United States Patent [19]

Kenny

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[54] TEMPERATURE-SENSITIVE SNAP-ACTION VALVE

[76] Inventor: Thomas M. Kenny, 13 Cobblestone Dr., Paoli, Pa. 19301

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[21] Appl. No.: 472,095

[52] U.S. Cl. 169/60, 137/468, 169/19, 169/37

[51] Int. Cl. A62c 37/06

[58] Field of Search 169/60, 19, 37, 20, 26, 169/90; 236/93; 137/468; 251/75

[56] References Cited

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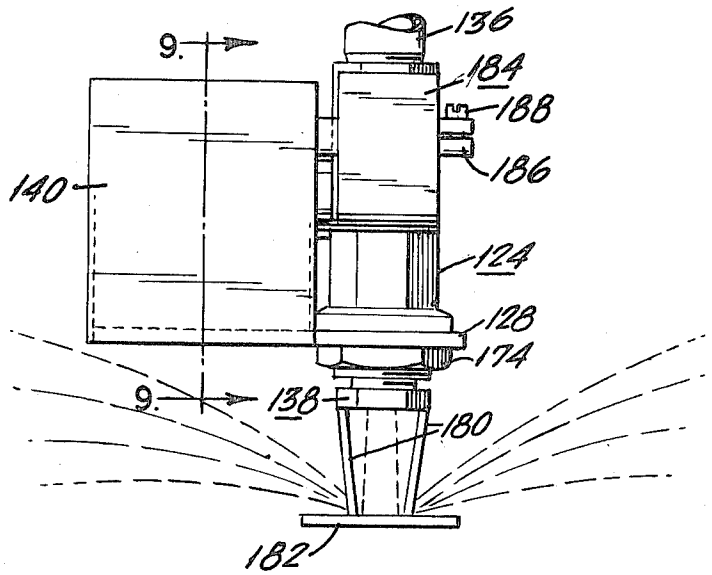
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Primary Examiner—Lloyd L. King
Assistant Examiner—Michael Mar
Attorney, Agent, or Firm—Howson and Howson

[57] ABSTRACT

A temperature-sensitive actuator is operatively connected to a valve by means of a spring-loaded linkage. The actuator causes a tensioned spring in the linkage to pass over center upon the occurrence of a predetermined temperature, thereby fully opening or closing the valve. The invention may be embodied in several forms including an automatic drain for water systems and a fire extinguishing system sprinkler control.

4 Claims, 16 Drawing Figures



3 Sheets-Sheet 1

FIG. 1.

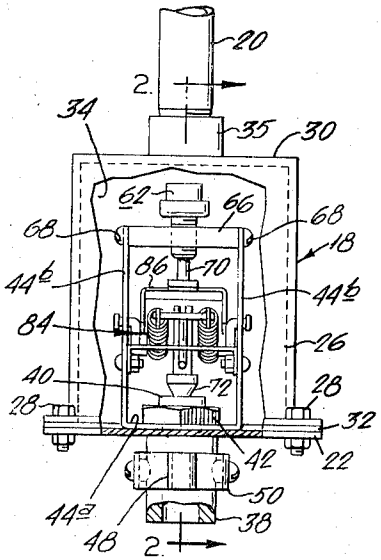


FIG. 2.

