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VALVE STRUCTURE

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2 Sheets-Sheet 1

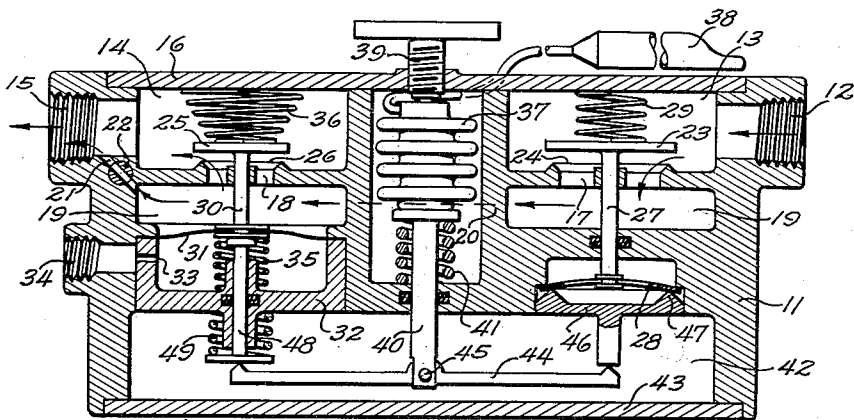


Fig. 1
HIGH FIRE

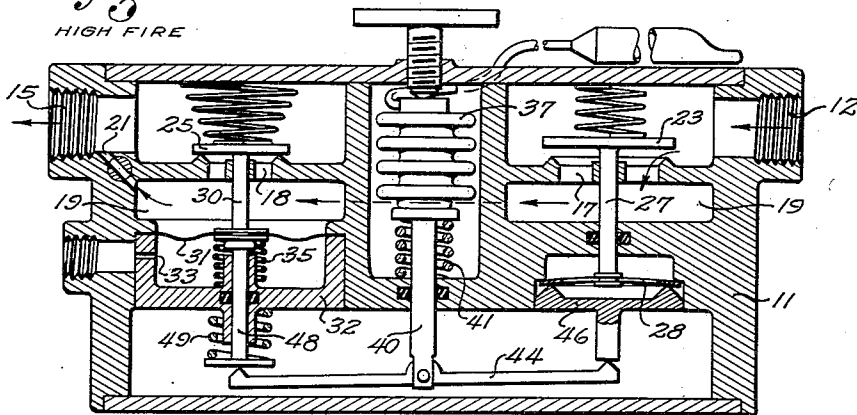


Fig. 2
LOW FIRE

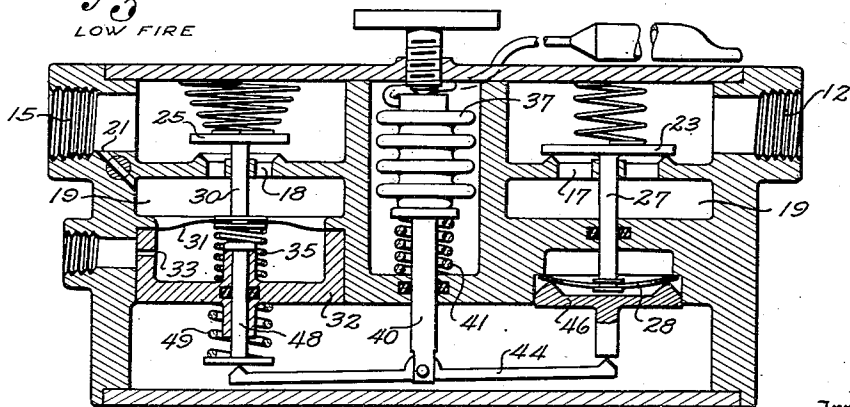


Fig. 3
OFF

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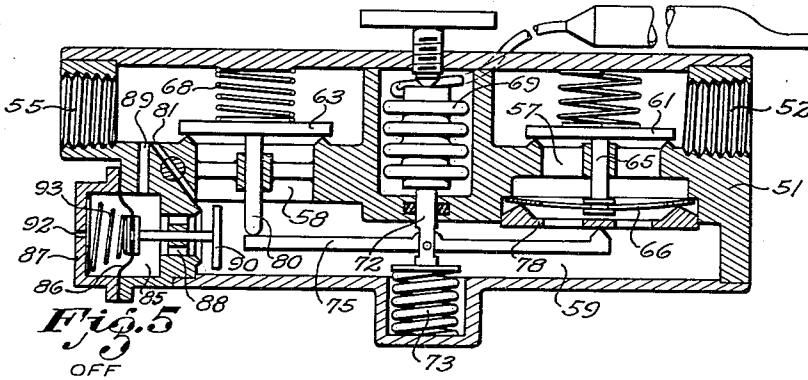
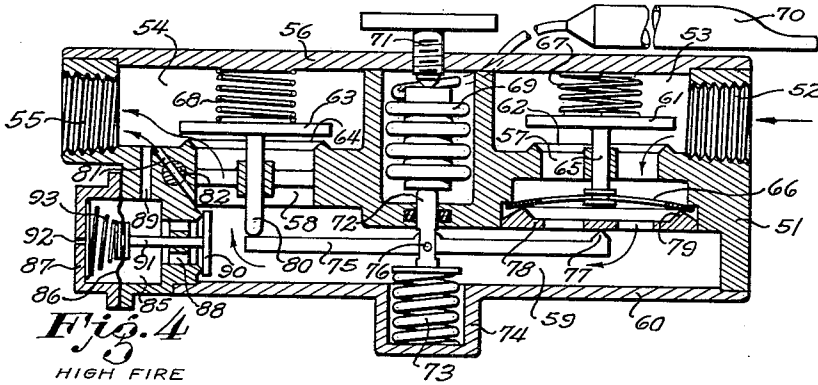
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VALVE STRUCTURE

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8 Claims. (Cl. 236—48)

This invention relates to valve structures of the type more particularly adapted for controlling supply of fuel gas to heating apparatus and including thermostatically operated valve means for maintaining an even temperature in a space, such as a room or oven, heated by the apparatus.

The invention of the present application is similar to those disclosed in my copending applications Serial No. 476,633 filed December 21, 1954, and Serial No. 483,683 filed January 24, 1955, now Patent No. 2,741,266, in that each of the inventions relates to a thermostatically operated valve structure which comprises a pair of valves interconnected in series to control flow of gas from an inlet to a main outlet, both of the valves being open when the space temperature is considerably lower than that desired so that a high-fire condition of the apparatus-burner is established; the valves being arranged for sequential operation and so that with rise of space temperature the main-outlet one of the valves is closed and gas then passes from the inlet through a restricted outlet, provided between the valves, to produce a low-fire condition; continued rise of space temperature, if such should occur despite the low-fire, effecting closing of the inlet valve and thereby complete shut-off of the gas.

An object of the present invention is to provide gas-pressure operated means for establishing, temporarily, relatively unrestricted communication between the inlet and the main outlet of the valve structure upon opening of the inlet valve (which, according to the present invention, occurs prior to normal opening of the main-outlet valve) so that gas can then pass at high rate to the burner to ensure prompt lighting of the same.

Another object of the invention is to establish said communication between the inlet and the main outlet by temporarily opening the main-outlet valve itself.

For full understanding of the invention, and further appreciation of its features and advantages, reference is to be had to the following detailed description and accompanying drawing, and to the appended claims.

In the drawing:

Figures 1, 2 and 3 are diagrammatic sectional views of a valve structure embodying this invention and particularly adapted for controlling supply of gas to the burner of a domestic space-heater; the parts being shown in these figures in the positions assumed, respectively, during "High-Fire," "Low-Fire" and "Off" conditions of the burner; and;

Figures 4 and 5 are similar views of a modified form of the invention wherein the parts are shown in positions corresponding to "High-Fire" and "Off" conditions of the burner.

