device that isolates part of a plumbing or fluid flow system by stopping supply of fluid in the event of freezing conditions comprises a valve 1 and a spring actuator (4, Fig. 4) for actuating the valve. The actuator biases the valve to a closed position but is restrained from doing so by restraining means in above freezing conditions, so that the valve remains normally open. The restraining means comprises a frangible vessel 3 that contains a trapped volume of liquid that may be the same as that which flows in the system (e.g. water for a plumbing system). The vessel will break on freezing expansion of the liquid and allow the actuator to close the valve.

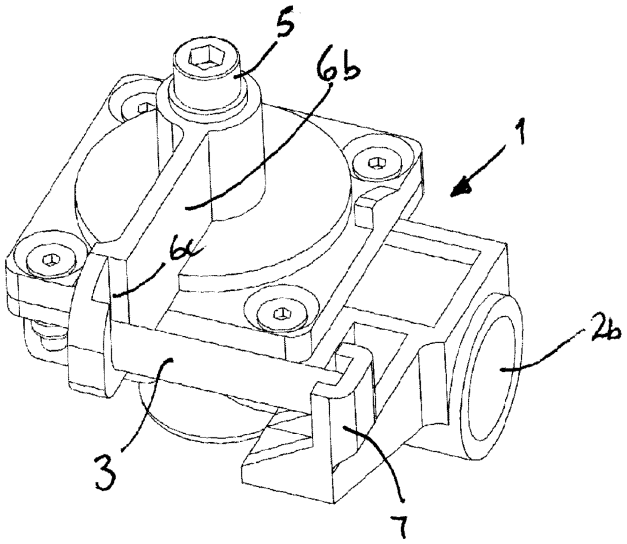

Figure 1

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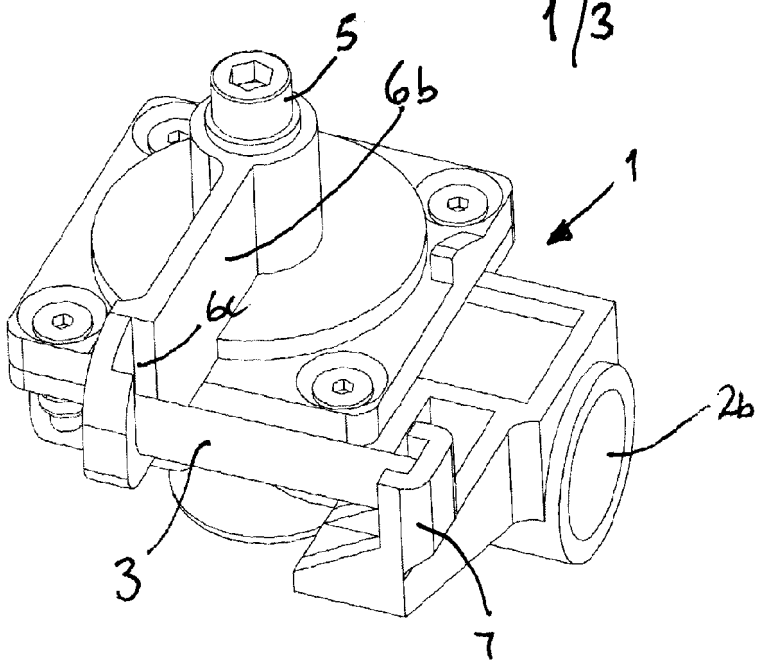