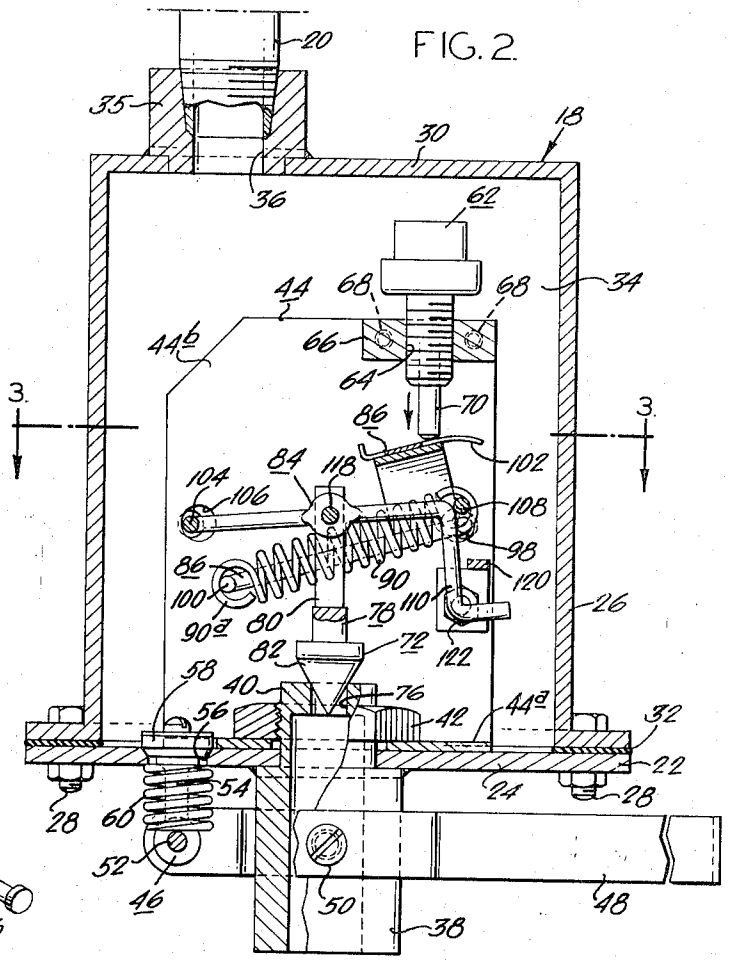


FIG. 4.

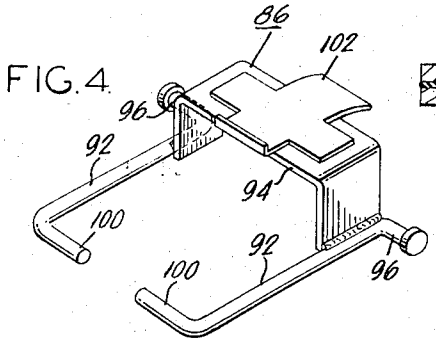


FIG. 5.

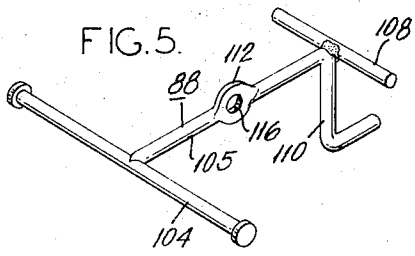


FIG. 6.

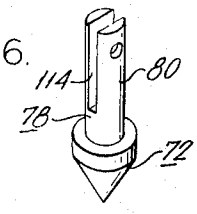
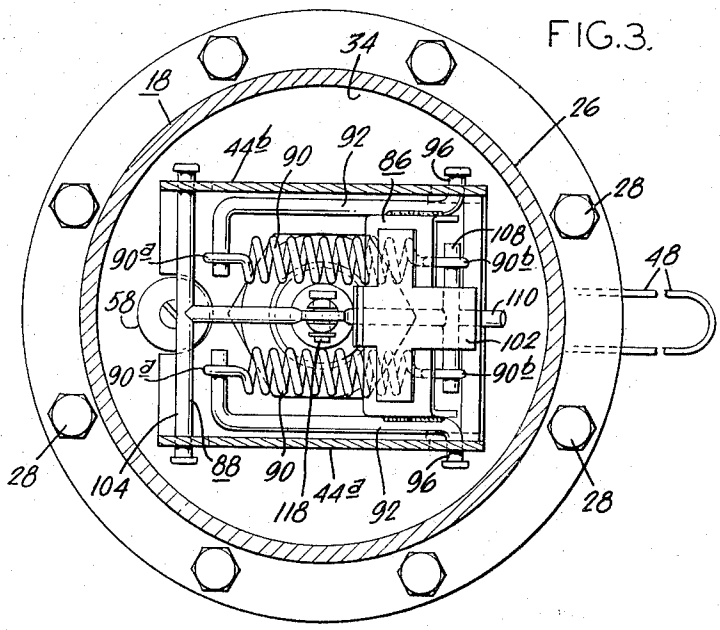


FIG. 3.



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FIG. 7.

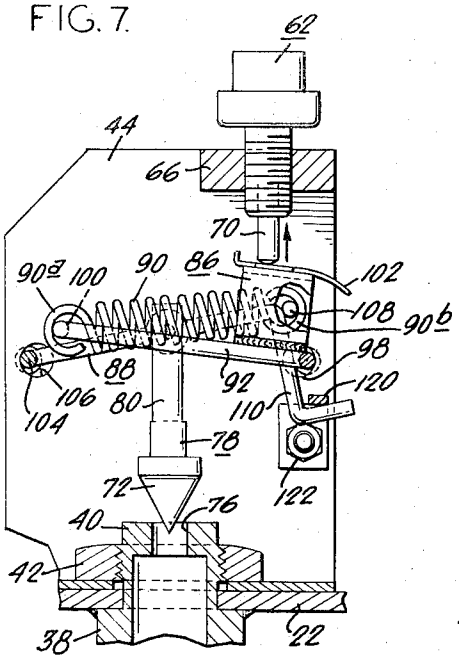


FIG. 8.

