(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 447 851 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **91102985.8**

(51) Int. Cl.[5]: **F16K 11/22**

(22) Date of filing: **28.02.91**

(30) Priority: **08.03.90 IT 1961590**

(43) Date of publication of application:
25.09.91 Bulletin 91/39

(84) Designated Contracting States:
ES GB NL

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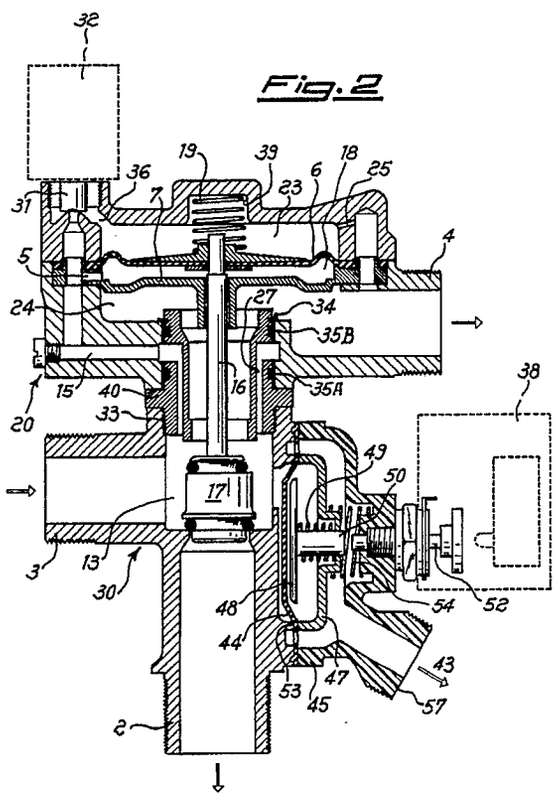
(54) An improved three-way valve.

(57) A three-way valve for use with boilers adapted to supply both heating hot water and domestic hot water, comprising an upper portion (20) and a lower portion (30) coupled together through a threaded section (33) and sealing members (35A, 35B) so as to allow for a relative rotation thereof.

The upper portion (20) comprises an output duct (4) in communication with a heat exchanger (11), and an axially movable stem (16) carrying at one end thereof a double plug (17) and at the other end an assembly made up by a rigid dividing wall (7) and a flexible diaphragm (6), with a helical spring (19) axially acting on said stem (16), whereas the lower portion (30) comprises a chamber (13) in communication with two output ducts (2, 3) and within which the double plug (17) is movable.

The valve can further comprise a combined device performing both the flow control function (in case of lack of water in the plant) and that of automatic bypass in case of excessive loss of pressure in the plant.

Fig.2



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The present invention concerns a three-way valve of the type to be used together with boilers that are adapted to supply both heating hot water and instant domestic hot water in a residential system or plant.

There are known diverting three-way valves adapted for being used together with a boiler, e.g. a gas-fired boiler, supplying both the heating hot water and the domestic (sanitary) hot water, i.e. the (somewhat less) hot water delivered by taps and the likes for several purposes.

Usually, the known valves of this kind are either of the direct-control type, e.g. operated by a small electric motor, or operated by a hydraulic valve, and suffer the inconveniences of possible leakages due to wear of the seal rubber rings (O rings) in the piping circuitry of the heating water.

An additional inconvenience of the known valves is that their output conduits may be located in such a manner as to make troublesome the assembling of the plant. Further these plants usually require additional fittings, such as bypass and flow control devices, that are to be mounted onto the above mentioned valve, thus further worsening the assembling conditions.

The object of the present invention is that of overcoming the above mentioned shortcomings and drawbacks, by means of a compact direct-control valve, easy to be mounted due to its peculiar design, ad reliable thanks to the lack of sealing members in the heating hot water piping circuitry.

