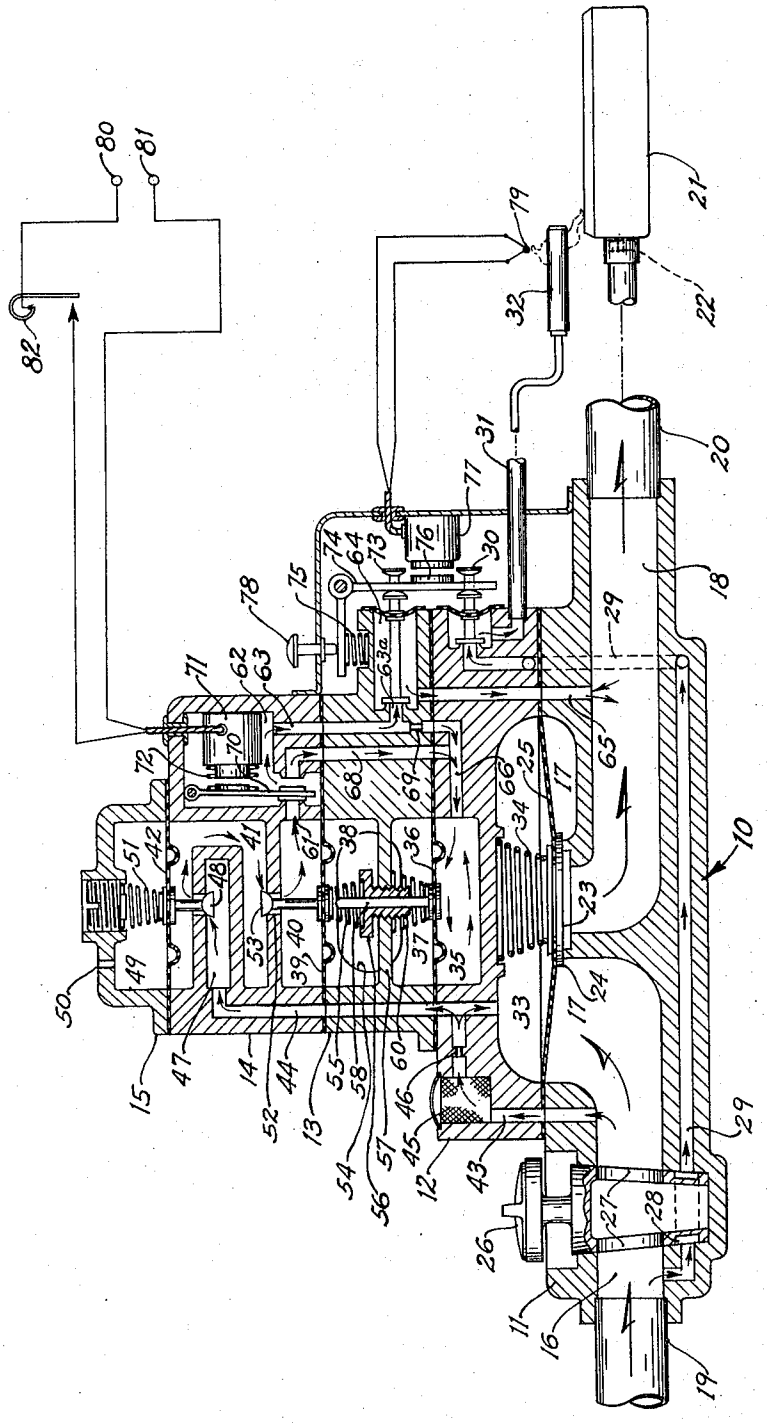
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GAS VALVE

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GAS VALVE

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This invention relates to gas valves for controlling the operation of gas burners and particularly concerns fluid pressure operated valves including regulating means for regulating the fluid pressure applied to the valve operator in a manner to maintain a predetermined gas pressure at the burner metering orifice.

An object of the invention is to provide a generally new and improved fluid pressure operated gas valve which when operated from closed to open position automatically supplies gas to a burner initially at a relatively low rate for a predetermined relatively short period of time and thereafter at a relatively high rate until the valve is operated to a closed position.

