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[54] **COMPRESSED STOPPER CHANNEL BYPASS PIPE BURST PRESSURE RELIEF APPARATUS FOR PLUMBING FIXTURES**

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Related U.S. Application Data

[62] Division of Ser. No. 666,064, Jun. 14, 1996, Pat. No. 5,730,168.

[51] **Int. Cl.**^{6} **F16K 31/64**; F16K 11/06; F16K 15/04; F16K 15/14

[52] **U.S. Cl.** **137/59**; 137/60; 137/62; 137/79; 137/468; 137/878; 137/879; 137/881

[58] **Field of Search** 137/59, 60, 62, 137/79, 468, 597, 115.26, 115.27, 115.28, 878, 879, 881

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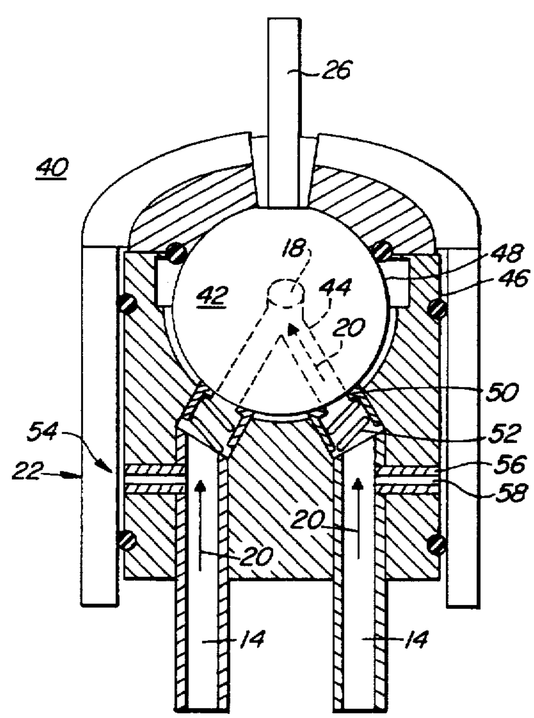
[57] **ABSTRACT**

According to the present invention, water regulation assemblies disposed in the water supply path of conventional fixtures are modified to include a pressure relief assembly which permits release of water under elevated pressures. A shut-off seal of a fixture is by-passed by a pressure relief water path which opens in response to elevated pressures. This permits relief of elevated pressure in water supply lines which might otherwise produce a burst event within the water supply lines. The path includes a stopper having a compressed channel that opens to release water at the elevated pressure.