Referring first more particularly to Figs. 1-3 of the drawing, the numeral 11 indicates an elongated casing having at its right an inlet opening 12 and inlet chamber 13, and at its other end an outlet chamber 14 and outlet opening 15, these chambers being defined in part by a plate 16 covering the top of the casing. Leading downwardly from the chambers 13 and 14, respectively, is an inlet port 17 and an outlet port 18. At their lower ends

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these ports are interconnected by an elongated chamber 19. In the middle of this chamber is a hollow portion 20 of the casing which, however, is spaced from the back and front walls of the chamber so that fluid can pass freely around it. Chamber 19 is continuously in communication with the outlet 15 by way of a restricted opening 21, the rate of flow through which opening can be adjusted by rotation of an apertured plug 22.

For controlling flow through the inlet port 17 there is a disk-shaped closure 23 cooperable with a valve seat 24 around the top of that port, there being a similar closure 25 cooperable with a valve seat 26 around the outlet port 18.

On the underside of the inlet closure 23 is a stem 27 which extends, sealingly, through an opening in the bottom wall of chamber 19 and is connected at its lower end to the central part of an apertured snap-disk 28 disposed in a recess below the stem-opening, the margin of the disk abutting a shoulder on the side wall of the recess. The snap-disk 28 is resilient and serves to bias closure 23 downwardly to seated position, the normal shape of the disk being such that its top surface is concave as shown in Fig. 3. Compressed between plate 16 and the top of closure 23 is a light stabilizing spring 29 whose effect can be ignored in connection with the operation of the valves.

The stem 30 of the outlet closure 25 is fastened at its bottom to a diaphragm 31 of rubber-like material which closes an opening in the bottom wall of chamber 19, the diaphragm being clamped at its margin between a shoulder in the opening and the rim of a cup-shaped member 32 secured in the opening. The space within member 32 and below the diaphragm is in communication with the atmosphere by way of a bleed opening in the side wall of the member and registering with an opening 34 through an end wall of the casing. Opening 34 is threaded for connection of a pipe (not shown) which, in the event of rupture of the diaphragm, would serve to conduct safely away any gas then escaping from chamber 19.

The outlet closure 25 is biased upwardly toward open position by the force of a spring 35 compressed between diaphragm 31 and the bottom wall of the cup-shaped member 32. However, when the inlet closure 23 is unseated (as shown in Figs. 1 and 2) and chamber 19 is subjected to the pressure of gas supplied to the inlet, the force produced by the pressure of the gas on the diaphragm is greater than the force of spring 35 so that the outlet closure is then urged downwardly toward seated position. Compressed between plate 16 and the top of the outlet closure is a light stabilizing spring 36 whose force is considerably less than that of spring 35 so that the effect of spring 36 can be ignored in connection with the operation of the valves.

Within the hollow of casing-portion 20 is a fluid pressure motor comprising an expansible-contractible bellows 37 and an interconnected thermal bulb 38 which, it is to be assumed, is arranged to respond to variations of the temperature of a space heated by apparatus supplied with fuel gas by way of the valve structure. Bellows 37 is interposed between an adjusting screw 39, threaded in an opening through plate 16, and a stem member 40 which is loaded by a stiff spring 41 and projects through an opening in the casing into a recess 42 in the underside thereof, the recess being covered by a plate 43. At its end within recess 42 the stem member 40 is slotted to receive a medial portion of an arm 44 and is provided with a pin 45 pivotally supporting the arm.

Arm 44 is arranged so that its right-hand end engages the stem portion of a disk 46 having on its top a knife-edged annulus 47 which bears against the snap-disk 28 inwardly of its marginal support. The opposite end of arm 44 engages the flanged bottom end of a plunger 48 sealingly reciprocable in an opening through a thickened

central portion of the bottom wall of cup-shaped member 32 and aligned with the outlet-closure stem 30. Plunger 48 is operatively engageable with the portion of stem 30 to which diaphragm 31 is fastened, and is biased downwardly by the force of a spring 49 compressed between its flanged end and the underside of member 32.