Such object is accomplished though a three-way valve for use with boilers adapted to supply both heating hot water and domestic hot water, characterized in that such valve comprises an upper portion and a lower portion,

said upper portion comprising an output duct in communication with a heat exchanger, and an axially movable stem carrying at one of its ends a double plug and at the other end an assembly made up by a rigid dividing wall and a flexible diaphragm, with a helical spring axially acting on said stem;

said lower portion comprising a chamber in communication with two output ducts and within which the double plug is movable;

and in that said two portions are fitted together by means of a threaded section and sealing members, so as to allow for their relative rotation.

Further advantageous characteristics are the objects of the dependent claims.

The invention will now be described with reference to preferred but non-limiting embodiments, illustrated in the attached drawings, in which:

Fig. 1 is a general schematic layout of a residential water supply system for both heating and domestic hot water incorporating a valve according to the present invention;

Fig. 2 shows a tranverse cross section of a preferred embodiment of the valve according to the invention;

Figs. 3 and 4 illustrate the valve in two conditions, a configuration for delivering heating hot water and a configuration for delivering domestic hot water;

Fig. 5 shows the external appearance of an embodiment of the valve according to the invention; and

Fig. 6 shows an enlarged detail of the valve of Fig. 2.

In Fig. 1, the valve according to the invention, provided with output ducts 2, 3 and 4, is illustrated as incorporated in a heating plant comprising a pump 10, a gas/water heat exchanger component generally designate at R, a generic heat distribution unit or radiator RD and pipes A, B, C, D.

Fig. 1 further shows a heat exchanger 11 used to heat the domestic hot water flowing through a coil 12 and the associated plant, schematically indicated by pipe sections S1 and S2; for an easier illustration, the other components of the boiler have not been shown, the boiler being in general of the type burning either a fluid fuel such as for example gas or gas oil, or a solid fuel.

With particular reference to Fig. 2, the valve according to the invention comprises an upper portion 20 mounted on a lower portion 30 and capable to be rotated up to 360° with respect to the former.

More particularly the two portions are joined together by a coupling sleeve 40 having a lower threaded section 33 which engages a complementary female threaded section formed in the upper part of the lower portion 30, the sleeve being upwardly bound to the upper portion 20 only along the axial direction through a blocking Seeger ring 34, whereas the sealing is ensured by two O rings 35A and 35B. This results in the two portions being completely rotatable in respect of each other, thus allowing for positioning the conduits and the outer members in the best way for an easy assembling of the plant.

The upper portion 20 is provided with an outlet duct 4 communicating with the heat exchanger 11, and comprises a valve body within which a stem 16 is axially movable, the stem carrying at one end (inside the valve lower portion 30) a double plug 17. At its other end the stem carries an assembly comprising a rigid dividing wall 7 and a flexible diaphragm 6 axially movable with respect to the rigid wall, with a helical spring 19 partially housed in a recess 39 urging the stem downward.

The lower portion 30 comprises a chamber 13 communicating with the two output ducts 2 and 3, and within which the double plug 17 is movable between a lower position in which it closes the output duct 2 of the valve, and an upper position in

which it closes a narrow annular passage 27 communicating the two valve portions 20 and 30.

The rigid dividing wall 7 and flexible diaphragm 6 assembly divides the inside of the valve into two spaces or chambers, 23 and 24 respectively, and a variable volume interstitial space is defined between the dividing wall and the diaphragm.

The chamber 24 communicates with the output 4 of the upper body, with the valve lower portion 30 and through a narrow passage 25 with the upper chamber 23.

A channel 15 further communicates the chamber 13 of the valve lower body with the interstitial space 6-7 through the passage 5 and, through a passage 36 controlled by a piston 31 of an auxiliary valve 32, with the upper chamber 23 of the upper body.

The auxiliary valve 32 is for example a small power solenoid valve, either of the D.C. or A.C. type. As an example, a D.C. valve eliminates any hum. As an alternative, a small hydraulic valve actuated by the domestic hot water draw can be used. Therefore, according to the invention, in order to determine the supplied flow rate of domestic hot water, there is used an ON/OFF valve in lieu of a three-way valve equipped with a small exhaust tube.