Figure 1

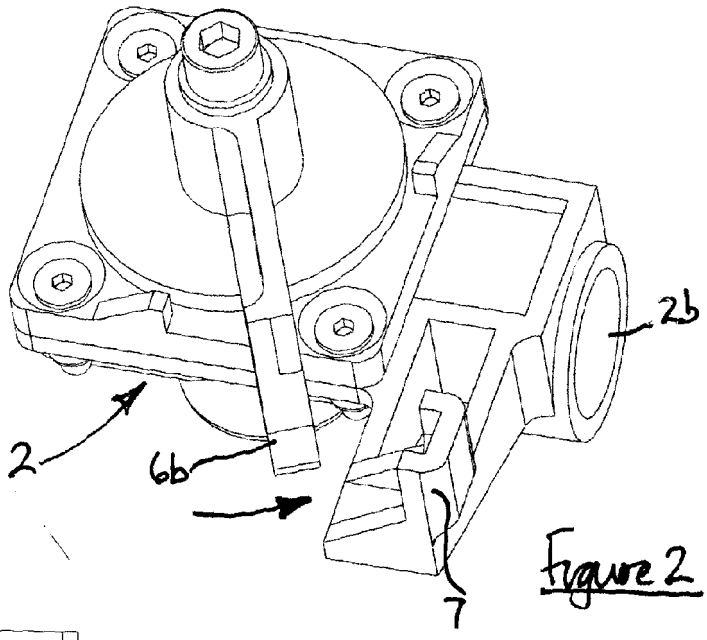

Figure 2

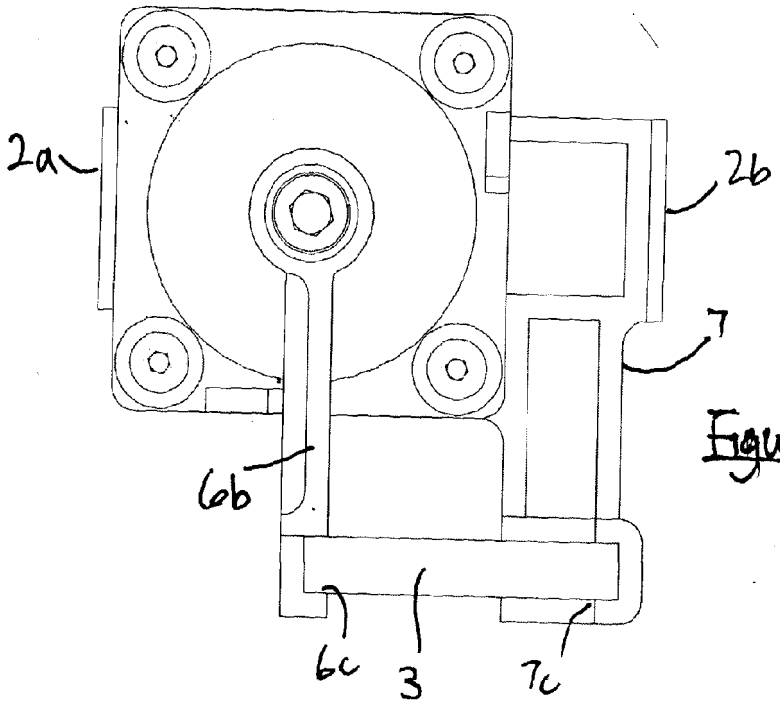

Figure 3

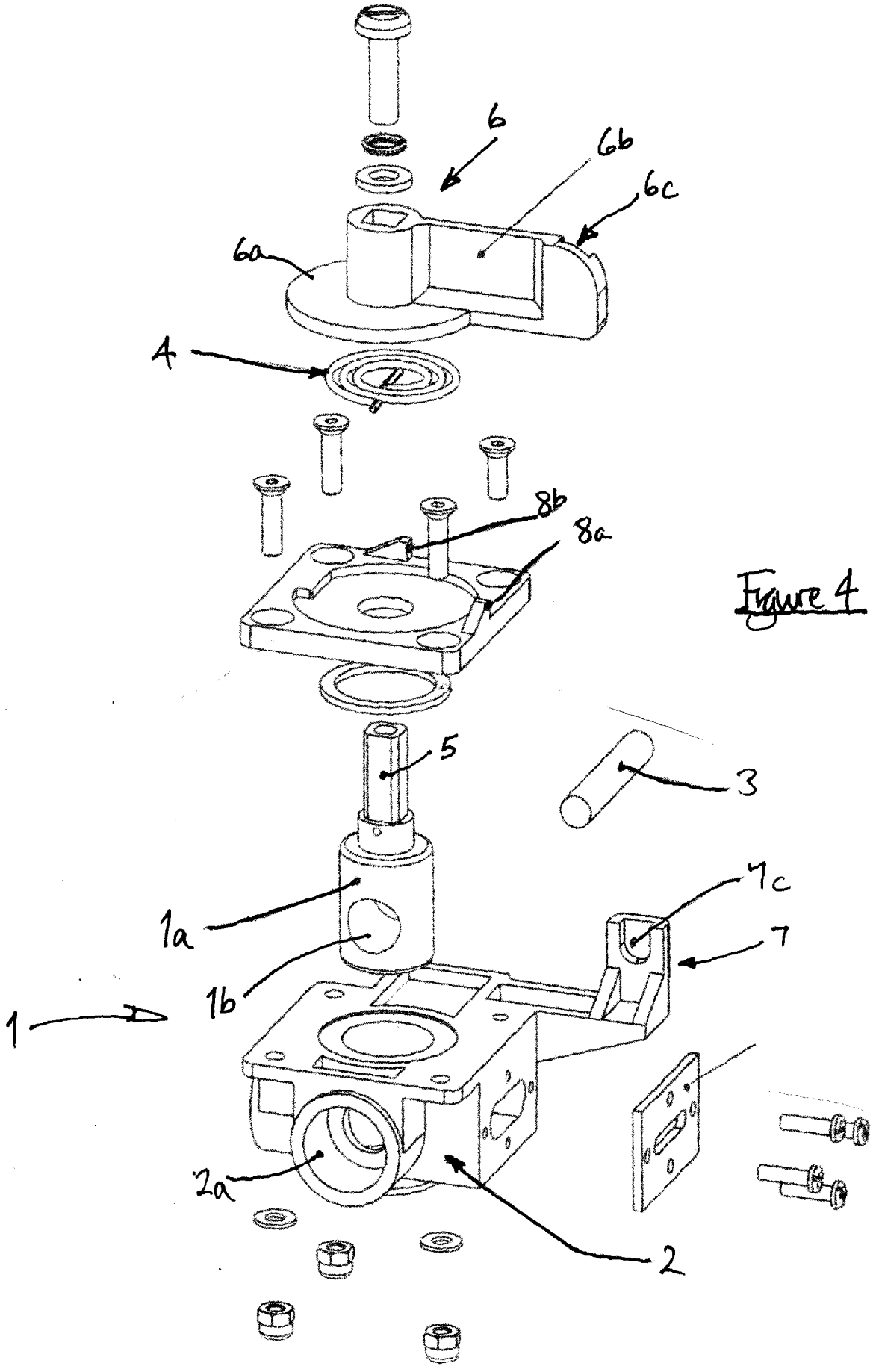

Figure 4

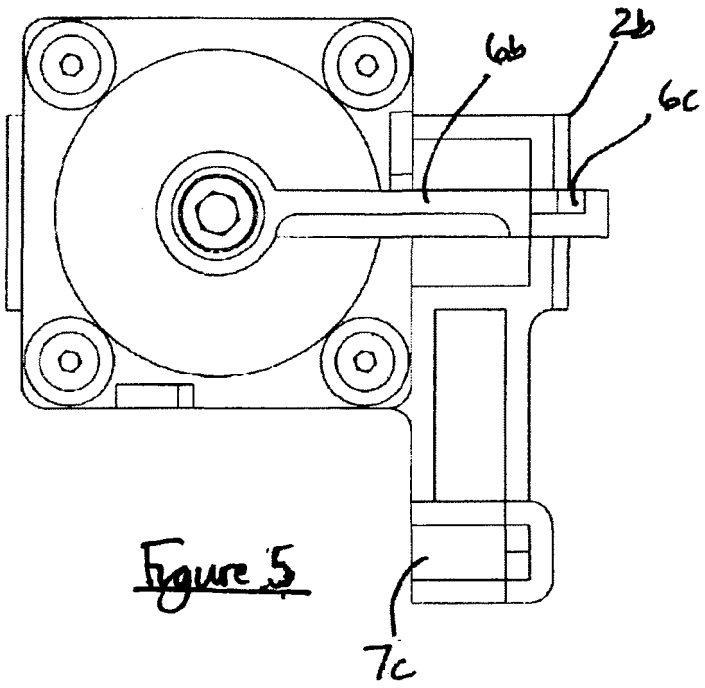

Figure 5

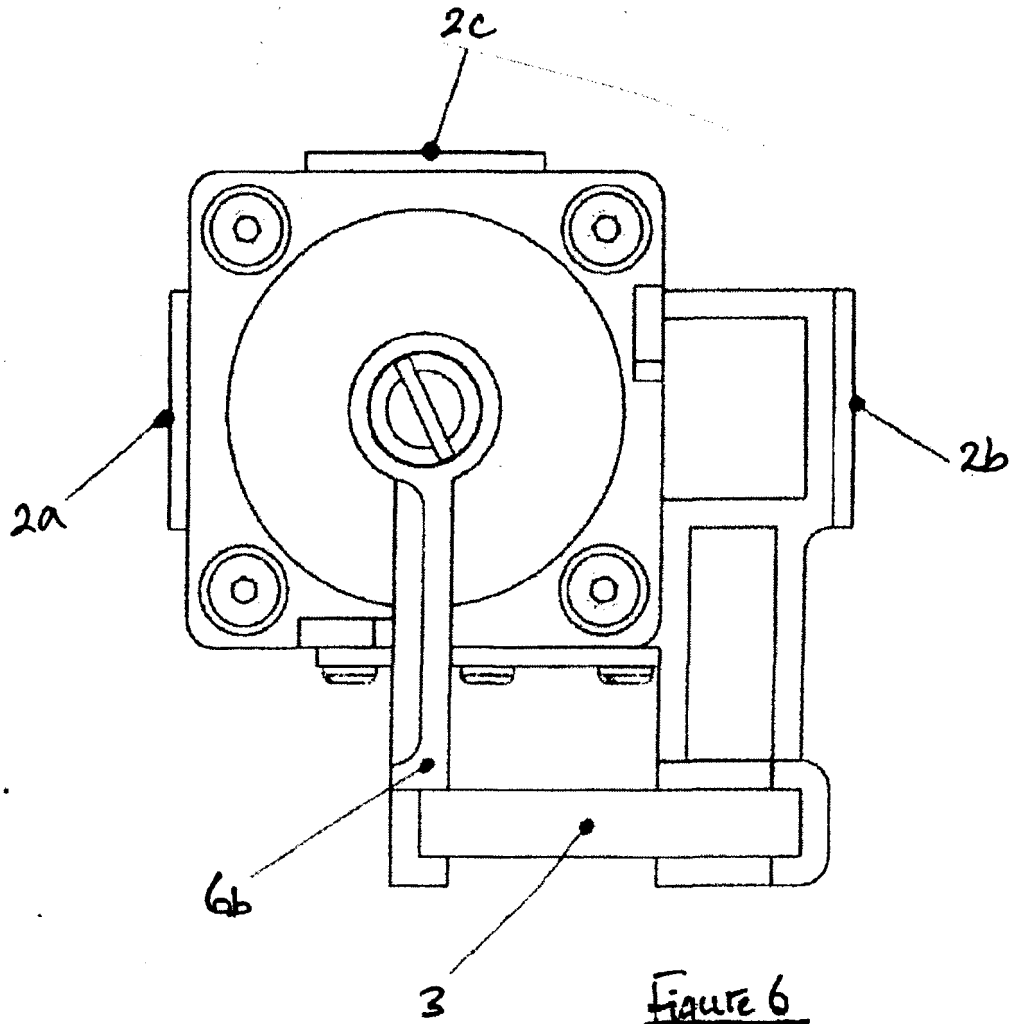

Figure 6

Plumbing Protector

Field of the Invention

The present invention concerns plumbing protection devices and especially valves, and actuators for valves, to isolate plumbed systems to protect against the effects of freezing.

Background of the Invention

The bursting of water pipes due to freezing of water within the pipes represents a major problem both nationally and internationally and extends across all property types including domestic, industrial and commercial. A large proportion of the vast annual insurance payouts in the UK alone relate to flood damage caused by the fracturing of pipes in freezing conditions.