A further object is to provide a valve of this character which includes adjustable pressure regulating means whereby the relatively low initial flow rate as well as the subsequent higher flow rate may be preselected and maintained irrespective of variations in supply line pressure.

These and further objects and advantages will appear from the following description when read in connection with the accompanying drawing.

In the drawing, the single figure is a schematic view of a valve constructed in accordance with the present invention, shown associated with main and pilot gas burners.

Referring to the drawing, a valve body is generally indicated at **10** and comprises a lower main valve section **11**, three successive overlying sections **12**, **13**, and **14**, and a cover member **15**, all suitably connected. The main lower valve section **11** is provided with an inlet passage **16** leading to a chamber **17** and a main burner fuel outlet passage **18** leading from chamber **17**. A supply conduit **19** is connected to inlet **16**, and a conduit **20** is connected to outlet **18** and leads to a main burner **21** which is provided with the usual fuel metering orifice **22**. The main valve section **11** is further provided with an annular valve seat **23** with which a main disc valve **24** cooperates to control the flow of gas to the main burner **21**. The valve **24** is attached to and is movable with the central portion of a flexible diaphragm member **25** which forms the flexible upper wall of chamber **17**.

Interposed in inlet passage **16** is a manually rotatable plug valve **26** having main transverse ports **27** therethrough and an arcuate groove **28** at the lower end thereof forming a pilot burner fuel port. The arcuate groove **28** extends somewhat more than 180° around the plug valve **26** so as to permit the plug valve to be rotated to a position in which fuel is permitted to flow through a pilot burner fuel passage **29** when the ports **27** are in a position to cut off flow through main inlet passage **16**. The plug valve **26** may therefore be moved to three positions, one, in which all flow is cut off through both the main inlet **16** and the pilot burner fuel passage **29**, two, in which fuel is permitted to flow through pilot passage **29** only, and, three, in which fuel is permitted to flow through both the main inlet passage **16** and the pilot burner fuel passage **29**. The pilot burner fuel passage **29** extends from a point in the main inlet passage **16** anterior to plug valve **26** to an outlet in the first overlying body section **12** controlled by a valve **30**. A conduit **31** connected to the outlet of pilot burner fuel passage **29** leads to a pilot burner **32** arranged to ignite gas issuing from main burner **21**.

Body section **12** has a lower cavity forming a chamber **33** opposed to inlet chamber **17** and separated therefrom by flexible diaphragm **25**. A spring **34** in chamber **33** biases the central part of diaphragm **25** downward and valve **24** on its seat **23**. Body section **12** is further provided with an upper cavity forming a smaller chamber **35**. A flexible diaphragm **36** clamped between sections **12** and **13** forms the flexible upper wall of chamber **35**. Body section **13** in turn has a lower cavity forming a chamber **37** opposed to chamber **35** which is separated from chamber **35** by the flexible diaphragm **36**. The body section **13** is further provided with an upper cavity forming a chamber **38**, and a flexible diaphragm **39** clamped between body sections **13** and **14** forms the flexible upper wall of chamber **38**.

Body section **14** is again in turn provided with a lower cavity forming a lower chamber **40** opposed to chamber **38** and is separated therefrom by the flexible diaphragm **39**. Body section **14** is further provided with an upper cavity forming an upper chamber **41**. A flexible diaphragm **42** clamped between body section **14** and cover **15** forms the upper flexible wall of chamber **41**.

Upper chamber **41** and lower chamber **33** both communicate with the inlet chamber **17** through a common passage **43** and branched passage **44**. A filter **45** and a restricting orifice **46** are interposed in common passage **43**. The lower end of branch passage **44** opens directly into lower chamber **33**, but the upper end thereof opens into an extension passage **47** before entering chamber **41** and passage **47** is controlled by a valve **48**. The valve **48**, which will be hereinafter referred to as the full flow regulator valve, is attached to the central portion of diaphragm **42** forming the upper flexible wall of chamber **41**. A chamber **49** formed in cover **15** opposed to chamber **41** and separated therefrom by the diaphragm **42** is vented to atmosphere through vent **50**. An adjustable compression spring **51** in cover **15** bearing downward on diaphragm **42** biases the valve **48** openward.