Under rest conditions, as shown by Fig. 2, the pump 10 is still, the flexible diaphragm 6 is in a rest (not-deformed) condition and the spring 19 urges the double plug 17 to the lower position closing the output 2 wich communicates with the pump 10. The valve 32 keeps the passage 15 to the chamber 23 closed.

When the pump is started for heating purposes (Fig. 3), the heating hot water is admitted into the chamber 13 of the valve 1 from the duct 3 and returns to the pump 10. The pressure within the valve chamber 13 is transmitted through the channel 15 and the passage 5 to the insterstitial space 18 formed between the flexible diaphragm 6 and the rigid dividing wall 7. On the contrary, within the chamber 23 the pressure is lower than the above mentioned pressure due to the pressure-drop through the passage 27. The so formed pressure differential causes the swelling of the flexible diaphragm 6 which overcome the force of the spring 19 and lift the stem 16 with the attached plug 17.

In order to achieve such operation, the cross section of passage 36 has to be considerably larger than that of passage 25. It has been found that for the proper operation of the valve according to the invention, the ratio between the cross section areas of passages 25 and 36 is comprised between 3.5 and 6, and preferably between 4 and 5. In a preferred embodiment it has been found as optimum a ratio value of about 4, with cross section areas of about 5 mm^2 and about 1.2 mm^2 for the passages 36 and 25, respectively, both having a circular shape. Anyhow, the head or pressure difference for the proper operation of the valve is in the order of 30-40 cm. Moreover the diameter of passage 25, or in case the maximum transverse dimension thereof, is preferably comprised between 0.5 and 1.5 mm, which allows for eliminating the effects due to the water hammering when switching from one operating condition to the other.

As a result a communication path is opened that includes components D, 3, 2, and the passage 27 to the valve upper portion 30 is closed.

Under these conditions the hot water only circulates along the heating circuit A, B, 10, C, R and D.

When domestic hot water is drawn from the water supply system, e.g. by opening one of the taps (not shown) of the plant S1-S2, the auxiliary valve 32 is energized.

The energization of the valve 32, as illustrated in Fig. 4, causes the passage 15 to be communicated with the chamber 23, thus rendering substantially equal the two pressures acting over the walls of the flexible diaphragm 6 (a slight difference is due to the presence of the small exhaust passage 25), so that the spring 19 extends and the plug 17 closes the communication toward the duct 4 (see Fig. 4). Under these conditions there is established the path D, 3 and 4 allowing for the return of the heating hot water to the pump by flowing through the heat exchanger 11 and thus heating the water in the domestic supply circuit.

The outer appearance of the valve according to the invention as above described is shown in Fig. 5, in which it is further shown a threaded duct section 58 for the fitting of a control gauge.

According to another preferred embodiment of the invention shown in Figs. 2-4, there is further provided a device combining both the flow control and the automatic bypass functions.

A flow control device (also called flow valve) is used to stop the system operation in case of lack of water in the plant, to prevent damages thereto.

The purpose of a bypass device is that of returning to the delivery duct of the pump a certain amount of water bypassing the main plant (through the dashed pipe 43 of Fig. 1) when the heating plant causes an excessive pressure-drop for the pump capability, e.g. due to a wrong sizing thereof. In fact, in case of an excessive loss of pressure in the plant, by opening the passage 43 between the valve 1 and the pump return, a part of the water goes to the heating and the remaining part to the boiler, thus preventing noisiness in the water/gas exchanger R.

In the valve according to the invention the above two devices are combined as it will now be illustrated with particular reference to Fig. 2.