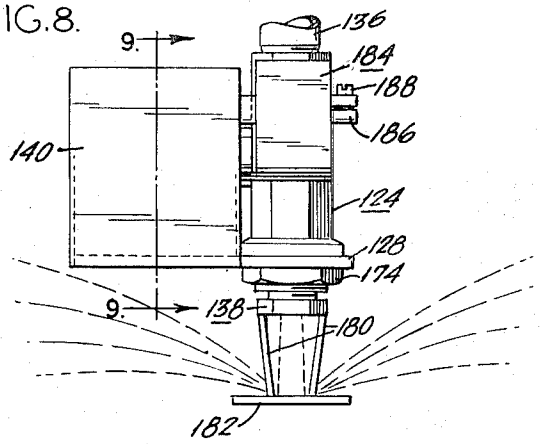


FIG. 9.

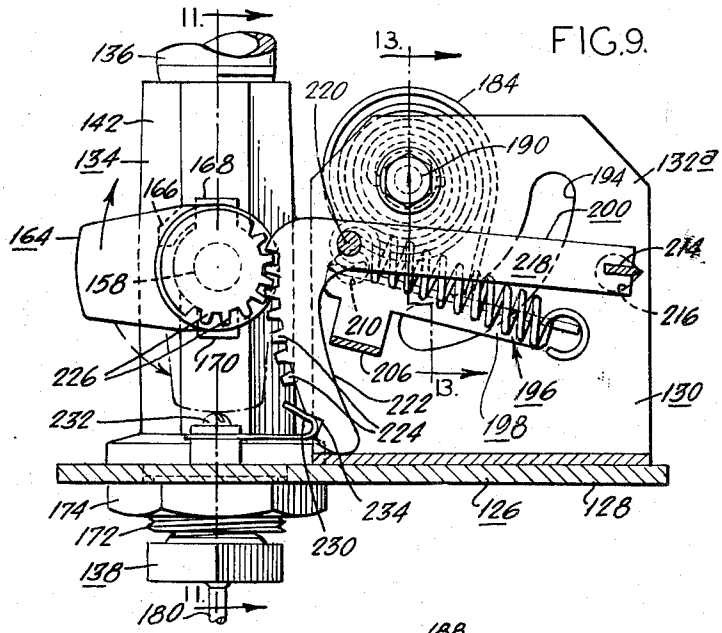


FIG. 10.

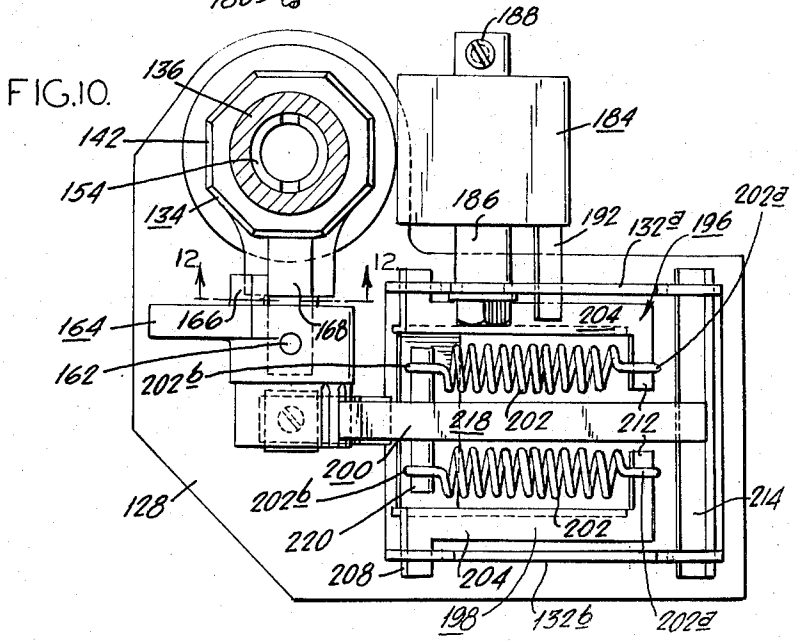


FIG. 11.

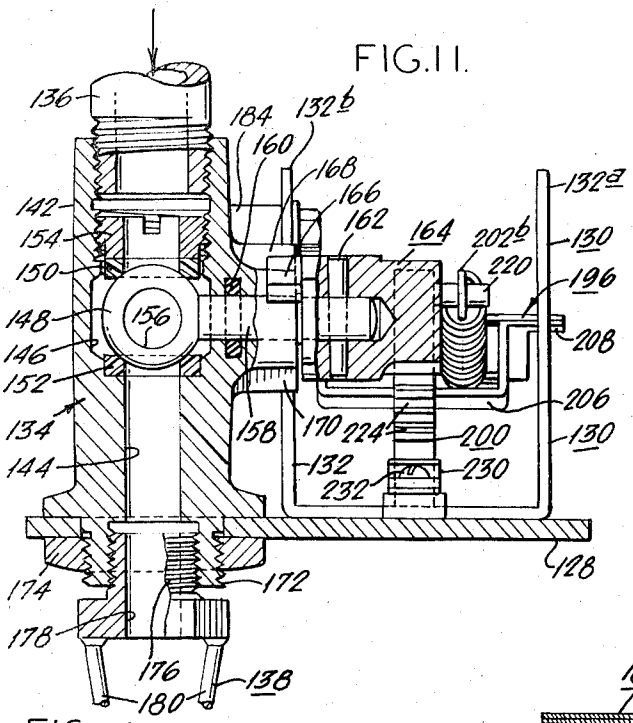


FIG. 12.

