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(54) CONTROL VALVE

(71) We, CHUBB FIRE SECURITY LIMITED, a British Company, of Pyrene House, Sunbury-on-Thames, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a control valve, and particularly to a control valve for use in a water sprinkler system for protecting a building, or in a water deluge system generally used for external protection, and to a system including such a control valve.

Fixed installations of pipework through which water is conveyed to the seat of a fire for internal or external fire protection are very commonly used.

In systems using such installations, the releasing of the water occurs automatically in response to detection of heat or flame resulting from a fire.

Such systems are of five basic types, namely the "wet pipe" sprinkler system, the "dry pipe" sprinkler system, the "alternate" sprinkler system which is a combination of the wet and dry pipe systems, the "pre-action" sprinkler system, and the "deluge" open nozzle system. The basic characteristics of these systems are as follows.

A sprinkler system comprises a fixed network of pipes run close to the ceiling of a building, and the main feed pipes are connected via control valves to a main water supply. Pipes referred to as "range pipes" are connected to the main feed pipes, and sprinkler heads are fitted at intervals along these pipes, the heads being positioned so that every unit of area of the building can be sprayed with water by a respective head.

In a "wet-pipe" sprinkler system, water is permanently fed under pressure to each sprinkler head, and each head is constructed to remain closed until it is heated by fire. Under such temperature increase conditions the head opens and discharges the water into the space beneath it to extinguish the fire. Such a system wherein the pipework always remains filled with

water under pressure is very effective, and suitable for building and contents protection where ambient temperature is maintained above freezing point.

In a "dry-pipe" sprinkler system, any problem with freezing in the pipe network and heads is avoided by filling the pipes with air under pressure to hold back the water at the control valves. When a sprinkler head opens as a result of an increase in temperature, the air pressure is released and the water can flow through the pipe connected to that head and is discharged by the head. The pipework therefore contains water only in the event of fire. Such a system avoids the problem of freezing, but the fact that water is not present at the sprinkler heads at the moment they open on detection of a fire, means that there is a delay in the discharging of the water and valuable time is lost in extinguishing the fire. However, exhaust valves are available to assist in reducing this time delay.

The "alternate" system is one in which the pipework is filled with water to act as a "wet pipe" system during the warmer months of the year and is filled with air under pressure to act as a "dry pipe" system when freezing conditions are likely. This is therefore a good compromise between the previously described systems.

The "pre-action" system is one in which the pipework is kept free of water under normal conditions; not usually to avoid freezing, but to avoid any condensation problems which might occur due to the presence of cold water in the pipework situated in a relatively warm atmosphere, such as that occurring in a computer room. Water is allowed to flow into the pipework only when a fire in the vicinity is detected by temperature or smoke monitoring devices separate from the pipework, and then the individual sprinkler heads retain the water until caused to release it by an increase in temperature at the site of the respective head.

In the "deluge" system the pipework and nozzles are all open for simultaneous dis-

charge over a wide area. Such a system is used in areas of very high fire risk such as on offshore drilling platforms and in oil refineries. A separate small bore pipeline is also arranged around and over the fire risk area. At strategic positions sprinkler heads are located on this pipeline to act as heat detectors.

Various forms of control gear used in these systems include very large and sometimes cumbersome main water control valves which have been specially built for the systems, some of which valves have a right-angled path between their inlet and outlet which gives rise to a loss in the useful water pressure. Reclosing of most valves after operation entails the removal of fixing bolts and the use of thrust bolts to remove heavy cover plates from the valves, which sometimes requires the use of lifting gear.

It is an object of the present invention to provide an improved auxiliary control valve which permits the use of conventional water control valves in such systems.

According to the invention, a control valve comprises a chamber having main fluid supply inlet and outlet ports; a sealing member operable by a diaphragm assembly to open and close the inlet port; the diaphragm assembly comprising a first diaphragm to which can be applied a control fluid pressure to cause the sealing member to maintain the inlet port closed against a main fluid supply pressure applied to said port; and a second diaphragm having a larger effective area than the sealing member and a larger effective area than the first diaphragm, so that if the control fluid pressure decreases sufficiently to allow the inlet port to open thereby allowing the main fluid supply to enter the chamber and to pass to the outlet port, the resultant fluid pressure in the chamber acting on the second diaphragm causes the diaphragm assembly to hold the sealing member clear of the inlet port.