A port **52** providing communication between chamber **41** and next lower chamber **40** is controlled by valve **53**. The valve **53**, which will hereinafter be referred to as the low flow regulator valve, is connected to the central portion of flexible diaphragm **39** which forms the lower flexible wall of chamber **40**. Chambers **38** and **37** underlying the chamber **40** are both vented to atmosphere through a side opening **54**. An adjustable compression spring **55** acting on the underside of diaphragm **39** biases valve **53** openward. The spring **55** bears at its lower end on a hollow threadedly adjustable member **56** threadedly engaged in a partition **57** separating chambers **38** and **37**. Access for adjustment of member **56** is provided by side opening **54**. A vertical pin **58** slidable in hollow member **56** abuts the lower side of diaphragm **39** under certain conditions to move valve **53** openward. The lower end of pin **58** is connected to the central portion of diaphragm **36**. The pin **58** and diaphragm **36** are biased downward by a spring **60**.

Chamber **40** communicates with main fuel outlet passage **18** through a port **61** opening into a chamber **62**, a passage **63** having a port **63***a* leading to a chamber **64**, and a passage **65** leading from chamber **64** to outlet passage **18**. Chamber **40** also communicates with chamber **35** through port **61**, passage **63**, passage **66**, and through passage **68** parallel with passage **63**. Passage **68** is unrestricted while passage **63** has a calibrated restriction **69** therein between chamber **64** and common passage **66**. It will be seen that chamber **35** is also in communication with the main fuel outlet passage **18** via passage **65**, chamber **64**, port **63***a*, passage **63** with restriction **69**, and passage **66**.

The passage **61** leading from chamber **40** to chamber **62** is formed with a valve seat on the chamber **62** side

as is the upper end of passage 68. These valve seats are axially aligned and opposed and are controlled by a double throw valve 70. The valve 70 is operated by a solenoid actuator 71 which when energized moves valve 70 from the position shown to a position wherein it opens with respect to port 61 and closes the upper end of passage 68. When solenoid 71 is de-energized a spring 72 returns valve 70 to the position shown, closing port 61 and opening the upper end of passage 68.

A valve 73 controls port 63*a* leading to chamber 64. The valve 73 controlling port 63*a* and valve 30 controlling the outlet of pilot burner fuel passageway 29 are operated simultaneously by a lever 74. The lever 74 is biased by a spring 75 in a direction to move valves 73 and 30 to a closing position with respect to port 63*a* and the pilot outlet. Lever 74 is provided with an armature 76 which is moved into contact with the core of an electromagnet 77 by a push pin 78, and when moved to this position opens valves 73 and 30. Electromagnet 77 is energized by current generated at a thermocouple junction 79 arranged to be impinged by a flame at pilot burner 32. Therefore, armature 76 will remain against the core of electromagnet 77 and valves 73 and 30 will remain open so long as there is pilot burner flame to generate electric current.

The energization of electromagnet 71, which actuates double throw valve 70, is effected through a circuit connected to commercial power source terminals 80 and 81 and controlled by a thermostat 82.

Operation

The elements of the device are shown in the positions they assume when the main and pilot burners are inoperative. The manual plug valve 26, however, for the purpose of better illustration, is shown in a position to admit fuel to inlet chamber 17 and to the pilot burner fuel passage 29. Under these conditions supply line pressure is applied to both sides of main valve diaphragm 25 inasmuch as chamber 33 is in open communication with chamber 17 through passages 43 and 44. The area on the lower side of diaphragm 25 exposed to this pressure being somewhat less than the exposed area on the upper side thereof due to the valve port area, the valve 24 will be biased on its seat. The closing spring 34 adds further seat pressure. The high and low flow regulator valves 48 and 53, respectively, will be closed, as shown, due to supply line pressure acting on their respective operating diaphragms 42 and 39.

When it is desired to operate the pilot burner, the push pin 78 is depressed and held down. This action rotates lever 74, moving armature 76 into contact with the core of electromagnet 77 and opening control valve 73 and pilot burner outlet valve 30, thereby permitting fuel to flow from passage 29 through conduit 31 to the pilot burner 32. The pilot burner is then lighted and push pin 78 is held down until sufficient electrical energy is generated at thermocouple junction 79 to hold lever 74 in the set position. With pilot burner 32 in operation and valve 73 being held in the open set position, the main valve 24 may now be operated to an open position by the closing of thermostat 82.