The parts are shown in Fig. 1 in the positions assumed when the temperature at the thermal bulb is low and bellows 37 so contracted that the stem member 40 is raised under the force of spring 41 and, through arm 44, both of the closures 23 and 25 are raised to fully-open position. It is to be understood that the pressure applied to diaphragm 31 by the gas in chamber 19 produces no appreciable opposition to the opening of closure 25 under the control of the temperature responsive means. The path of flow through the casing is then (as indicated by the flow arrows) from inlet 12 through port 17 to chamber 19 and thence through port 18 (and restricted opening 21) to the main outlet 15.

The force of spring 49 is greater than the resilient (downward) force of snap-spring 28 so that upon rise of space temperature and consequent depression of stem member 40 the arm 44 is rocked counterclockwise under the force of spring 49, and plunger 48 falls gradually to a position wherein the outlet closure 25 is seated by the pressure of the gas on the diaphragm—the inlet closure 23 being still fully open. The parts are then in the positions shown in Fig. 2 wherein flow through the casing is by way of the restricted opening 21 only, the adjusted rate of this flow being such that a low-fire condition of the heating apparatus is established. Under cold-weather conditions the operation of the valve structure is mainly such that the outlet closure 25 modulates between its high-fire position of Fig. 1 and its low-fire position of Fig. 2.

If the space temperature continues to rise despite the small amount of heat produced by the low fire, farther expansion of the bellows and depression of stem member 40 result, so that the force applied to the snap-disk is reduced sufficiently to permit it to assume its normal shape and snap the inlet closure 23 onto its seat and thus shut-off flow of gas to the burner.

Upon seating of the inlet closure the gas pressure in chamber 19 falls so that the force of spring 35 is then effective to raise the diaphragm and unseat the outlet closure, the rise of the diaphragm being gradual as air must be drawn through bleed opening 33 into the space below the diaphragm to permit the diaphragm to rise to its full extent. The parts are shown in their final positions in Fig. 3.

When, in response to subsequent cooling of the space, the bellows contracts, equal components of the force of spring 41 are applied through arm 44 to plunger 48 and disk 46. The force required to snap disk 28 upwardly from its normal position (while greater than the resilient force of the disk) is less than the force of spring 49 resisting upward movement of plunger 48, so that with contraction of the bellows the inlet closure is snapped open before any movement of the plunger can occur. Since the outlet closure 25 is then in its fully open position gas flows at high rate to the burner, so that prompt lighting of the gas by the usual pilot burner or other igniting means is ensured.

The pressure of the gas now in chamber 19 urges the diaphragm and the outlet closure in a downward direction against the force of spring 35, but to permit full movement of the diaphragm and outlet closure in that direction air must be expelled from the space below the diaphragm through bleed opening 33, and this opening is made of such size that seating of the outlet closure does not occur until a few seconds after the inlet closure has been snapped open. The parts are then again in their low fire positions, generally as shown in Fig. 2. With continued contraction of the bellows the outlet closure is forced from its seat to increase flow of gas to

the burner, and may finally reach its high fire position of Fig. 1.

It is to be observed that if the pressure of the gas supplied to the valve structure were to become abnormally low, there would be a tendency for the outlet closure to rise relative to its seat (and out of engagement with plunger 48) under the force of spring 35, so that in spite of its low pressure the gas would still be supplied in sufficient amount to the burner.

The modified valve structure of Figs. 4 and 5 is, in part, the same as the structure shown in my aforementioned application Serial No. 483,683 but includes an independent pressure-operated valve for temporarily supplying gas at high rate to the burner upon opening of the inlet valve.

The structure of Figs. 4-5 comprises an elongated casing 51 having at its right an inlet opening 52 and inlet chamber 53, and at its other end an outlet chamber 54 and outlet opening 55, these chambers being defined in part by a plate 56 covering the top of the casing. Leading downwardly from the chambers 53 and 54, respectively, is an inlet port 57 and an outlet port 58. At their lower ends these ports are interconnected by an elongated chamber 59 defined in part by a plate 60 covering the bottom of the casing.