The problem arises whenever the ambient temperature falls below the freezing point of water causing standing (non flowing) water within a pipe or vessel to freeze. Since frozen water is approximately 10% greater in volume than liquid water, on freezing it is liable to apply immense forces on any restriction that doesn't allow for this volumetric expansion. In the case of plumbing the restrictions are determined by the features and dimensions of the plumbing (pipes and fittings) including closures due to valves / taps and other flow preventing elements. The freezing water applies more than enough pressure to split or burst a pipe. Whereas a resulting flood will not occur at the time of freezing and bursting of the pipe, as soon as the ambient temperature rises sufficiently to thaw the frozen water it will be released to flood out of the damaged pipework. Where the water in the pipes is under continuous pressure of supply it will continue to flood out of the fracture until remedial action is taken to stop the supply or the fracture is sealed closed.

Shutting off a valve to stop the flow of water in this situation is traditionally a manual job, where the responsible person must first locate the valve (eg water supply stopcock) and turn it by hand to the off position. One major problem with

this is that the emergency will often be occurring when the responsible person, eg the home-owner, is absent from the property and not there to know of the problem and to shut the supply of water off. With a burst pipe it is, of course, important to be able to shut the supply to the fractured pipe down as soon as possible to minimise damage. If, for example, the homeowners are away at work, or on holiday or visiting family and friends, or if the premises are business premises and the proprietor is a company that doesn't work at weekends or are on a period of shutdown a burst pipe can run for hours, days or even weeks causing catastrophic flood damage.

At present, there are only a handful of systems on the market that can shut off plumbing valves automatically and most rely on electronics and sensors and therefore introduce electrics into a plumbing problem. Apart from the electrical side of these solutions having their own set of potential failings such as power cuts, all current commercial solutions are system based and all carry a significant cost to implement. Although mechanical devices have been proposed, such as disclosed in US5113891 to automate isolation of pipe-work/ plumbing in the event of freezing conditions to prevent flooding, these generally rely on the expansion of a volume of ice to directly power the movement of a valve actuator – an approach that is particularly difficult to get to worlk reliably in practice.

It is thus an objective of the present invention to provide a simple practical, mechanical device to reliably automate isolation of pipe-work/ plumbing in the event of freezing conditions to prevent flooding.

Summary of the Invention

According to a first aspect of the present invention there is provided an actuator for a valve to isolate a part of a plumbing system/ fluid flow system to protect against the effects of freezing by stopping supply of fluid in the event of freezing conditions, the device comprising an actuator member for actuating the valve and the actuator member being biased to move the valve to closed but restrained therefrom by restraining means in normal (above freezing) conditions

so that the valve remains normally open, the restraining means comprising a frangible vessel that in use contains a trapped volume of liquid that suitably is the same liquid as flows in the system (e.g. water for a water flow system) whereby the restraint will collapse on freezing expansion of the liquid and allow the actuator to close the valve. The frangible vessel functions, in a sense, like a thermal fuse that blows when the temperature drops too low and that allows the valve actuator to move to its closed state stopping further fluid flow through the pipe-work. The vessel has a small cross sectional area and walls that are weak enough to be shattered by the expansion of the liquid contents on freezing and so that the restraint collapses, but strong enough to resist the force of the resilient biasing means prior to that point. This can be readily engineered and operates very reliably in practice.

The vessel can enable the trigger point (temperature) for closure of the valve to be adjusted by selection of the materials, shape and dimensions of the vessel and/ or by the composition of the liquid content of the vessel too. This latter adjustability might be by using different liquids or using mixtures of liquids or doping the liquid with solids. The valve can be made to reliably close when the temperature drops close to freezing point of the flowing liquid in the plumbing system but before the liquid in the plumbing freezes. The small size and static nature of the volume of liquid in the vessel relative to that supplied to the plumbing system ensures prior breakage and collapse of the vessel before the liquid in the plumbing freezes.

Particularly preferably the actuator is rotary, i.e. an actuator that revolves or moves through an arc of a circle (e.g. through 90 degrees) to close the valve. It may, for example, be a ball valve or cylindrical in form. The corresponding biasing means is preferably a resilient biasing means such as a torsion spring that suitably is coiled around the axis of rotation of the rotary actuator. This suitably rotates a rotary valve member.

The rotary actuator preferably comprises a rotor arm or a fin that projects radially outwardly and turns with the body of the rotary actuator. The frangible vessel preferably is positioned between the arm or fin and a fixed surface – eg a

shoulder of an outer structure of the device – so that the vessel opposes the spring-driven turning of the rotary actuator body and its arm. The surface preferably is formed as a recess or socket as a receptacle for an end of the frangible vessel.