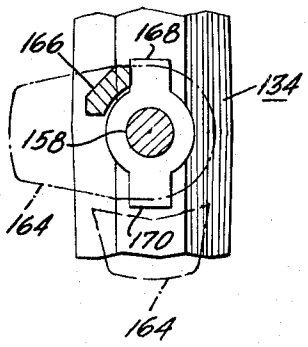


FIG. 13.

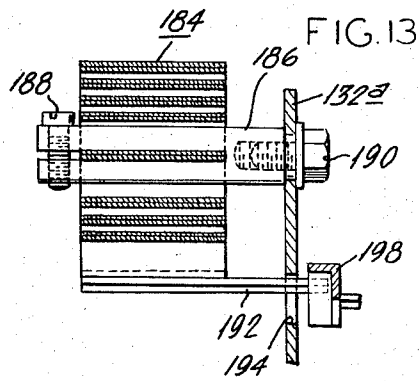


FIG. 14.

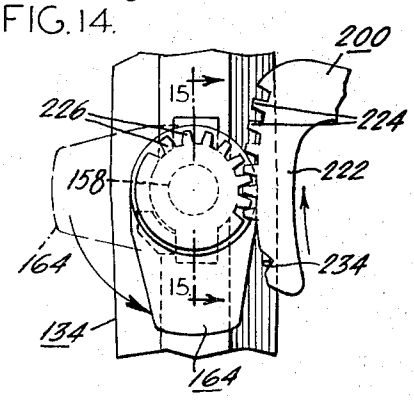


FIG. 15.

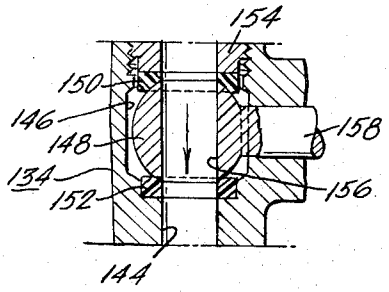
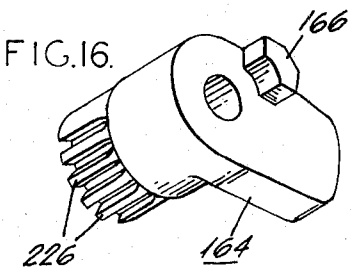


FIG. 16.



TEMPERATURE-SENSITIVE SNAP-ACTION VALVE

The present invention relates generally to automatic valve control mechanisms and relates more particularly to a novel temperature-sensitive snap-action valve.

There are many situations which require an arrangement for automatically opening or closing a valve when a predetermined temperature is reached. Examples include water lines exposed to freezing conditions such as on piers and water tanks. Similarly, locomotives and stationary engines utilize water cooling systems which in view of their large size and continuous operation, are not usually provided with an anti-freeze solution. Other examples include busses, cooling towers, mobile homes, outdoor safety showers, and the like which require an automatic drain valve to bleed the system before freezing damage occurs. Another category of valves requiring automatic thermal actuation is fire extinguishing system sprinkler valves which must reliably operate at a predetermined elevated temperature despite years of non-use. Sprinkler valves should preferably also close automatically when the temperature drops below a predetermined level.

Devices have previously been developed for automatically actuating valves in response to temperature change. However, various shortcomings have characterized the operation of most prior devices. In one form of automatic valve, the valve is opened slowly by the contraction of a medium within a thermal actuator. When used to guard against freezing, such a valve is often too slow in operation to prevent freezing at the valve orifice and a consequent blocking of the valve. Although an effective sprinkler valve controller has been developed utilizing a pilot valve for operating the main valve, such a unit is complex in structure and thus expensive to manufacture.

In the present invention, a relatively simple, mechanical arrangement is provided for automatically fully opening or closing a valve when a predetermined temperature is reached. In brief, the invention comprises a base to which is secured a valve and a temperature-sensitive actuator which controls the valve through a spring-loaded linkage. The linkage includes an actuator member pivotally mounted on the base for pivotal movement by the actuator in response to temperature changes. A valve member pivotally mounted on the base is connected to the valve so that rotation of the valve member will open and close the valve. A tension spring extends between the valve member and actuator member, the spring normally serving to bias the valve member to hold the valve in the closed position. Upon occurrence of a predetermined temperature, the actuator rotates the actuator member to a degree sufficient to cause the spring to pass over-center with respect to the valve member, thereby rotating the valve member and opening the valve with a snap action. When the temperature returns to a predetermined level, the actuator will rotate the actuator member to cause the spring to again pass over-center, thereby causing the valve member to rotate and close the valve.