For controlling flow through the inlet port 57 there is a disk-shaped closure 61 cooperable with a valve seat 62 around that port, there being a similar closure 63 cooperable with a valve seat 64 around the outlet port 58. Projecting centrally from the underside of the inlet closure 61 is a stem 65 which is connected at its lower end to the central part of an apertured snap-disk 66 disposed in a symmetrical enlargement of port 57 and with its margin abutting a shoulder therein. Snap-disk 66 is resilient and serves to bias closure 61 to seated position, the normal shape of the disk being such that its top surface is concave as shown in Fig. 5. Compressed between plate 56 and the top of closure 61 is a light stabilizing spring 67 whose effect can be ignored in connection with the operation of the valves. The outlet closure 63 is biased to seated position, as shown in Fig. 5, by the force of a spring 68 compressed between it and plate 56.

For producing force for actuating the valve closures 61 and 63 there is a liquid-filled thermostatic motor comprising a bellows 69 disposed in a recess between the chambers 53 and 54, and an interconnected thermal bulb 70, which, it is to be assumed, is arranged to respond to variations of space temperature in the same manner as does the motor 37, 38 of Figs. 1-3. Bellows 69 is interposed between an adjusting screw 71 and a stem member 72 which projects sealingly into chamber 59 and is loaded by a stiff spring 73 in a protuberance 74 of plate 60. Stem member 72 is slotted to receive an arm 75 which extends lengthwise of chamber 59 and is pivoted intermediate its ends on a pin 76 fixed to the stem. Arm 75 is arranged so that a projection 77 on its right end engages the central part of an apertured disk 78 having a knife-edged annulus 79 which bears against the snap-disk 66 adjacent its periphery. The left end of arm 75 engages the tip of a stem 80 on the underside of closure 63. The chamber 59 is continuously in communication with the main-outlet opening 55 by way of a restricted passage 81, the rate of flow through which can be adjusted by manipulation of a rotary valve plug 82.

In the outer surface of the valve casing at its left is a recess 85 which is covered by a flexible diaphragm 86 clamped at its margin to the casing by a hollow cap 87. The recess 85 is fluidly connected to the chamber 59 inside the casing by a port 88, and to the main outlet 55 by a passage 89. Controlling flow through port 88, and cooperating with a seat around the inner end of the port, is a supplemental closure 90 whose stem 91 is fastened to diaphragm 86. The space inside cap 87 communicates with the atmosphere by way of a bleed opening 92 and

contains a spring 93 acting on diaphragm 86 so as to urge closure 90 toward open position.

The parts are shown in Fig. 4 in position to produce high-fire at a burner; bellows 69 being contracted so that, through arm 75, both of closures 61 and 63 are raised to open position. Flow through the casing is then from inlet 52 through port 57 and the apertures of snap-disk 66 and disk 78 to chamber 59, and thence through port 58 (and passage 81) to the main outlet 55. The supplemental closure 90 is seated under the pressure of the gas in chamber 59 and against the force of spring 93 which is less than the force produced by the gas pressure.

The force of spring 68 on closure 63 is greater than the resilient (downward) force of snap-spring 66, so that when bellows 69 expands the outlet closure 63 seats while the inlet closure 61 is still open, and gas then flows through the restricted passage 81 to produce a low-fire at the burner. Upon farther expansion of the bellows the inlet closure also seats, so that the pressure of the gas in chamber 59 falls and the supplemental closure 90 opens under the force of spring 93. The parts are then in the positions shown in Fig. 5.

The force of snap-spring 66 resisting reopening of the inlet closure is less than that of the outlet-closure spring 68, so that upon subsequent contraction of the bellows the inlet closure opens while the outlet closure is still held closed. Since the supplemental closure 90 is then open, gas flows at relatively high rate to the burner through port 88, chamber 85, passage 89 and the outlet 55. The pressure of the gas acting on diaphragm 86 and on closure 90 effects reseating of this closure after a delay period determined by the flow capacity of the bleed opening 92.