Due to the action of the pressure on the second diaphragm, the inlet port is held open even in the event of a quite large increase in pressure acting on the first diaphragm.

The control valve is particularly useful in a fire fighting system of any of the above-described types, and allows the use of a standard hydraulically or pneumatically operated main water valve in the system, and particularly a piston-operated butterfly valve of standard design. Such a valve has considerably lower losses than the special valves which have previously been used as the main water valves in such system, and the valve can therefore be smaller and lighter than the previously-used valves. Furthermore, a much wider range of sizes of main valves becomes usable, making size selection

more compatible with water capacities for individual installations.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a longitudinal cross-section through a control valve in accordance with the invention,

Fig. 2 is a schematic diagram of the control gear of a fire fighting system incorporating the valve of Fig. 1, and

Fig. 3 is a pictorial schematic view of control gear for a marine deluge fire fighting system.

Referring to Fig. 1 of the drawings, a control valve in accordance with the invention comprises a lower casing part 1 having an inlet port 2 and an outlet port 3. An upper casing part 4 has an inlet port 5. The casing parts 1 and 4 are spaced apart by an annular spacer 6 having a central aperture 7 which is chamfered so that its edge adjacent the upper casing part is of smaller diameter than that adjacent the lower casing part. The casing parts have flanges so that the parts can be bolted together with the spacer 6 therebetween.

A diaphragm 8 closes the lower end of the casing part 4, and a diaphragm 9 closes the upper end of the casing part 1, so that, in effect, separate upper and lower reservoirs are formed. The diaphragms are clamped between the spacer 6 and the respective casing parts, and at least one of the diaphragms is bonded at its central region to a spacer 10.

A sealing member 11 comprises a disc 12 at one end in contact with the centre of the diaphragm 9 and of substantially the same diameter as the lower edge of the aperture 7. The other end of the member 11 comprises a disc 13 which seals the port 2. The member 11 slides axially of the valve in a spider 14 within the casing.

In use of the valve, a compressed air or water supply is first connected to the port 5 so that the pressure acting on the diaphragm 8, and hence through the spacer 10 and the diaphragm 9, holds the seal 13 in sealing engagement with the port 2. A high pressure water supply or a low pressure air supply, according to the mode of operation, is connected to the port 2, and because the seal 13 has a small effective diameter, the water or air pressure acting on it cannot cause the member 11 to move against the pressure on the larger diameter diaphragm 8.

However, if the pressure at the port 5 decreases below a predetermined level, the pressure acting on the seal 13 will overcome the force on the diaphragm 8 and will cause the member to move away from the port 2. Water or air therefore enters the reservoir within the lower casing part and is fed under pressure through the port 3. The water or

air pressure also now acts against the larger diameter of the diaphragm 9 and the valve is held very strongly in the open condition. When, according to the mode of operation, the water pressure is applied to the port 5 (e.g. as a result of the opening of the valve 15 of Fig. 2), it cannot cause reclosure of the port 2 whilst the water or air pressure is present in the lower reservoir.

In Fig. 2 a comprehensive control system incorporating the valve of Fig. 1 is shown. This system is capable of operating as any of the above-described types, merely by opening and closing the relevant valves. In this figure, the control valve of the present invention is referenced 16, the main water valve is a piston-actuated butterfly valve 15 and the feed to the system from a main inlet pipe 17 is controlled by a hand-operated butterfly valve 18. The sprinkler or open deluge pipework (not shown) is connected to the upper end of a supply pipe 19 shown centrally in the figure.

The valve 15 is provided with a manual operation spindle 20.

The upper (control) port of the valve 16 is connected to the outlet pipe 19 (as shown in full lines) via a valve 21 if the pipe is to supply a sprinkler system, or is alternatively connected via a pipe 22 (shown dotted) to an air detector line if the pipe 19 is to supply a deluge system. A compressed air line is also connected to the pipe 22 via an on/off valve 23 and a non-return valve 24.