In view of the foregoing, it is accordingly a first object of the present invention to provide a temperature-sensitive snap-action valve of a novel mechanically actuated type.

A further object of the invention is to provide a temperature-sensitive snap-action valve as described

which is characterized by an over-center spring linkage which may be triggered by various types of temperature-sensitive actuators and which is adaptable for use with various types of valves.

Another object is to provide a temperature-sensitive snap-action valve as described which is readily adaptable for use in low temperature applications such as a drain valve to prevent freezing, or for high temperature applications such as for a fire extinguishing sprinkler system.

Still another object of the invention is to provide a temperature-sensitive valve as described which is spring-loaded into either a fully opened or fully closed position.

A still further object of the invention is to provide a temperature-sensitive valve as described of a relatively simple construction which may be economically manufactured.

Additional objects and advantages in the invention will be more readily apparent from the following detailed description of embodiments thereof when taken together with the accompanying drawings wherein:

FIG. 1 is an end elevational view of a temperature-sensitive snap-action valve assembly in accordance with the present invention with a portion of the casing thereof broken away to show interior details;

FIG. 2 is an enlarged sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a perspective view of the actuator member of the valve assembly of FIGS. 1–3;

FIG. 5 is a perspective view of the valve member of the valve assembly of FIGS. 1–3;

FIG. 6 is a perspective view of the valve element of the valve of FIGS. 1–3;

FIG. 7 is a partial view similar to FIG. 2 but showing the valve in the open position;

FIG. 8 is an end elevational view of a further embodiment of the invention in the form of a fire extinguishing system sprinkler valve control;

FIG. 9 is a enlarged view taken along line 9—9 of FIG. 8 with the cover removed;

FIG. 10 is a plan view of the valve assembly shown in FIGS. 8 and 9;

FIG. 11 is a sectional view taken along line 11—11 of FIG. 9;

FIG. 12 is a partial sectional view taken along line 12—12 of FIG. 10 showing details of the valve stop;

FIG. 13 is a sectional view taken along line 13—13 of FIG. 9 showing details of the bimetallic coil actuator;

FIG. 14 is a partial view of the valve control member similar to the view of FIG. 9 but showing the valve in the open position;

FIG. 15 is a sectional view taken along line 15—15 of FIG. 14; and

FIG. 16 is a perspective view showing the valve control member.

Referring to the drawings, and particularly FIGS. 1–7 thereof, a temperature-sensitive snap-action valve assembly generally designated 18 is illustrated in the form of a drain valve for a fluid system (not shown) connected thereto by the conduit 20. The fluid system might, for example, comprise outdoor water lines which are intended to be automatically drained by the

valve assembly should the temperature drop toward the freezing mark.

The valve assembly **18** comprises a base **22** including a circular base plate **24** to which a cylindrical casing **26** is secured by bolts **28.** The casing **26** includes a closed top **30** and is sealed to the plate **24** by an annular gasket **32.** A chamber **34** of cylindrical shape is accordingly formed by the casing **26** and the base plate **24.**

The inlet conduit **20** is threadedly engaged within a boss **35** secured to the top **30** of the casing **26.** A bore **36** in boss **35** connects the conduit **20** with the chamber **34** so that the chamber is continually filled with the system fluid. A drain conduit **38** extends downwardly from the base plate **24** and is secured thereto such as by welding. A reduced diameter portion **40** of the conduit **38** extends through a suitable bore in the base plate and is threaded to receive a nut **42** which serves to clamp the bracket **44** to the base plate **24.**

A manual drain valve assembly **46** includes a handle **48** pivotally mounted at **50** to the drain conduit **38** and pivotally attached by pin **52** to a valve element **54** which extends vertically through a valve port and seat **56** in the base plate **24.** The valve element **54** includes a resilient member **58** adapted to cooperate with the valve seat to tightly seal the drain valve in the usual closed position of the valve. A spring **60** disposed around the valve element **54** extends between the base plate **24** and the pivot pin **52** to bias the valve into a normally closed position. The depression of the handle **48** will raise the valve element **54** against the force of the spring **60** to permit the draining of the chamber **34.**

The bracket **44** as shown most clearly in FIGS. **1** and **3** is of a U-shape and includes a base portion **44***a*, secured by the nut **42** to plate **24,** and spaced parallel upstanding sidewall portions **44***b*. A temperature-sensitive actuator **62** is threadedly mounted in a suitable bore **64** of the horizontal actuator support member **66** which extends between the bracket walls **44***b* adjacent their upper edges, being secured thereto by screws **68.** The temperature-sensitive actuator **62** illustrated is a commercially available unit of the type sold under the trade name "Vernatherm" by Scoville Manufacturing Co., Waterbury, Conn. The actuator includes an actuator piston **70** which extends from the actuator when the actuator is subjected to increasing temperatures, and which retracts into the actuator when the actuator is subjected to decreasing temperatures. The rate of travel and the displacement of the actuator piston **70** can be accurately predetermined and the actuators are obtainable for a variety of temperature conditions.