The device preferably has a pair of end stop protrusions or walls to limit the turning of the arm and suitably to define the fully opened and fully closed positions of the valve. These end stop protrusions or walls are suitably provided on an outer face of the actuator body.

In a preferred embodiment the device comprises an actuator for a valve in combination with a valve and preferably the device has a housing that accommodates the valve and the actuator is provided in or on the housing. The actuator may be integral to the valve or separate from it.

The device may, however, be supplied as an actuator only for fitting (eg retro-fitting) to a valve or simply as a part for an actuator comprising a frangible vessel to be fitted to such an actuator or as a kit comprising at least a resilient biasing means an actuator arm and a frangible vessel.

The frangible vessel is suitably a vial or ampoule. It may be of glass or Bakelite or other brittle plastics / brittle materials and is configured to have the required restraint and breakage performance characteristics. The vessel may be provided with an opening sealed by a closure to allow user filling or else it may be factory pre-filled and moulded/ heat sealed closed.

Brief Description of the Drawings

A preferred embodiment of the invention will now be more particularly described, solely by way of example, with reference to the accompanying drawings in which:

Figure 1 is an isometric view from above of the plumbing protection device in its normal operation/ primed state with a frangible vessel fitted in place restraining the valve from closing;

Figure 2 is an isometric view from above of the device following removal of the

frangible vessel (eg by shattering of the vessel on its contents freezing) so that the actuator begins to swing in the closure direction under the force of the spring;

Figure 3 is a plan view of the device in its normal / primed state from above;

Figure 4 is an exploded general assembly diagram of the device showing each of the components, including the rotary valve actuator and rotary valve and the frangible vessel;

Figure 5 is a plan view from above of the device in its shut-down state, following disintegration of the vessel;

Figure 6 is a plan view from above of a preferred variant of the device in its normal operation/ primed state, this variant being provided with a valve having a second outlet port for pressure relief of the downstream plumbing when the valve moves to close off the supply and thereby preventing damage to the downstream plumbing.

Description of the Preferred Embodiment

Referring to the Figures, the device of the present invention is especially suitable for use in a water supply plumbing system (eg a domestic plumbing system for water distribution to taps, dish washers, washing machines et cetera) to protect against flood damage from pipe breakage in freezing weather. The device is formed as a unitary assembly comprising a valve 1, a spring actuator and a frangible (breakable) restraint 3 for the spring actuator – being a vessel 3 that contains a fluid (water) that will break the vessel 3 when the ambient temperature drops to the freezing point.

The valve 1 of the device comprises a cylindrical rotary valve member 1a, like a ball valve but cylindrical, with a passage 1b therethrough and rotatably mounted in a valve body 2. The version of valve 1 shown in Figures 1 to 5 has a simple straight linear passage and the valve body 2 has two ports, an inlet port 2a on one side and an outlet port 2b on the other side and which are placed in fluid communication with each other by the passage in the valve member 1a during

normal conditions (ie while ambient temperature is above the freezing point of the fluid).

The valve 1 is actuated by a resilient biasing means/ torsion spring 4 and has a valve stem 5 that extends axially from the valve member 1a (along the axis of rotation of the valve member 1a) and which has the torsion spring 4 assembled around it and impinging on the stem 5 to turn the stem 5 in a direction of rotation that will move the valve member 1 to close the passage 1b. The valve stem 5 has a rotor 6 comprising a rotor plate 6a and integral radially outwardly projecting arm/ fin 6b, the rotor 6 being fitted as a collar on the stem 5. The rotor 6 is keyed to the valve stem 5 to turn therewith, since the latter has a squared profile and the rotor 6 has a squared internal bore. The purpose of the rotor 6 is to act as a latch that holds the valve 1 open. The arm/ fin 6b of the rotor 6 latches against the frangible restraint 3 and keeps the valve 1 open permanently all the while that the restraint 3 is intact and in place.