The inlet port at the lower end of the valve 16 is connected via valve 25 to the pipe 17, and the outlet port of the valve 16 is connected via a non-return valve 26 and an on/off valve 27 to an alarm gong (not shown). The junction between the valves 26 and 27 is connected via a valve 28 to the pipe 17, and is also connected via a restrictor 29 to a waste outlet.

The outlet port of the valve 16 is also connected to the actuator of the butterfly valve 20 and via a restrictor 30 to a waste outlet.

The space between the valves 15 and 18 is connected to waste via a waste and test valve 31. It is also connected via a valve 32 to the inlet pipe 17, and via valves 33 and 34 to the outlet pipe 19. The valve 34 has a small hole (e.g. 1.5mm diameter) through its gate to provide a bleed. A priming cup 35 is connected via a sleeve 36 to the junction of the valves 33 and 34.

A connection 37 to the space between the valves 15 and 18 is provided for use only if the system is to be a pre-action system. In that case the valve 21 would be connected to the connection 37 instead of to the pipe 19.

Pressure gauges 38 and 39 are connected to the pipes 17 and 19, respectively.

In order to describe the various operating modes of the system and the functioning of

the various valves in the system, the commissioning procedures to obtain the various modes are described below.

1. As a "wet pipe" system —
(a) Ensure that the source of water supply is turned off at the town's main supply stop valve (not shown).

(b) Close the butterfly valve 18.

(c) Open the valve 15 by means of the manual operation spindle 20.

(d) Close the valves 21, 25, 27, 28, 31, 32, 33 and 36.

(e) Gently open the town's main supply stop valve to the fullest extent.

(f) Open the valve 18 only slightly to fill and charge all of the sprinkler pipework until the pressure gauges 38 and 39 have settled and read the same pressure.

(g) Open the valve 18 fully.

(h) Close the valve 15 by means of the manual spindle 20, using a key.

(i) Open the valve 33.

(j) Close the valve 34. The hole drilled through the gate of this valve acts as a bleed, which will effectively maintain a state of equilibrium upstream and downstream of the control valve system, but will also restrict "make-up" should a sprinkler operate causing pressure to fall within the system.

(k) Open the valve 21, causing pressure to be exerted on the top diaphragm of the valve 16, thereby closing the water inlet at the base connection of that valve.

(l) Open the valve 25 gently. Strap and padlock the valve in the open position.

(m) Open the alarm cock 27 and strap in the open position.

Operation of the system is thereafter effected, in response to detection of a fire, by reduction of pressure above the valve 15 as the result of a sprinkler opening, whereby the diaphragm valve 16 open to release a continuous flow of water at pressure via the pipe controlled by the valve 25. This water will take three separate courses; an open line to the piston-actuated valve 15 effecting its opening, and two restricted flows for hydraulic alarm gong operation and for drain-off, respectively. The alarm gong is connected above the valve 27 and can be tested by the opening of the test valve 28.

2. As a "dry pipe" system.

The basic difference between the above procedure and that for commissioning as a "dry pipe" system is the need to provide a water seal above the valve 15 whilst it is in its closed position after effecting operations

(a) and (b) of the "wet pipe" system procedure. Ensure that all valves are closed as in (d) above. Close the valve 15 by means of the manual spindle 20. Open the valves 33, 34 and 36 and observe an over-flow condition as it appears in the priming

cup above the valve 36 by gently opening the valve 32. The valve 32 is closed immediately following the overflow. The procedure then is:—

- 5 (n) Open the valve 31 to drain the priming cup 35.
- (o) Close the valves 33, 34, 36 and 31.
- 10 (p) With the valves 21 and 23 open, apply air pressure to the pipe 22 from a compressor until a pressure of 2.8 bars (40 p.s.i.) is registered on the pressure gauge 39.
- (q) Stop the compressor and close the valve 23. (If the air compressor is automatically operated, the valve 23 will be similar to the valve 34 but with a 2mm bleed hole drilled through the gate).
- 15 (r) Complete the sequence as in (l) and (m) above.
- (s) Open the valve 18 fully.
- 20 The operation is then effected as above on opening of a sprinkler head.