The flow control device (or flow valve) is of a known type and is housed in the valve lower portion 30, and comprises a flexible diaphragm 44, preferably with a circular shape, positioned between the chamber 13 of the lower portion 30 and a duct section 57 which in coupled to the pipe 43 (not shown). More particularly, the flexible diaphragm 44 is clamped along its periphery between the body of the lower portion 30 and the edge of an enveloping structure or bell 45 in which it is formed also the outlet duct 57. This structure 45, formed for example of plastic material, is further provided with an opening for a stem 52 the outer end of which is adapted for opening or closing a microswitch 38 (shown with dashed line in Fig. 2) that blocks or enables the plant's operation.

The flexible diaphragm 44 is further positioned between a shoulder 53 of the lower portion 30 and the edge of a second inner bell-shaped structure 47. Such second structure is provided with an opening for a stem 50 with a coaxial helical spring 49. The stem 50 is aligned and adapted to act on the stem 52 that actuates the microswitch 38. A calibrated spring 54 is interposed between these two structures 45 and 47 that is coaxial with both stems and has a greater strenght than that of the spring 49. The end of the stem 50 near the flexible diaphragm 44 carries a pan 48 on which the flexible diaphragm acts. This latter is further provided with a plurality of openings or peripheral holes 56 formed in an annular crown defined by the permanently clamped periphery (between 30 and 45 in Fig.5) and the annular portion between the shoulder or projection 53 and the edge of the structure 47.

The working of the device is as follows.

Should water be lacking in the plant, the flexible diaphragm 44 is no longer able to overcome the bias of the spring 49, and the stem 50 through the hole in the bell-shaped structure 47 pushes the stem 52 and closes the microswitch 38, thus blocking the plant. The bell-shaped structure 47 is kept against the flexible diaphragm by the spring 54.

In case of an excessive pressure drop in the plant, as it can better be seen in the detail of Fig. 6, firstly the pressure difference is enough to overcome the resistance opposed by the (properly adjusted) spring 54 and to cause the initial separation of the members 47 and 53, after which the water succeeds in passing through the holes 56 of the flexible diaphragm, thus causing the quick separation of the parts and therefore supplying a path (57, 43) to the pump for part of the water.

Claims

1. A three-way valve for use with boilers adapted to supply both heating hot water and domestic hot water, characterized in that such valve comprises an upper portion (20) and a lower portion (30),

   said upper Portion (20) comprising an output duct (4) in communication with a heat exchanger (11), and an axially movable stem (16) carrying at one of its ends a double plug (17) and at the other end an assembly made up by a rigid dividing wall (7) and a flexible diaphragm (6), with a helical spring (19) axially acting on said stem (16);

   said lower portion (30) comprising a chamber (13) in communication with two output ducts (2, 3) and within which the double plug is movable;

   and in that said two portions (20, 30) are fitted together by means of a threaded section (33) and sealing members (35A, 35B), so as to allow for their relative rotation.

2. A valve as claimed in claim 1, characterized in that said rigid dividing wall and flexible diaphragm assembly (7, 6) divides the inside of the valve into two spaces or chambers (23, 24) and that a variable volume interstitial space (18) is defined between said dividing wall (7) and said diaphragm (6).

3. A valve as claimed in claim 2, characterized in that one (24) of said chambers communicates with an outlet (4) of the upper portion, with the valve lower portion (30) and through a first passage (25) with the other chamber (23).

4. A valve as claimed in claim 3, characterized in that it provides for a communication channel (15) between the chamber (13) of the valve lower body and said interstitial space (6-7), and that such channel further extends to the upper chamber (23) of the upper portion through a second passage (36), this communication being controlled by a piston (31) operated by an auxiliary valve (32) of the on/off type.

5. A valve as claimed in claim 4, characterized in that the cross section of said second communication passage (36) is substantially larger than that of said first passage (25).

6. A valve as claimed in claim 5, characterized in that the ratio between the cross section areas of said passages (36 and 25) is comprised between 3.5 and 6, and preferably between 4 and 5.

7. A valve as claimed in claim 6, characterized in that the diameter of said first passage (25), or in case the maximun transverse dimension

thereof, is comprised between 0.5 and 1.5 mm.