A valve assembly generally designated **72** is formed in the lower end of the chamber **34** by a restricted portion **74** of the outlet conduit **38** in which a concentric bore **76** is disposed, the upper edge of which forms a valve seat. A valve element **78** including a valve stem **80** and a conical poppet **82** is disposed above the conduit **38** with the poppet **82** normally in a sealing relation with the valve seat. The primary novelty of the invention resides in the mechanism employed for operatively connecting the temperature-sensitive actuator **62** with the valve element **78** to open the valve when the temperature drops below a certain minimum level. This mechanism comprises a spring linkage generally designated **84** which will now be considered in detail.

The linkage **84** comprises an actuator member **86** as shown in FIG. **4,** a valve member **88** as shown in FIG. **5,** and a pair of tension springs **90, 90** extending between the actuator member **86** and valve member **88.** The actuator member **86** includes a pair of spaced parallel rod-like elements **92** which are joined by cross member **94.** The rod-like elements **92** each include outwardly projecting horizontal pivot portions **96** adapted to extend through holes **98** in the bracket walls **44***b* to pivotally support the actuator member about a horizontal axis. The elements **92** at their ends opposite the pivot portions **96** terminate in inwardly directed spring mounting portions **100** around each of which one end **90***a* of one of the springs **90** is attached as shown in FIGS. **1–3.** An actuator slide plate **102** is mounted on the cross member **94** and slidably engages the piston **70** of actuator **62** as shown in FIG. **2.** Since the actuator axis is positioned to the left of the pivot holes **98** as viewed in FIG. **2,** the extension of the actuator piston **70** will rotate the actuator member **86** in a counterclockwise direction. The spring force always serves to rotate the actuator member **86** in a clockwise direction, thereby maintaining the engagement of the actuator plate **102** with the actuator piston **70.**

The valve member **88** as shown in FIG. **5** includes a horizontal pivot bar **104,** the ends of which extend through holes **105** in the bracket sidewalls **44***b* to provide a horizontal pivot axis for the valve member. The valve member further includes a central rod-like member **106** extending perpendicularly from the bar **104** and having a transverse spring connector bar **108** attached at one end thereof parallel to the bar **104.** The member **106** is formed with an L-shaped portion **110** depending downwardly beneath the spring attachment arm **108** for a purpose described below. A flattened portion **112** of the member **106** is adapted to slidably fit within a slot **114** in the valve stem **80,** and a bore **116** in the portion **112** permits a pivotal connection with the valve stem **80** by means of pivot pin **118** as shown in FIG. **2.** The ends **90***b* of spring **90** are looped around the spring connector bar **108** to each side of the member **106** and accordingly place the springs in a constant state of tension.

A stop member **120** extending between the bracket sides **44***b* and secured thereto by bolts **122** limits the upward pivotal movement of the valve member **88** by engagement with the L-shaped portion **110** thereof as shown in FIG. **7.** In this position, the valve element **78** is raised sufficiently to fully open the valve port **76.**

With the valve element **78** in the closed position on the valve seat as shown in FIG. **2,** the spring bar **108** is disposed above the pivot holes **98** of the actuator member **86** so that the springs **90** urge the actuator member in a clockwise direction and thus hold the plate **102** against the actuator piston **70.** Since the position of the valve member **88** in FIG. **2** is the lowermost possible of that member, it can be appreciated that the spring force will always act to produce a clockwise rotation of the actuator member.

The rotation of the valve member **88** and hence the opening and closing of the valve is effected by the force of the springs **90** acting on the spring bar **108.** When the ends **100** of the actuator member are disposed below the plane passing through the pivot bar **104** of the valve member **88** and the spring bar **108,** the spring force will act to urge the valve into a closed position as illustrated in FIG. **2.** When the actuator piston **70** moves upwardly permitting clockwise rotation of the actuator member **86,** the ends **100** of the actuator

member will pass to the other side of the plane passing through the valve member pivot bar **104** and spring bar **108**, thereby causing the springs **90** to pass over center and, with a snap action, reverse the spring force on the valve member **88**. The valve will accordingly open with a quick motion when the spring passes over center, even though the actuator **62** may have moved very slowly with a consequent slow rotation of the actuator member **86**.