3. As an "alternate" wet or dry system.

This system is a modified function of the dry pipe system.

The procedure for changing over from the "wet pipe" to the "dry pipe" systems to take account of seasonal weather conditions will be evident from the above procedures, it being necessary to drain down the entire pipe network by closing the valve 18 and opening the valve 15, allowing the head of water to discharge via the valve 31 and the waste outlet, to revert to a "dry pipe" system.

4. As a "deluge" system.

In this case the upper (control) port of the valve 16 is connected to a pilot detector line via the pipe 22. The detector line would normally be charged with compressed air, a reduction in pressure being produced in the event of a fire.

5. As a "preaction" system.

In this case the sprinkler system is designed and installed as a standard "dry pipe" system, but the detection/operation facilities are provided by means of an electrical detection system (not shown).

To ensure that the pipework is leakproof when commissioned, a low air pressure is maintained in the pipework to monitor the integrity of the pipework and the fittings.

The valve 21 will, in this case, be connected to the connection 37 instead of the pipe 19. The valve 16 is then in direct communication with the pressurised water supply. This line would also include a restricted orifice union and a solenoid-operated valve which will receive a signal from the electrical detection system. The solenoid valve would have a side outlet discharge which provides for the input to the solenoid valve to be isolated on operation. The solenoid valve would be set immediately above the valve

16 to ensure immediate release of water pressure acting on the upper diaphragm of the valve 16. Hence, release of the pressure on the sealing member 11 would permit high pressure water to flow continuously through the inlet port to the outlet port of the valve 16 via the pipeline controlled by the valve 25.

Operation of the pre-action control valve assembly, following the activation of the electrical detection system, causes water to flow through to charge all the pipework up to the sprinkler heads which, when affected by an increase in temperature as a result of the growth of a fire, will operate to release water on to the seat of the fire.

Fig. 3 shows a pneumatically controlled deluge system. Components corresponding to those in Fig. 2 have the same reference numerals as in that figure.

A solenoid valve 40 is connected between the pipe 22 and the control port of the valve 16. A manual pressure release valve 41 is connected to the junction between the valves 40 and 16.

The pipework connected to the control port of the valve 16 is charged with compressed air and the pressure is maintained constant by an automatic compressor. This pressure acts on the upper diaphragm of the valve 16 and holds the lower inlet port closed. When any of a network of pneumatic detectors connected to the pipe 22 opens as a result of fire, the pressure in the pipe 22 drops, and the valve 16 opens, feeding compressed air to the actuator of the valve 15. The valve 15 opens, and the deluge water is released to the outlet pipe 19.

The solenoid valve 40 can be operated alternatively, or additionally, to cause releasing of the pressure in the pipe 22, under the control of an electrical smoke or flame detector. If necessary, the pressure can be released manually by means of the valve 41.

The use of pneumatic control of the valves 16 and 15 is especially important on offshore platforms, where the obvious choice of fire fighting medium is sea water. If sea water were used for the control function, considerable corrosion of the valves would be caused.

There is clearly a very large variety of fluid discharge systems which can be built around the control valve of the present invention. Any other suitable kinds of control and discharge fluids may be used besides those mentioned above.

WHAT WE CLAIM IS:—

1. A control valve, comprising a chamber having main fluid supply inlet and outlet ports; a sealing member operable by a diaphragm assembly to open and close the inlet port; the diaphragm assembly comprising a first diaphragm to which can be applied a control fluid pressure to cause the sealing