5 Claims, 3 Drawing Sheets



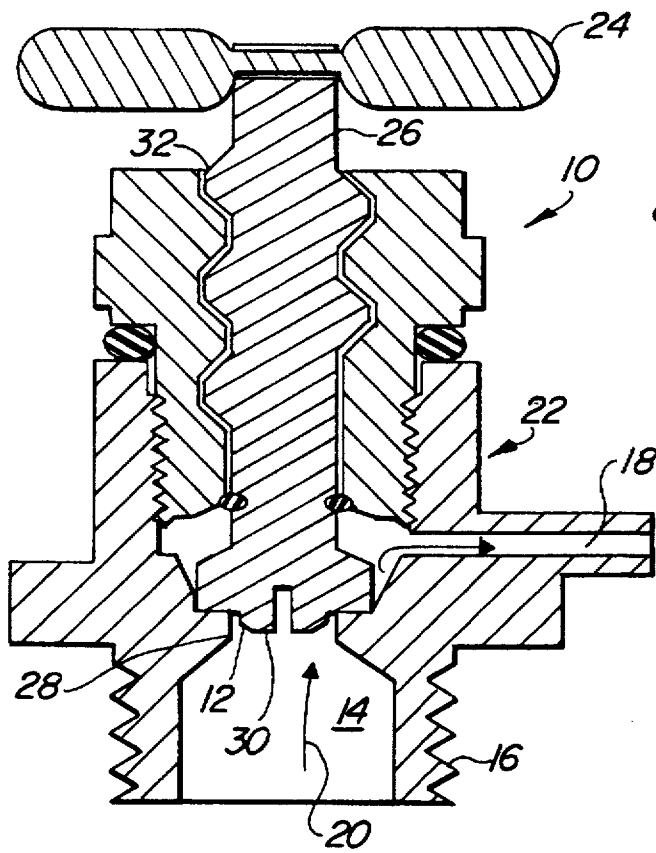


Fig. 1

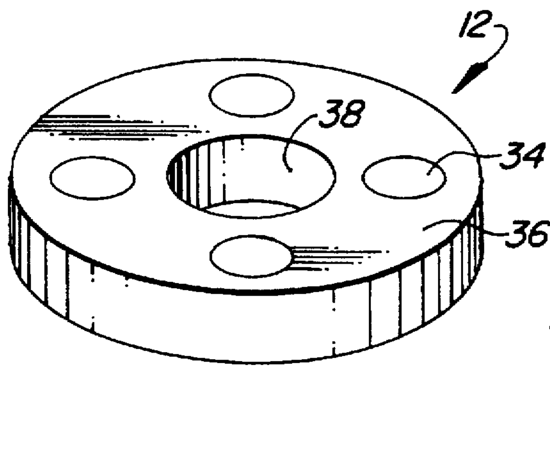
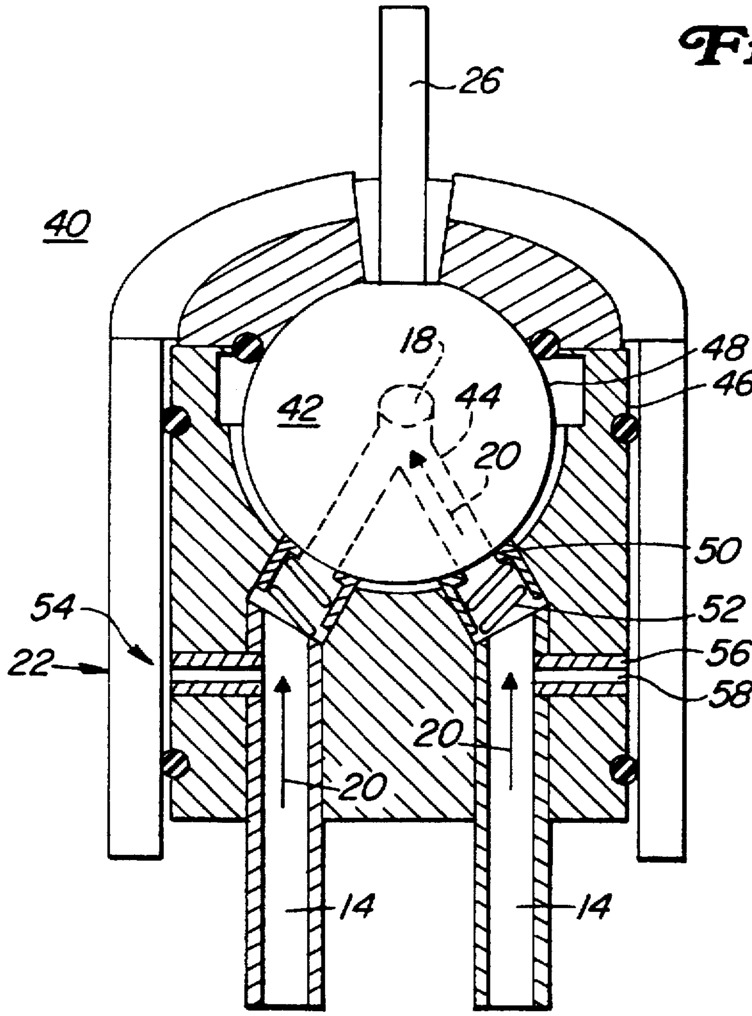