The frangible restraint 3 is exemplified by a factory pre-filled vial/ ampoule that contains water and is sealed closed. It may have a circular cylindrical shape as illustrated and in one functioning embodiment is of glass that is of 0.9mm wall thickness and which has a length of 40mm and diameter of 7mm. The restraint 3 is configured for the walls to shatter and for it to collapse when the water in the vessel freezes and expands. The restraint 3 is held on the device by an end mount/ receptacle 7 at one end and at the other end by the rotor arm/fin 6b. The end abutting the rotor arm/fin 6b may fit in a recess/ slot 6c or other socket at or near the outer end of the rotor arm/fin 6b or simply be gripped by the rotor arm/fin 6b pressing against it. The end mount/ receptacle 7 has a recess/ slot 7c or other socket for the end of the restraint frangible vessel 3 and it projects tangentially to the axis of rotation from the device's body.

As noted earlier, the device here is a spring return valve that is held in an open state by the restraint frangible vessel 3 that comprises a glass tube filled with a small amount of water. The restraint frangible vessel 3 holds a much smaller volume than that in the pipe plumbed to the valve outlet port 2b, therefore when the ambient temperature falls to freezing point the water inside the vessel 3 will naturally freeze before the greater volume of water in the pipe. The freezing

process will easily break the glass body of the vessel 3 causing it to fall away. The torsion spring 4 will then return the valve member to the closed state as the rotor arm 6b is no longer detained and able to swing through a 90 degree arc until it abuts an end stop 8b that limits it from rotating further (see Figure 5). The rotation of the arm 6b through 90 degrees moves the valve from fully open to fully closed in this embodiment. As will be appreciated, this first embodiment two port device will not prevent pipes from bursting but will stop the ensuing flood damage since the ongoing supply of water is blocked.

Turning to Figure 6, a three port valve device is shown that adds to the device the ability to prevent damage to the plumbing/ pipework. This device provides a third port 2c on the valve body 2. This third port 2c is brought into fluid communication with the downstream plumbing/ pipework when the valve 1 is in its closed state. In the valve 1 closed state the supply from port 2a is shut-off and the outlet port 2b is brought into fluid communication by the valve passage 1b with the third port 2c. This third port 2c gives pressure relief to the downstream plumbing/ pipework, so that ice formed in that pipework will on volumetric expansion be able to spread out and not constrained thereby relieving pressure on the pipe walls.

The device of the present invention in the form described and illustrated is a compact and relatively simple product in the form of a valve with inlet and outlet and that can be plumbed into any water pipe with existing plumbing fittings. A blown 'fuse' (frangible vessel 3) can easily be visually identified and the valve 1 can be reset with a replacement fuse in seconds. Installation of this device can be carried out by DIY enthusiasts and professionals alike, with absolutely no specialist skills required. The fuse can be supplied separately of the unit, but suitably is supplied to the user/ installer with at least one and preferably a spare included in the kit.

The user can readily install the device and prime it. To set the valve 1, the rotor arm 6b is rotated through 90 degrees to an end stop 8a. The rotor 6 is under tension from the torsion spring 4. To hold it in this set position, the frangible

vessel/ fuse 3 is placed between the rotor arm 6b and the end mount/ receptacle 7. The valve 1 is now set and inlet port 1 is now connected directly to the outlet port 2. Outlet port 2 is cut off from relief port 3. During a freeze, the water within the frangible vessel/ fuse 3 expands and breaks the glass from which it is made. When this happens, the valve 1 automatically returns to its closed position under the pre load spring tension. This shuts of mains pressure in the circuit by cutting off supply from inlet port 1 to outlet port 2; and it connects the existing water in the system beyond the valve 1 to the relief port/ third port 2c, which acts like a vent. Thus when the water inside the pipe freezes and starts to expand it will do so in the direction of least resistance and is allowed to exit the system via relief port 3. This relieves the pipes from any internal pressure and therefore preventing a burst. After the valve 1 has been actuated to the closed state it will require a manual reset utilising a new frangible vessel/ fuse 3.

Further developments may include utilising the basic mechanical elements of the valve 1 and/or 'fuse' 3 to actuate a built in electronic switch that can enable a signalling device to warn the owner that this has happened. This could be via mobile phone signal (utilising a built in SIM card) or via WiFi, for example. Any such built in electronics may be powered either by the use of a mains plug or battery or other means. In short, the device may include a communication system whereby the spring return mechanism operation, eg the rotary movement, activated by the fuse breakage can actuate a small self contained switch and transmitter (Battery Powered) sending a signal (wirelessly or otherwise) to another valve, device or system.