8. A valve as claimed in any preceding claim, characterized in that it further comprises a device for the flow control and the bypass mounted on the valve lower portion (20) comprising a flexible diaphragm (44), positioned between the chamber (13) of the valve lower portion (30) and a duct section (57) which in coupled to the bypass piping, the flexible diaphragm (44) being clamped along its periphery between the body of the lower portion (30) and the edge of a bell-shaped structure (45) in which it is formed also said outlet duct (57).

9. A valve as claimed in claim 8, characterized in that said flexible diaphragm (44) is elastically opposed by a spring (49) coaxial with a stem (50) actuated by said diaphragm (44).

10. A valve as claimed in claim 9, characterized in that said bell-shaped structure (45) is pressed against said diaphragm (44) by a calibrated spring (54), and it is further provided with an opening for a stem (52) the outer end of which opens or closes a microswitch (38) controlling the water flow.

Fig.1

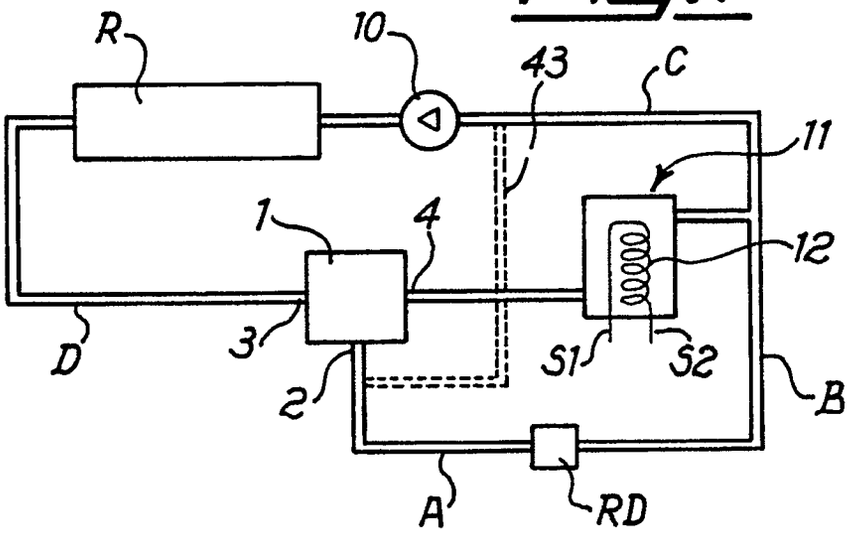

Fig.6

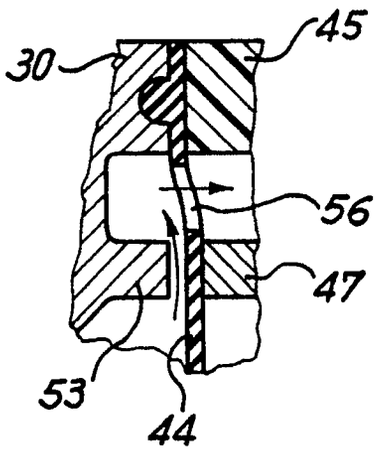

Fig.5

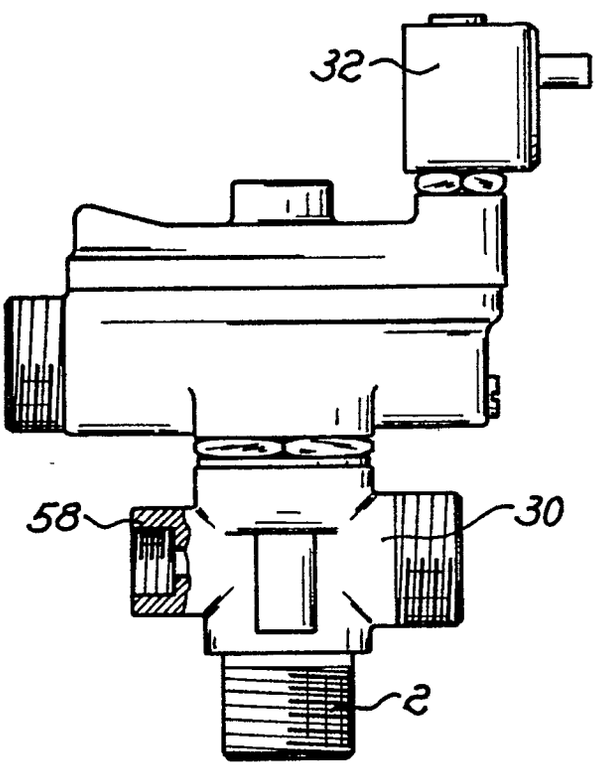

Fig. 2

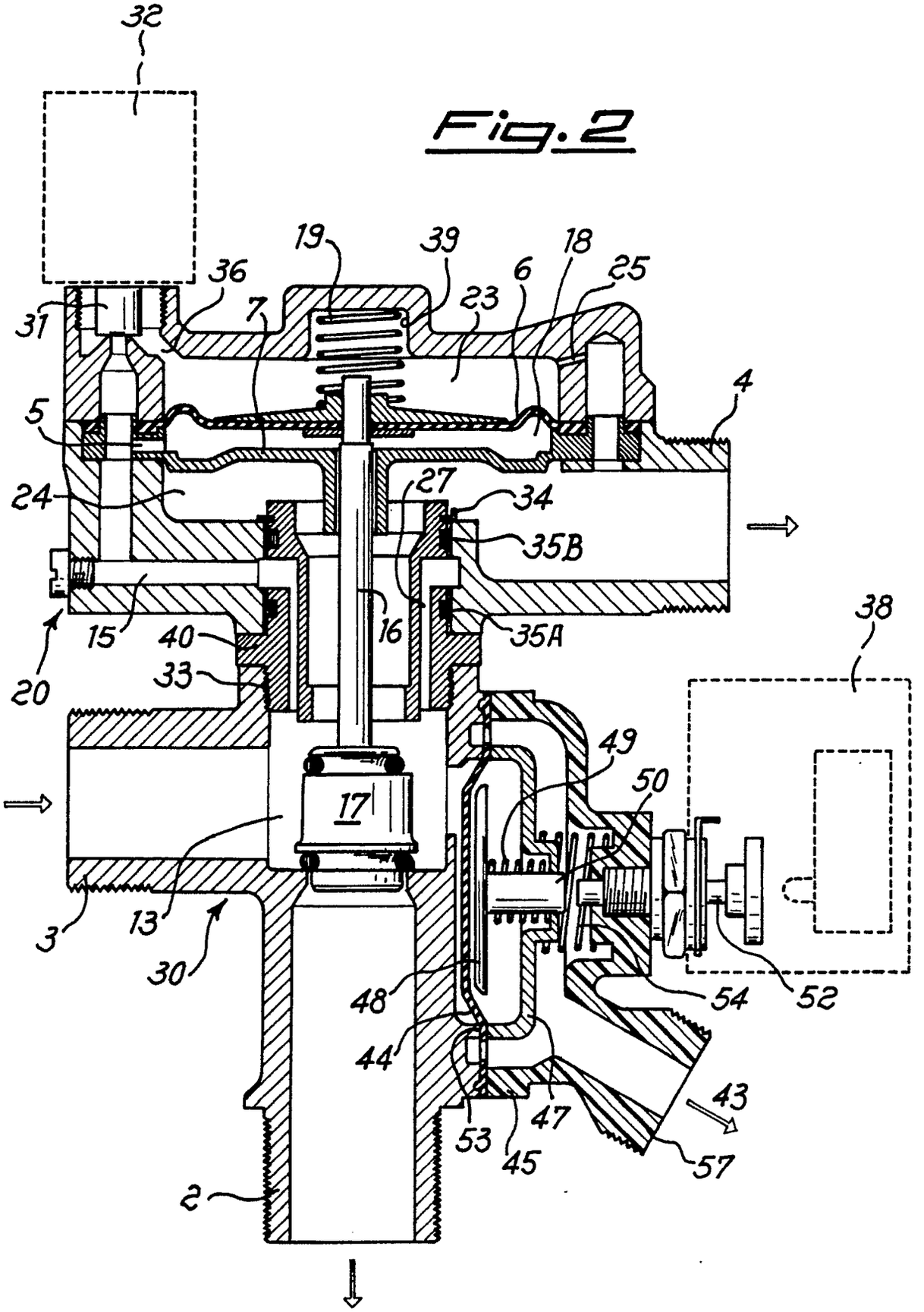
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Fig.4