Fig. 2

Fig. 3



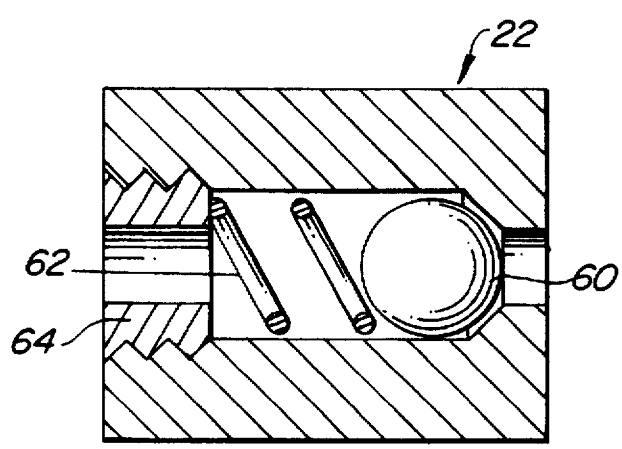


Fig. 4

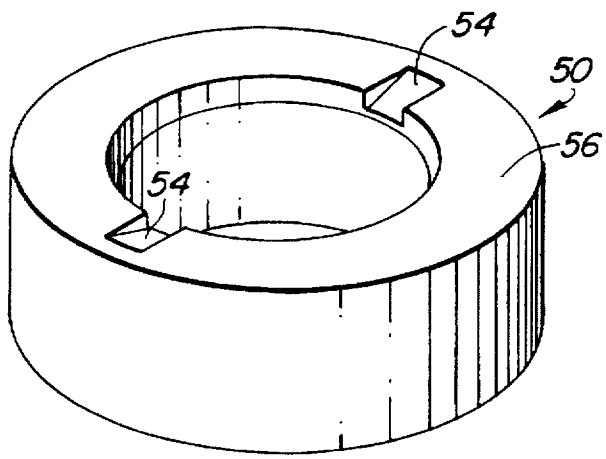


Fig. 5

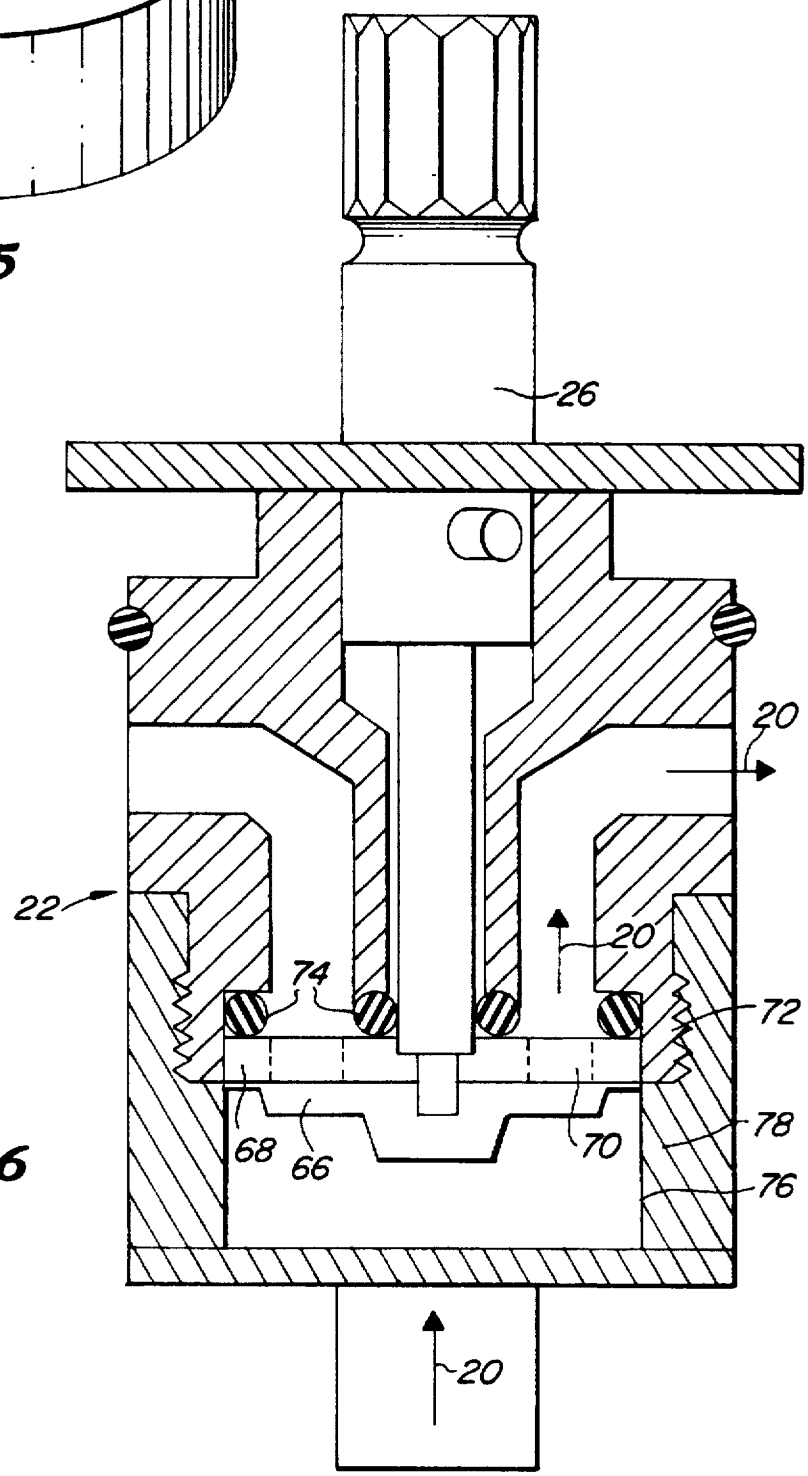


Fig. 6

COMPRESSED STOPPER CHANNEL BYPASS PIPE BURST PRESSURE RELIEF APPARATUS FOR PLUMBING FIXTURES

This is a divisional of application Ser. No. 08/666,064, filed Jun. 14, 1996, now U.S. Pat. No. 5,730,168.

The present invention relates generally to implementation of pressure relief in plumbing fixtures. More particularly, the present invention concerns an assembly for relieving feed line pressures resulting from the formation of ice, or another blockage, within the feed line. A plumbing fixture constructed in accordance with the present invention includes an assembly which releases water at a predetermined fluid pressure occurring after the formation of a blockage with the feed line, but prior to achieving a pressure which would rupture the feed line assembly.

BACKGROUND OF THE INVENTION

The bursting of water pipes causes extensive and expensive damage to residential and commercial properties during prolonged periods of cold weather. In many areas, buildings are constructed on slab or crawl space foundations, and water pipes are placed in areas with little temperature protection. For instance, in the southern region of the United States where such foundations are used in widespread fashion, pipes may be placed within the minimally protected foundation or within a poorly insulated attic area. Damage may be severe in such regions when a period of prolonged cold weather is encountered.

Recent events have emphasized the vulnerability of such piping arrangements. In a freeze event occurring during December of 1989, states from Texas to Georgia encountered a two day long period in which low temperatures were recorded at or below 10° F., and high temperatures did not exceed 25° F. Damages resulting from the bursting of water pipes during this relatively short event cost hundreds of millions of dollars. Historical weather data for the southern states reveals that similar conditions have been replicated in many locations within the past few decades. While the use of basement foundations and insulation provide more substantial protection of pipes in the Northern states and other geographical regions, the typically more severe weather conditions also periodically result in substantial damages resulting from the bursting of water feed pipes.