Claims

1. A device to isolate at least a part of a plumbing system/ fluid flow system to protect against the effects of freezing by stopping supply of fluid in the event of freezing conditions, the device comprising an actuator for actuating a valve and the actuator being biased to move the valve to closed but adapted to be restrained therefrom by restraining means in normal (above freezing) conditions so that the valve remains normally open, the device having a part to receive a said restraining means, the restraining means being a frangible vessel that in use contains a trapped volume of liquid that suitably is the same liquid as flows in the system (e.g. water for a water flow system) whereby the vessel will break apart on freezing expansion of the liquid and allow the actuator to close the valve.

2. A device as claimed in claim 1 in combination with a said restraining means that is a frangible vessel.

3. A device as claimed in claim 1 or 2 further in combination with a valve.

4. A device as claimed in claim 1, 2 or 3, wherein the actuator is rotary, ie an actuator that revolves or moves through an arc of a circle to close the valve.

5. A device as claimed in any of claims 1 to 4, wherein the biasing means is a resilient biasing means.

6. A device as claimed in claim 4 and 5, wherein the resilient biasing means is a torsion spring that is coiled around the axis of rotation of the actuator.

7. A device as claimed in claim 4 or 6, wherein the actuator comprises a rotor arm or fin that projects radially outwardly and turns with the body of the rotary actuator.

8. A device as claimed in claim 7, wherein the frangible vessel is positioned between the arm or fin and a fixed surface so that the vessel opposes the spring-driven turning of the rotary actuator body and its arm.

9. A device as claimed in claim 8, wherein the surface is formed as a recess or socket as a receptacle for an end of the frangible vessel.

10. A device as claimed in claim 7 or 8 or 9, wherein the device has a pair of end stop protrusions or walls to limit the turning of the arm and to define the fully opened and fully closed positions of the valve.

11. A device as claimed in claim 3, wherein the valve comprises a valve member and a valve body that accommodates the valve member.

12. A device as claimed in claim 11, wherein the valve body has an inlet port and an outlet port and the valve member has a passage to place the inlet port and outlet port in fluid communication with each other when the valve is in a first position and to prevent flow therebetween when the valve is in a second (closed state) position.

13. A device as claimed in claim 12, wherein the valve body further has a relief port whereby a or the passage through the valve member will place the outlet port in fluid communication with atmosphere when the valve is in the closed state.

14. A device as claimed in claim 11, wherein the actuator is in or on the valve body and connected to the valve member to move the valve member.

15. A device as claimed in any preceding claim, wherein the device comprises a valve and the actuator is integrally formed or assembled to the valve.

16. A device as claimed in claim 4, wherein the actuator comprises a stem and a rotor keyed to the stem.

17. A device as claimed in claim 2, wherein the frangible vessel of the restraining means is of glass or Bakelite or other brittle plastics.

18. A device as claimed in any preceding claim, wherein a switch/ sensor is provided on the device to sense the motion of the device on breakage/ collapse of the restraining means to send out a signal for alert or other remedial action.

19. A device substantially as hereinbefore described with reference to the accompanying drawings.

INTELLECTUAL PROPERTY OFFICE

Application No:	GB1113151.3	**Examiner:**	Vaughan Phillips
Claims searched:	1-19	**Date of search:**	11 August 2011

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 at least	GB 2220049 A (LEWIS) see abstract
X	1 at least	US 2005/0092663 A1 (SANSANO) see abstract
X	1 at least	US 5113891 A (CARNEY) see abstract
X	1 at least	US 4848389 A (PIRKLE) see abstract
X	1 at least	US 4815491 A (PIRKLE) see abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

E03B; F16K

The following online and other databases have been used in the preparation of this search report

Online: WPI, EPODOC

INTELLECTUAL PROPERTY OFFICE

International Classification:

Subclass	Subgroup	Valid From
F16K	0017/40	01/01/2006
E03B	0007/12	01/01/2006
F16K	0031/68	01/01/2006