The "surge-lighting" arrangement of Figs. 4 and 5 is also applicable to a valve system such as that disclosed in my aforementioned application Serial No. 476,633 wherein the inlet and outlet closures are both biased to open position.

The specific embodiments of my invention herein shown and described are obviously susceptible of modification without departing from the spirit of the invention, and I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a valve structure: a casing having an inlet and an outlet and a chamber therebetween; an inlet valve controlling flow from said inlet to said chamber and an outlet valve controlling flow from the chamber to said outlet; means, including means responsive to variation of a controlling condition, for producing mechanical force for actuating said valves; means for applying said force gradually to the valves and arranged so that when said condition varies in a given sense the inlet valve is opened before movement of the outlet valve in opening direction can be effected by said force, and the outlet valve is closed before the inlet valve is closed when the condition varies in the opposite sense; said chamber having a restricted opening leading to said outlet and by-passing the outlet valve so that when the inlet valve is open and the outlet valve is closed fluid can flow from said inlet to said outlet through the chamber and said restricted opening; means for supplying pressure fluid to said inlet; and a motor, operated in response to the change of fluid pressure in said chamber occurring upon closing and upon reopening of said inlet valve, for actuating said outlet valve independently of said force-applying means and of the inlet valve, said motor being arranged to effect opening of the outlet valve upon closing of the inlet valve, and delayed closing of the outlet valve upon reopening of

the inlet valve; said means for applying said force to the valves being arranged so that it is capable of actuating the outlet valve to open position against the force of said motor.

2. A valve structure according to claim 1 wherein said inlet valve is of the two-way snap-acting type.

3. In a valve structure: a casing having an inlet and a main outlet and an associated inlet port and main-outlet port; said casing having also a chamber interconnecting said ports, and a restricted outlet communicating with said chamber intermediate the ports; means for supplying pressure fluid to said inlet; means forming a valve seat around each of said ports; an inlet closure and an outlet closure mounted for movement into and out of engagement with said inlet-port seat and said main-outlet-port seat, respectively, to control flow through the ports; means biasing said inlet closure to seated position; a member operatively engageable with said outlet closure and biased to a position permitting seating of the outlet closure; means, including means operated by the pressure of fluid in said chamber, biasing said outlet closure toward closed position when said inlet closure is unseated and the chamber is subjected to the pressure of said fluid, and biasing the outlet closure toward open position upon seating of the inlet closure and reduction of pressure in the chamber; means movable gradually in response to variation of a controlling condition for producing actuating force superior to the individual biasing forces of said closures and of said member; and yieldable means for dividing said actuating force and for applying components of it gradually to said inlet closure and to said member so as to effect unseating of the inlet closure prior to movement of said member from its biased position when said condition varies in a given sense, and seating of the outlet closure prior to seating of the inlet closure when the condition varies in an opposite sense.

4. A valve structure according to claim 3 wherein a two-way snap-acting spring is employed for biasing said inlet closure.

5. A valve structure according to claim 3 and including means for delaying movement of said outlet closure to closed position under the force of its bias when said inlet closure is unseated.

6. A valve structure according to claim 3 wherein said outlet-closure biasing means comprises a spring urging the outlet closure toward open position, and a movable wall subjected on one side to the pressure of the fluid in said chamber and connected to the outlet closure so as to urge it toward closed position, with a force superior to that of said spring, when said inlet closure is unseated and the chamber is subjected to the pressure of the fluid supplied to said inlet.

7. A valve structure according to claim 6 and including means defining, with the other side of said movable wall, a chamber having a restricted vent communicating with a region of relatively low fluid pressure.

8. A valve structure according to claim 3 wherein said yieldable means comprises an arm pivotally connected intermediate its ends to said force-producing means, and means operatively connecting the respective opposite ends of said arm to said inlet closure and to said member.

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