The closing of thermostat 82 energizes electromagnet 71 moving double throw valve 70 to a position to open port 61 and close passage 68. Opening of port 61 permits the existing supply line pressure in chambers 41 and 40 to exhaust at a relatively rapid rate to the instant existing atmospheric pressure in outlet passage 18 through port 61, chamber 62, passage 63, port 63*a*, chamber 64, and passage 65. When this occurs the pressure drop permits springs 51 and 55 to move high and low flow regulator valves 48 and 53 openward. As valves 48 and 53 move openward chamber 33 is also permitted to exhaust to main outlet passage 18 at a relatively rapid rate, thereby permitting the line pressure existing in chamber 17 and acting on the underside of main diaphragm 25 to move valve 24 openward. It will be seen that while chambers 33, 41, and 40 are thus exhausting to main outlet passage 18, they are also being supplied with gas at line pressure through passages 43 and 44, but this flow is restricted by orifice 46 to such extent that the net effect is a substantial drop in pressure in chambers 33, 41, and 40.

As main valve 24 moves open gas flows through outlet passage 18 and conduit 20 to burner metering orifice 22 which restricts the flow and causes the pressure in conduit 20 and outlet passage 18 to rise above atmospheric. When the pressure in outlet passage 18 rises to a predetermined pressure (above atmospheric), the pressure again increases in chamber 40 causing diaphragm 39 to depress downward to move the low flow regulator valve 53 toward a closed position. The low flow regulator valve now assumes that partially open position which permits chamber 33 to exhaust at a sufficiently greater rate than the input thereto through restriction 46 to position main valve 24 so as to maintain that predetermined pressure in outlet passage 18. This predetermined pressure in outlet passage 18 corresponds to a predetermined low flow rate through orifice 22.

This pressure increase in outlet passage 18, due to partially opening valve 24, also acts of course on diaphragm 42 which actuates the high flow regulator valve 48, but the spring 51 urging valve 48 openward is considerably stronger than spring 55 urging the low flow regulator valve 53 open so that, at the lower outlet pressures, the low flow regulator valve is the controlling point. In this connection the diaphragm 39 may be made of considerably larger area than diaphragm 42, if desired, so that it responds to close valve 53 at a lower pressure than that required to act on diaphragm 42 to close valve 48.

Under these low flow conditions the predetermined pressure existing in outlet passage 18 is slowly communicated to chamber 35 through the highly restricting orifice 69, the valve 73 being open. The passage 68 is closed at its upper end by double throw valve 70 under these conditions so that communication between main outlet passage 18 and chamber 35 is limited to orifice 69. As the pressure in chamber 35 attains that in main outlet passage 18, diaphragm 36 bulges upward, moving sliding pin 58 upward into engagement with diaphragm 39, and further so as to move diaphragm 39 upward and the attached low flow regulator valve 53 openward to a position in which it is no longer controlling. It will be understood that regulator spring 58, in any adjusted position is considerably stronger than diaphragm return spring 60. The elapsed time between the partial opening of main valve 24 and opening of valve 53 to a non-controlling position is in the order of five seconds. This time, of course, may be varied by providing an adjustable needle valve for orifice 69, which is contemplated. The purpose of providing an initial low flow fuel rate to the main burner for a short period is to allow time for a natural draft to develop through the burner combustion chamber before permitting a high or full flow rate to the burner to occur.

When the limiting low flow regulator valve 53 is moved openward to a non-controlling position, the chamber 33 above main diaphragm 25 may now be exhausted at a higher rate, permitting valve 24 to move farther open to a position which results in a higher predetermined pressure (above atmospheric) in main outlet passage 18. When this higher predetermined pressure in chamber 18 occurs, high flow regulator valve 48 is moved toward a closed limiting position which permits chamber 33 to exhaust at that rate which positions valve 24 so as to maintain the higher predetermined pressure in main outlet passage 18. This higher predetermined pressure in passage 18 corresponds to a predetermined higher flow rate through burner metering orifice 22.