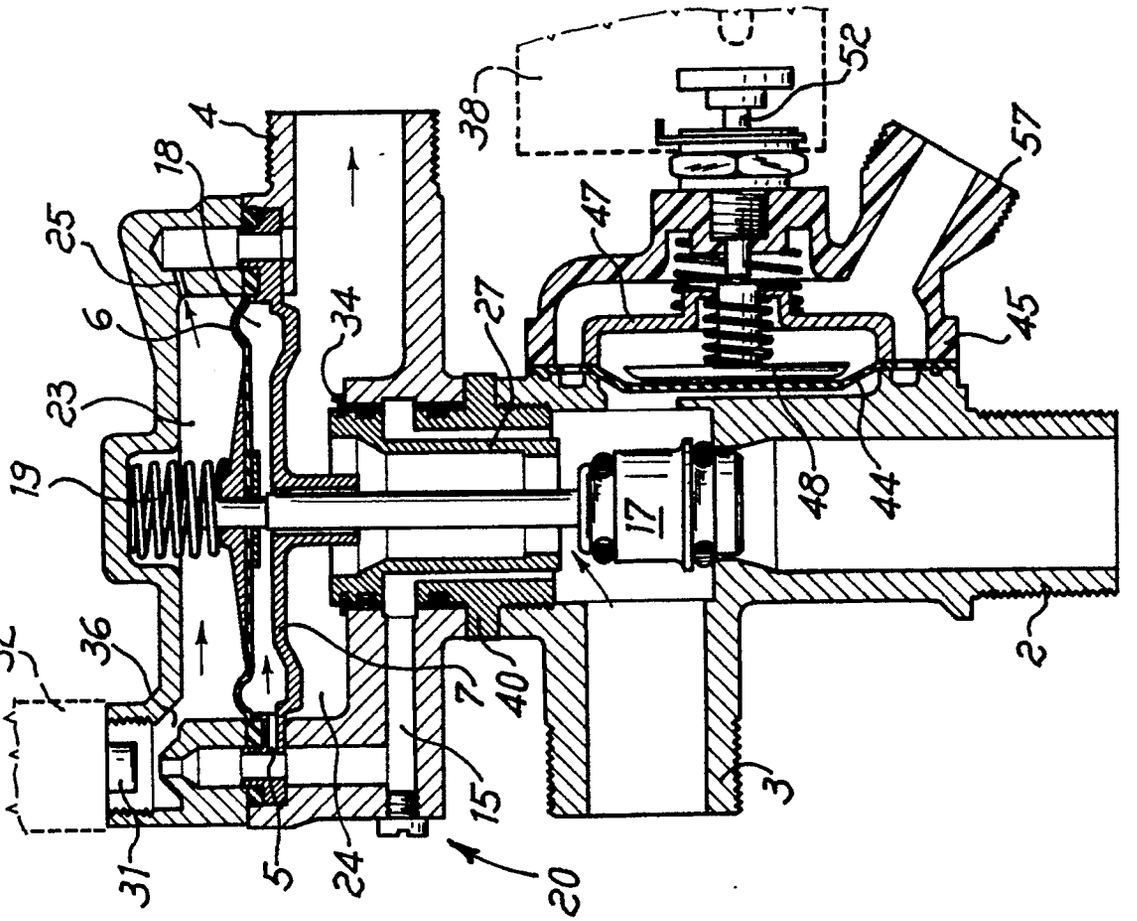
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