The physical phenomena within a feed pipe during a freeze event reveal that increased fluid pressure downstream from a frozen and blocked section most often leads to a bursting event. As water turns to ice, an approximate 8% volumetric increase results. Ice typically forms in the center portion of a pipe which defines a cold region disposed between two warmer regions. One of the warmer regions corresponds to a portion of the pipe disposed in a heated region of a building and leading to one or more plumbing fixtures and the other to a supply line disposed underground. Because conductive heat transfer occurs from the warmer sections of pipe to the colder, ice begins to form away from the warmer sections through heat losses of the colder portion to the surrounding environment. This pattern may be modified somewhat by additional air-induced convective heat losses generated from air movement, e.g. "wind chill", of pipe sections exposed to moving cold air. In such case, the formation of ice is accelerated in the section experiencing the additional wind chill convective heat losses. After an ice blockage occurs in the pipe, water trapped between the blockage and a plumbing fixture is subject to increased pressure as the ice expands, and may lead to the bursting of the water pipes when the fluid pressure exceeds the burst strength of the pipe.

Plumbing system components, installation techniques, and the character of the water itself may affect the characteristic of ice formation within a section of pipe. Pipe insulation may slow convective heat transfer, but will not prevent burst events once ice begins and continues to form. In addition, the insulation adds labor installation costs, and requires additional space for accommodation of pipes within a given structure. Air chambers installed in some plumbing systems as water hammer arresters will also forestall, but not prevent pipe bursting. Typical air chambers are separated from the water by a diaphragm and provide an area which the water may compress to relieve pressure, but reaching the limit of compression or diaphragm strength will lead to a continued increase in pipe pressure causing an eventual bursting event in pipes of sufficient length. Field and lab studies reveal that bursting most often occurs in a section of the pipe where little or no ice has formed.

Relief of pressure at the plumbing fixture is a more promising approach for pipe burst protection than insulation or other techniques. One such approach has been proposed by Westerberg in U.S. Pat. No. 5,014,731. A number of methods are proposed in that patent to relieve pressure prior to the formation of ice when water within the pipe reaches a small range of temperatures between +4° and +1° C. and undergoes a pressure rise as a result of the changing density of water in this range. The embodiments of Westerberg include rupture tabs and a fixture with a pressure-relief valve, and rely upon a non-return valve in the plumbing system. Rupture tabs are inconvenient because they must be replaced after one event including a discharge. Non-return valves are not typically included in plumbing systems of many municipalities, and retrofitting would be expensive. Westerberg also proposes a modified knob type fixture including a channel having multiple turns extending through an otherwise solid portion of the fixture to a diaphragm normally used, through depression of a knob, to activate the water flow in the fixture. In addition to requiring sealing around the knob itself because of water introduced to the knob by the channel, the thin channel presents a manufacturing challenge because somewhat sophisticated molding or drilling techniques are required to produce such a thin channel in the solid portion of the fixture. The applicability of the channel modification also appears to be limited to the specific knob-diaphragm fixture, which is not widely used in residential applications.

Applicability to many more commonly used types of fixtures is required for a pressure relief assembly to be applied in large scale to residential and commercial water supply systems. Changes to fixtures to accommodate burst protection should not require modifications to the plumbing supply system itself, which might be expensive or even incompatible with the water systems of some municipalities. Incremental cost additions to the manufacture of a modified plumbing fixture including burst protection should also be kept small.

Accordingly, it is an object of the present invention to provide an improved plumbing fixture including burst protection applicable to commonly used fixture structures, and which relieves pressure in a water supply pipe to avoid a burst event.

A further object of the present invention is to provide an improved plumbing fixture including a pressure relief path disposed upstream of the fixture's normal shut-off assembly, and which opens in response to elevated water supply line pressure to discharge water.

An additional object of the present invention is to provide an improved plumbing fixture having a pressure relief path disposed upstream of the fixture's normal shut-off assembly, and a stopper in the pressure relief path having a compressed channel that opens in response to elevated water supply line pressure to discharge water.

SUMMARY OF THE INVENTION

The above-listed and other objects are met or exceeded by the present fixture which allows water discharge in response to elevated water supply pressures typically resulting after the formation of ice within the water supply line. According to the present invention, the shut-off seal of a fixture is bypassed by a pressure relief water path which opens in response to elevated pressures. This permits relief of elevated pressure in water supply lines which might otherwise produce a burst event within the water supply lines.