The provision of an adjustable needle valve for varying the restriction at orifice 46 is contemplated. The use of an interlocking arrangement between manually ro-

tatable plug valve **26** and push pin **78**, which prevents the manual operation of push pin **78** to open valves **73** and **30** when plug valve **26** is in a position to permit flow from inlet **16** to chamber **17**, is also contemplated. Arrangements of this kind are well known and understood in the art.

When heat produced by main burner **21** satisfies thermostat **82**, it opens breaking the circuit energizing electromagnet **71**. When this occurs double throw valve **70** moves to a position to close port **61** and open passage **68**. The closing of port **61** again results in a pressure buildup in chambers **40**, **41**, and **33** equal to supply line pressure, whereupon main valve **24** closes. Unrestricted passage **68** now being open, chamber **35** is rapidly restored to the atmospheric pressure again existing in outlet passage **18** thereby permitting rapid recycle operation of the device. If the pilot burner is extinguished at any time, the supply of electrical energy to electromagnet **77** is no longer generated at thermocouple **79** and, therefore, valves **73** and **30** are closed. The closing of valves **30** cuts off flow to the pilot burner, and the closing of valve **73** cuts off all communication between chambers **33**, **41**, and **40** and the main outlet passage **18**. Under these conditions the pressure in chamber **33** attains that of inlet chamber **17** and main valve **24** closes.

It will be seen from the foregoing that we have provided a fluid pressure operated gas valve which functions automatically when operated from closed to open or from off to on position to supply an initial relatively small flow of gas to a burner for a predetermined relatively short period of time and, thereafter, supplies gas to the burner at a relatively high flow rate until the valve is operated to an off or closed position. It will also be seen that gas at both the initial small flow rate and the subsequent relatively high flow rate is supplied to the burner at a predetermined pressure irrespective of variations in supply line pressure.

Adjustment of the low flow regulator spring **55** to a stronger biasing position will result in a higher pressure in main outlet passage **18** and therefore a greater initial flow to the burner through metering orifice **22**, and adjustment of the high flow regulator spring **51** to a stronger biasing position will likewise increase the pressure in outlet passage **18** and therefore increase the subsequent higher flow rate to the burner.

Inasmuch as the position of main valve **24** is dependent on the pressure in outlet passageway **18** when the valve is operating, the substitution of a larger diameter burner orifice will cause valve **24** to open wider under both low and high flow operating conditions and thereby permit greater flow at the same predetermined pressures.

We claim:

1. In a gas valve, a valve body having an inlet passage, an outlet passage, and a valve chamber therebetween, a biased closed valve in said chamber controlling the flow from said inlet to outlet passage including a pressure responsive actuator operative to move said valve openward when greater fluid pressure is applied to one side thereof than to the other, means providing communication between said inlet passage and one side of said actuator, means providing relatively restricted communication between said inlet passage and said other side of said actuator, a bleed passage providing relatively unrestricted communication between said other side of said actuator and said outlet passage, a control valve movable to open and close said bleed passage, two pressure regulating valves arranged in series in said bleed passage, one of which is operative to maintain a higher fluid pressure on said other side of said actuator than the other, pressure responsive means in communication with said outlet passage and operative in response to an increase in pressure in said outlet passage to move said one pressure regulating valve to an inoperative position, and said communication between said pressure responsive means and said outlet passage comprising a highly restricted passage whereby the response to said pressure responsive means to an increase in pressure in said outlet passage is delayed.

2. A gas valve as set forth in claim **1** which further includes a second passage providing relatively unrestricted communication between said pressure responsive means and said outlet passage, and valve means movable with said control valve to close said second passage when said control valve is moved to open position with respect to said bleed passage and movable therewith to open said second passage when said control valve is moved to a closed position with respect to said bleed passage, whereby said pressure responsive means is permitted to exhaust rapidly into said outlet passage when said bleed passage is closed to effect closure of said main valve.

References Cited by the Examiner

UNITED STATES PATENTS

2,262,825	11/1941	Welliver	236—9
2,765,029	10/1956	Wolff.	
2,876,951	3/1959	Matthews	236—84
3,036,778	5/1962	Dillman	236—80
3,064,900	11/1962	Ages	236—80 X
3,235,180	2/1966	Graham et al.	236—80

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