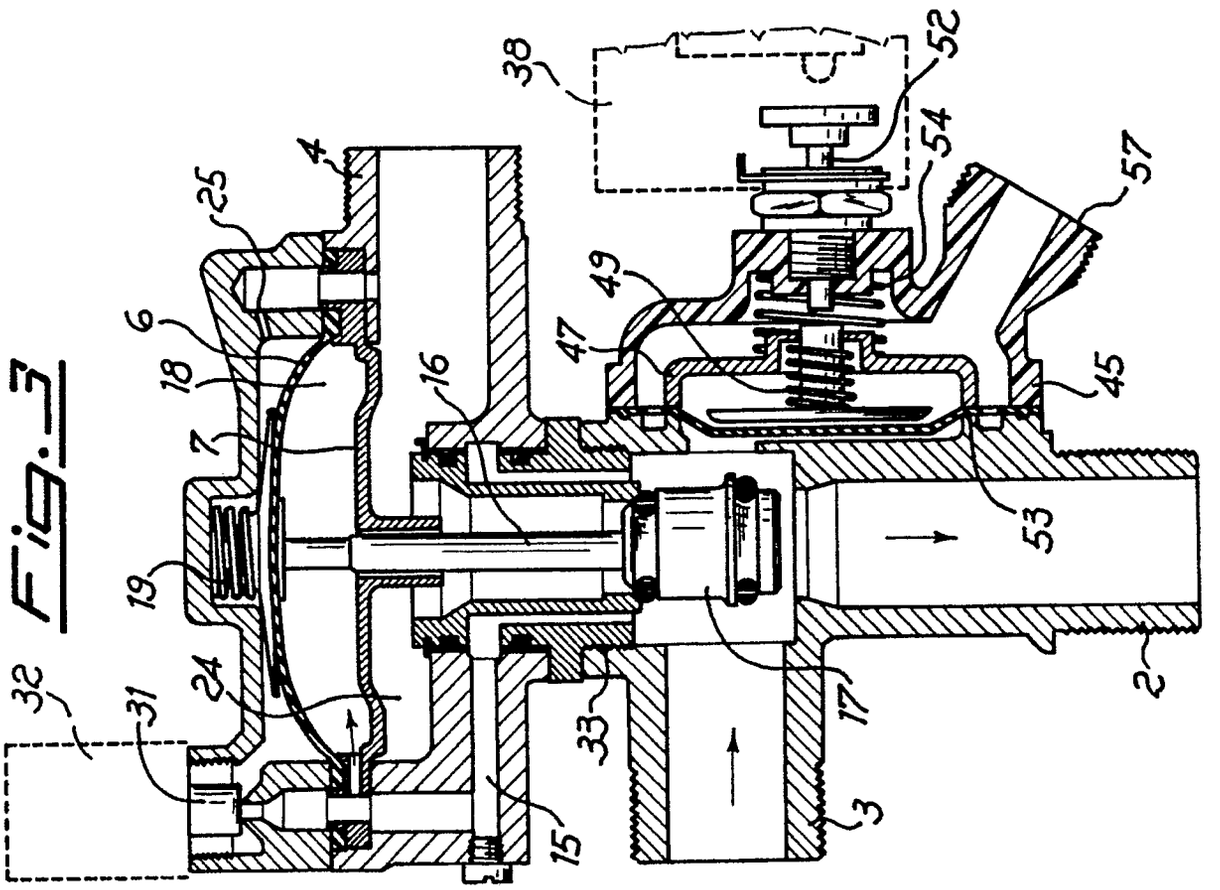
Fig.3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