By-passing of the shut-off seal of the water regulation assembly is accomplished through a pressure relief water path upstream of the shut-off seal. Under normal pressures, the pressure relief water path is blocked. Elevated pressures result in an opening of the pressure relief water path. The preferred assembly is a compressed stopper having a channel which opens in response to the elevated pressure.

According to the present invention, effective pressure relief is obtained with modifications to conventional fixtures that add little to the cost of the fixture, and which may even be retrofitted to certain fixtures. The pressure relief achieved by the present invention also returns the shut off mechanism of a fixture to its shut-off position after pressure has been relieved.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, advantages and objects of the invention will be readily apparent to those skilled in the art by reference to the detailed description and drawings, of which:

FIG. **1** is a partial cross sectional view of a threaded stem type fixture constructed in accordance with the present invention including a washer which partially deforms in response to elevated water supply line pressures;

FIG. **2** is a perspective view of a washer used in the fixture of FIG. **1**;

FIG. **3** is a partial cross sectional view of a ball and socket type fixture constructed in accordance with the present invention;

FIG. **4** shows a relief path release assembly;

FIG. **5** is a perspective view of a gasket;

FIG. **6** shows a washerless type fixture constructed in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, shown is a partial cross section of a movable stem style fixture assembly **10** constructed in accordance with the present invention including a washer **12** which partially deforms in response to elevated water supply line pressures. The fixture **10** has a threaded water inlet **14** for connection to a water supply line (not shown). Threads **16** permit a fixed connection to a water supply line. While only one water supply line is pictured, the fixture would typically have two assemblies **10** for separate hot and cold water supplies. As is typical, the inlet **14** leads to a water outlet **18** to form a water path **20** within fixture housing **22**. The path **18** may mix hot and cold water from separate assemblies prior to flowing out of the fixture through a spout.

Regulation of the flow of water through the water path is controlled by operator manipulation of a water control handle **24** which is connected to a water regulation assembly including a stem **26**, a seat **28**, and the washer **12** connected to an end **30** of the stem **26**. Threads **32** on the stem **26** move the stem **26** vertically (in FIG. **1**) in response to manipulation of the water control handle **24**. FIG. **1** pictures an "off" positioning of the stem **26** where the washer **12** is tightly pressed against the seat **28** to completely obstruct the water flow path **18**. A limited range of upward stem movement provides for turning "on" and varying the amount of water flow through the path **18**.

However, even in the "off" position, limited water flow is permitted past the shut-off washer **12** because the washer will deform in response to elevated water supply line pressures communicated through the water supply opening **14**. For instance, a typical normal line pressure of 40 psi is considered normal, in which case the washer **10** will maintain a complete seal. At substantially elevated pressures, such as those arising from an expanding ice blockage, portions of the water will deform to allow release of water and pressure. The pressure at which deformation should occur must be less than the pressure at which the water supply line to which the fixture is connected would burst or permanently deform, and should exceed a range pressure normally experienced during water supply. For the most residential water supply systems, deformation of the washer **12** occurring in the approximate range of 100 to 250 psi will guard against pipe bursting and also avoid release of water during normal water supply system conditions.

A preferred washer **12** of the fixture assembly **10** in accordance with the present invention is shown in FIG. **2** in perspective form. The washer **12** includes separate hard portions **34** surrounded by soft portions **36**. These soft portions **36** deform in response to elevated pressures as discussed above. Hard portions **34** have a hardness corresponding to conventional washers used in the type of fixture shown in FIG. **1**. As is known in the art, such hardness provides a seal, while also defining the extent to which a user of the faucet can tighten the handle **24** into its off position by providing resistance to further compression between the end **30** of the stem **25** and the seat **28**. Surrounding soft portions **36** must deform at the elevated pressures discussed above to release water during a potential burst event. Determination of the point at which the soft portions **36** will deform depend upon the surface area of the soft portions facing upstream of the washer **12** (e.g. the portions against the seat **28**), the thickness of the washer, and the inherent compressibility (or spring force) of the elastic material used for the portions **36**. The sizing of the washer, which determines surface area and thickness, will be determined from the particular conventional fixture seat and stem dimensions to which the modifications of the present invention are practiced upon, and the desired softness may be obtained by selecting an appropriate rubber or other elastomer with the correct characteristic.