In operation, the assembly is connected with a fluid source by means of the inlet conduit **20**, so that the fluid fills the chamber **34** and thereby immerses the temperature-sensitive actuator **62**. With the temperature above a predetermined minimum level, the actuator plunger **70** will bear downwardly on the actuator member **86**, holding the spring below the critical valve member plane described above. Any increased downward movement of the actuator plunger **70** will simply rotate the actuator member **86** in a counterclockwise direction without in any way affecting the valve condition. Should the temperature drop to the predetermined critical level, the actuator plunger **70** will retract in an upper direction, permitting the springs **90** to rotate the actuator member **86** until the ends **100** thereof pass across the plane defined by the valve member pivot bar **104** and the spring bar **108**. At this point, the spring force on the valve member is reversed and the springs act upwardly on the valve member **88** rotating the valve member in a counterclockwise direction and opening the valve element connected thereto. This counterclockwise rotation of the valve member will continue at a rapid rate until the L-shaped arm **110** of the valve member **88** engages the stop bar **120** as shown in FIG. **7**. The valve is then fully open and will remain fully open until the temperature rises to a predetermined level causing the actuator piston **70** to extend downwardly and move the spring attachment ends **100** of the actuator member **86** back across the valve member plane. The springs will then again pass over center and the valve will close with the same snap action with which it opened, even though the actuator movement may be very gradual.

For a manual draining of the system or simply to check on the filled condition of the chamber **34**, the handle **48** is depressed to open the valve element **54** against the force of spring **60**. A release of the handle **48** permits the spring **60** to reseat the valve element **54**, effectively resealing the chamber **34**.

The embodiment of FIGS. **8–16** is virtually identical in operational concept, although differing in the type of actuator and valve utilized. Referring to FIGS. **8–11**, a temperature-sensitive snap-action valve assembly **124** embodying the invention is shown in the form of an automatic fire extinguishing system sprinkler valve. The valve assembly **124** includes a base **126** comprising an irregularly shaped base plate **128** and a U-shaped bracket **130** mounted thereon. The bracket **130** includes spaced parallel upstanding sidewalls **132***a* and **132***b* similar to the sidewalls **44***b* of the previously described embodiment. A ball valve assembly generally designated **134** is mounted vertically on the base plate **128** and is connected at its upper end to a pressurized water conduit **136**. A splash plate assembly **138** is connected below the ball valve **134** as shown in FIG. **8** to direct the spray of water in all directions when the ball valve is automatically opened by the temperature-sensitive mechanism described below. This mechanism is largely enclosed by a cover **140** in the view of FIG. **8**, although in FIGS. **9**, **10** and **11** the cover is removed to show the mechanism details.

The ball valve assembly **134** includes a valve body **142** of generally octagonal section having a bore **144** passing vertically therethrough. An enlarged ball chamber **146** within the body **142** contains the valve ball **148** which is sealed by upper and lower seal rings **150** and **152** in a conventional manner. Threaded retainer **154** above the upper seal ring **150** secures the ball in fluid tight relationship within the body. A central passage **156** in the ball provides a continuation of the valve body bore **144** when the ball is rotated into the open position as illustrated in FIG. **15**. The rotation of the ball is effected by means of valve stem **158** which extends transversely through the valve body and is sealed by the seal ring **160**. The valve stem **158** is connected by pin **162** to the geared valve control member **164** as shown most clearly in FIG. **15**. A stop element **166** on the member **162** cooperates with the vertical flanges **168** and **170** of the valve body to limit rotation of the ball to 90°.

The ball valve assembly **134** is secured to the base plate **128** by means of a threaded portion **172** of the valve body which extends through a bore in the plate and secured thereto by the nut **174**. The splash plate assembly **138** includes a threaded head portion **176** which is secured within an enlarged portion of the lower end of valve body bore **144**. A concentric bore **178** in the head portion **176** forms a continuation of the valve body bore **144**. A plurality of thin rod-like members **180** depend downwardly from the head portion **176** and support a splash plate **182** (FIG. **8**) in a substantially horizontal plane.

The mechanism for actuating the ball valve is mounted on or within the bracket **130**. The temperature-sensitive actuator in this embodiment comprises a bimetallic coil **184**, one end of which is clamped within the split rod **186** and secured thereto by screw **188** as shown in FIG. **13**. The rod **186** is fastened by means of bolt **190** to the sidewall **132***a* of bracket **130**. Arm **192** attached to the free end of the bimetallic coil **184** extends through an arcuate slot **194** in the bracket sidewall as shown in FIG. **13**.