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- cup above the valve 36 by gently opening the valve 32. The valve 32 is closed immediately following the overflow. The procedure then is:—
- 5 (n) Open the valve 31 to drain the priming cup 35.
- (o) Close the valves 33, 34, 36 and 31.
- p) With the valves 21 and 23 open, apply air pressure to the pipe 22 from a compressor until a pressure of 2.8 bars (40 p.s.i.) is registered on the pressure gauge 39.
- 10 (q) Stop the compressor and close the valve 23. (If the air compressor is automatically operated, the valve 23 will be similar to the valve 34 but with a 2mm bleed hole drilled through the gate).
- 15 (r) Complete the sequence as in (l) and (m) above.
- (s) Open the valve 18 fully.
- 20 The operation is then effected as above on opening of a sprinkler head.
3. As an "alternate" wet or dry system.
- This system is a modified function of the dry pipe system.
- 25 The procedure for changing over from the "wet pipe" to the "dry pipe" systems to take account of seasonal weather conditions will be evident from the above procedures, it being necessary to drain down the entire pipe network by closing the valve 18 and opening the valve 15, allowing the head of water to discharge via the valve 31 and the waste outlet, to revert to a "dry pipe" system.
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- 50 To ensure that the pipework is leakproof when commissioned, a low air pressure is maintained in the pipework to monitor the integrity of the pipework and the fittings.
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There is clearly a very large variety of fluid discharge systems which can be built around the control valve of the present invention. Any other suitable kinds of control and discharge fluids may be used besides those mentioned above.

WHAT WE CLAIM IS:—

1. A control valve, comprising a chamber having main fluid supply inlet and outlet ports; a sealing member operable by a diaphragm assembly to open and close the inlet port; the diaphragm assembly comprising a first diaphragm to which can be applied a control fluid pressure to cause the sealing



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member to maintain the inlet port closed against a main fluid supply pressure applied to said port; and a second diaphragm having a larger effective area than the sealing member and a larger effective area than the first diaphragm, so that if the control fluid pressure decreases sufficiently to allow the inlet port to open thereby allowing the main fluid supply to enter the chamber and to pass to the outlet port, the resultant fluid pressure in the chamber acting on the second diaphragm causes the diaphragm assembly to hold the sealing member clear of the inlet port.

2. A valve as claimed in Claim 1, including a first casing part in which are provided the main fluid supply inlet and outlet ports; and a second casing part having a control fluid inlet port, the diaphragm assembly being clamped between said casing parts.

3. A valve as claimed in Claim 2, wherein the diaphragm assembly includes a first spacer clamped between the casing parts and spacing the diaphragms apart, the first spacer having a central aperture which is chamfered so that the area of the aperture is smaller adjacent the first diaphragm than adjacent the second diaphragm; and a second spacer within the aperture and bonded to at least one of the diaphragms.

4. A valve as claimed in Claim 3, wherein the sealing member includes a disc in contact with the second diaphragm and having an area substantially equal to the area of the aperture adjacent the second diaphragm.

5. A valve as claimed in Claim 4, wherein the sealing member further includes a rod attached to the disc and extending towards the main fluid supply inlet port; and a seal mounted on the free end of the rod to close said inlet port.

6. A valve as claimed in Claim 5, wherein the rod is slidable in a spider within the first casing part.

7. A fire fighting system, including a main valve for controlling the flow of fire

fighting medium to outlet pipework; in combination with a control valve as claimed in any preceding claim, the outlet port of the control valve being connected to an actuator of the main valve so that when the control valve main fluid supply inlet port is opened the main fluid supply pressure causes operation of the actuator to open the main valve.

8. A system as claimed in Claim 7, wherein the control fluid pressure is water or air pressure present in the pipework before the main valve is opened, and the main fluid inlet of the control valve is opened in response to a reduction in said water or air pressure.

9. A system as claimed in Claim 7, wherein the control fluid pressure is air pressure present in a fire detection system, which pressure decreases on detection of a fire hazard thereby causing opening of the main fluid inlet of the control valve.

10. A system as claimed in Claim 9, wherein the fire detection system includes a solenoid valve which is electrically controlled to open on detection of a fire hazard to cause said decrease in air pressure.

11. A system as claimed in any one of Claims 7—10, wherein the main valve comprises a butterfly valve.

12. A system as claimed in any one of Claims 7—11, including an alarm device operable by the main fluid supply from the control valve outlet port.

13. A valve as claimed in Claim 1 and substantially as hereinbefore described with reference to Fig. 1 of the accompanying drawings.

14. A system as claimed in Claim 7, and substantially as hereinbefore described with reference to Fig. 1 and Fig. 2 or Fig. 1 and Fig. 3 of the accompanying drawings.

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