Manufacture of the washer **12** structure may be accomplished by stamping holes in addition to the center hole **38** into which the hard portions **34** may be inserted. Holes for accommodating the hard portions **34** should be slightly smaller in diameter than the hard portions **34** so that a compression fit is realized when the hard portions are inserted. As will be appreciated from viewing the fixture assembly **10** in FIG. **1**, minimal vertical forces exist in the off position which could otherwise tend to dislodge the hard portions **34**. Accordingly, there is no need for an integrally formed structure having hard portions and soft portions. Of course, such an integral structure may be used in accordance with the teaching of the present invention as convenience permits.

Referring now to FIG. 3, shown is ball and socket style fixture **40** constructed in accordance with the present invention. In this fixture **40**, the stem **26** transmits movement to a ball **42** having hot and cold water channels **44** defined therein. The water path **20** is formed when the ball is positioned in a socket **46** to align one or both of the (hot and cold) water inlets **14**. The illustrated ball position in FIG. 3 corresponds to an on position which will mix hot and cold water from the inlets **14**.

Obstruction of the water path **20** to create an off position results by rotation of the ball **42** to align solid portions **48** of the ball's circumference with the inlets **14**. In this position gaskets **50** are pressed against the solid portion **48** of the ball **42** by springs **52** and water pressure thereby creating a seal blocking flow of water and the water path **20**. The areas **54** are formed in an upper surface **56** that normally forms the seal against the ball **42**.

The seal thus created may be broken, however, under the above discussed elevated water pressure since the gasket **50** has one or more areas of reduced thickness **54** (FIG. 5). The otherwise conventional gasket will deform at areas **54** under elevated water supply pressure to release some water into the socket **46**. Deformation of the areas **54** occurs at the elevated pressure exceeding normal water supply, but well below pressures which would damage supply pipes. Water released into the socket in response to elevated pressure finds its way to the water channels **44**. Like the washer **12**, the exposed surface area of the bottom portion of the areas **54**, their thickness and their inherent material characteristics will determine the deformation pressure, and may be selected to correspond to a desired elevated pressure.

A pressure relief path **54** bypass is also illustrated in FIG. 3, but may be used in any of the faucet types as an alternative, or in addition to, pressure relief along the normal water supply path **20**. The pressure relief path **54** penetrates the fixture housing **22** upstream of the gasket **50** and ball **42** shut-off mechanism. At the normal water supply pressure, the pressure relief channel is blocked by a compressible stopper **56**. The stopper has a channel **58** penetrating longitudinally through the stopper **56**. Because the pressure relief path **54** has a slightly smaller width than the stopper **56**, the channel **58** is closed under the above described normal water supply pressure.

The size of the channel (or compressibility) will depend upon the inherent hardness of the stopper material, the diameter of the stopper **56**, the diameter of the pressure relief path **54**, the diameter of the channel **58** and the length of stopper **56**. As an example, testing determined that a rubber stopper having a major diameter of 0.46 in., a minor diameter of 0.36 in., a length of ⅝ in. and a compression modulus of 0.016 lb. released droplets of water at 150 psi from a channel having a diameter of 0.375 inches. At a typical municipal water supply pressure of 40 psi, no water was released from the channel. Testing of other size stoppers may simply be conducted by gradually drilling channels in a given stopper when the stopper subjected to a desired elevated release pressure.