Within the bracket **130**, a spring linkage generally designated **196**, which is quite similar to the spring linkage **84** of the previously described embodiment, includes actuator member **198**, valve member **200**, and tension springs **202**, **202** connecting the actuator and valve members. The actuator member **198** includes a pair of parallel arms **204** joined by the connector portion **206**. Pivot arms **208** extending transversely from the actuator member adjacent the connector portion **206** are disposed in openings **210** in the bracket sidewalls **132***a* and **132***b*. Inwardly directed spring connecting arms **212** at the free ends of the arms **204** provide attachment means for the ends **202***a* of the springs **202**.

The valve member **200** comprises a horizontal pivot bar **214**, the ends of which are pivotally disposed in holes **216** in the bracket sidewalls **132***a* and **132***b*. A central arm **218** of the valve member **200** includes a transverse spring bar **220** extending therethrough to which the ends **202***b* of the springs **202** are attached. The arm **218** continues beyond the spring bar **220** in a downwardly directed arcuately shaped portion **222** having gear teeth **224** disposed along the outer surface

thereof in engagement with gear teeth **226** of the valve control member **164.** A clockwise rotation of the arm **218** about the pivot holes **216** will rotate the valve control member **164** and hence the valve stem **158** and valve ball **148** in a counterclockwise direction as viewed in FIG. **9** and will open the valve.

With the valve in the closed position as shown in FIG. **9,** the spring bar **220** is disposed above the pivot holes **210** of the actuator member **198.** Accordingly, the force of the tension springs will always serve to urge the actuator member in a counterclockwise direction, thereby maintaining engagement of the actuator member with the arm **192** extending from the bimetallic coil. The bimetallic coil will thus always control the rotational position of the actuator member **198** and thus also control the position of the ends **202***a* of the springs **202.**

In the position shown in FIG. **9,** the springs **202** are acting on the spring bar **220** at an angle serving to urge the valve member **200** in a counterclockwise rotational direction since the spring ends **202***a* are disposed below the plane passing through the spring bar **220** and the pivot bar **214.** Upon a predetermined rise in temperature, the bimetallic coil **184** will expand, thereby raising the arm **192** and allowing the actuator member **198** to rotate in a counterclockwise direction. When this rotation continues to the degree required to permit the spring ends **202***a* to cross the plane passing through the spring bar **220** and the pivot arm **214,** the springs will pass over center and instead of exerting a downward force on the valve member **200,** will exert an upward force on the valve member, thereby urging the valve member to rotate in a clockwise direction.

Since the spring force urging such clockwise rotation of the valve member will increase the higher the ends **202***a* of the springs are permitted to travel by the actuator member, and in view of the possibility of the ball valve becoming tight after a long period of non-use, means are provided to hold the valve member in the closed position until a predetermined spring force has been reached. This means as shown in FIGS. **9** and **11** comprises spring member **230** secured to the space plate **128** by screw **232.** A notch **234** in the valve member arm **222** engages a looped portion of the spring **230** in the closed position of the valve. When a suitable force of the springs **202** has been achieved, the spring **230** will release from the notch **234,** permitting the rapid clockwise rotation of the valve member **200** and hence the valve control member **164** to open the valve with a snap-action.

When the temperature falls below a predetermined level, the mechanism will reset automatically. The actuator member will rotate causing the springs **202** to pass back over center, thus acting on the valve member to rotate the valve ball into the closed position.

Manifestly, changes in details of construction can be effected by those skilled in the art without departing from the spirit and the scope of the invention.

I claim:

1. A fire extinguishing system automatic thermally actuated sprinkler valve assembly comprising a base, a fluid conduit on said base adapted for connection to a source of high pressure fluid, valve means in said fluid conduit for controlling flow therethrough, a splash plate assembly secured beneath said base aligned with said fluid conduit, a temperature-sensitive actuator mounted on said base, and a spring linkage assembly operatively connecting said actuator with said valve means, said spring linkage assembly comprising a valve member pivotally mounted on said base and operatively connected with said valve means, an actuator member pivotally mounted on said base for rotation about an axis spaced from and parallel to the pivot axis of said valve member, said actuator operatively engaging said actuator member to permit rotation of said actuator member in response to temperature variations, and a tension spring having one end thereof attached to said actuator member at a point remote from its pivot axis, the opposite end of said spring being connected to said valve member at a point remote from its pivot axis, said spring urging said actuator member in rotation toward said actuator, said spring normally urging said valve member in rotation to hold said valve means fully closed, said spring passing over center upon a predetermined temperature condition to urge said valve member in the opposite rotational direction, thereby fully opening said valve means with a snap action and permitting high pressure fluid to strike said splash plate assembly.

2. The invention as claimed in claim **1** wherein said valve means comprises a ball valve.

3. The invention as claimed in claim **1** including means for delaying opening of said valve means until a predetermined spring force acts on said valve member.

4. The invention as claimed in claim **1** wherein said temperature-sensitive actuator comprises a bimetallic coil.

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