The pressure relief path **54** may also be opened at elevated pressure by the alternative release shown in FIG. 4. A rubber stopper ball **60** is pushed against a tapered portion of the pressure relief path **54** by a spring **62** held in place by a threaded retainer **64**. Similarly to the other configuration in FIGS. 1–3, the seal created by the ball **60** should be broken

at an elevated pressure indicative of a blockage such as ice formation in the water supply line. The exposed circumference of the ball **60** at the narrower diameter of the pressure relief path **54** and the characteristic of the spring **62** will determine the release pressure. Specifically, the release pressure is equal to the spring force stored in the spring in its off position (where ball **62** is pressed against tapered portion) divided by the area of the ball **60** exposed to water in the "off" (sealed) position. A spring applying a force of four pounds therefore allows release at 320 psi for an exposed ball area of 0.012 in^2 (⅛" diameter path at tapered portion), and at 150 psi for an exposed ball area of 0.028 in^2 (3/16" diameter path at tapered portion).

Pressure relief may also be accomplished in the "washerless" sliding plate fixtures by causing the shut-off components to separate at elevated pressures. Such an arrangement is shown in FIG. 6, where a movable plate **66** is used to regulate water flow. The illustrated washerless arrangement has a schematically illustrated movable plate **66** to facilitate understanding of the present invention, plates of more complex three dimensional shapes are conventionally used to vary hot and cold water mixture. In the off position shown in FIG. 6, the movable plate **66** has been rotated into an off position which blocks water supply holes **70** disposed in a fixed plate **72** that is retained by o-rings **74**. In a conventional fixture, the fixed plate **72** is fitted directly against an inner portion of the housing **22** providing for no upward movement of the fixed plate **72**. In accordance with the present invention, the o-rings compress at the above discussed elevated water supply pressures. Springs or other compressible mechanisms may also be used in place of the o-ring **74**. Upward force is supplied by water within a supply chamber **76** which pushes against exposed portions **78** of the fixed plate **72**. The compressibility of the o-rings should be such that the rings **74** compress at the desired elevated pressure. Similarly to the ball and spring, the surface area of the exposed area **78** against which the water pushes and the spring force stored in the inherent compressibility of the o-ring **74** will determine the pressure at which the fixed plate **72** separates from the rotatable plate **66**. The softness of the o-ring **74** is most easily changed to accomplish this desired separation of an elevated pressure by selecting material having less resistance to compression than conventionally used in the washerless faucets. Exposed surface area of the fixed plate could also be increased, but this would require structural modifications to the fixture.

While the illustrated preferred embodiment achieves all of these advantages, it will be appreciated by those skilled in the art that changes and modifications may be made thereto without departing from the invention in its broader aspects and as set forth in the following claims.

What is claimed is:

1. A plumbing fixture comprising:

a water inlet including means for sealingly connecting the inlet to a water supply line;

a water outlet;

a housing accommodating a water supply path therein, said water supply path connecting said water inlet and said water outlet;

a manually activated water control;

water regulation means connected to said water control for controllably restricting said water supply path to control the flow rate of water through said path, said water regulation means having a shut-off seal for sealingly obstructing flow of water through said water supply path when said water control is placed in an off position;

a pressure relief path disposed upstream of said shut-off seal; and

a stopper disposed in said pressure relief path, said stopper having a compressed channel penetrating therethrough said channel permitting water to pass through said stopper to by-pass said shut-off seal only when said water control is placed in said off position and said water supply line is subject to an elevated water supply pressure exceeding a normal water supply pressure.

2. A plumbing fixture according to claim 1, wherein said pressure relief path penetrates said housing.

3. A plumbing fixture according to claim 1, wherein said stopper has an uncompressed width that is greater than a width of said pressure relief path.

4. A plumbing fixture according to claim 1, wherein said pressure relief path penetrates a housing of said fixture.

5. A plumbing fixture according to claim 1, wherein said channel has a compressibility determined as a function of a desired elevated pressure, a hardness of the stopper, the width of said stopper, the width of said pressure relief path, and a length of the stopper.

* * * * *