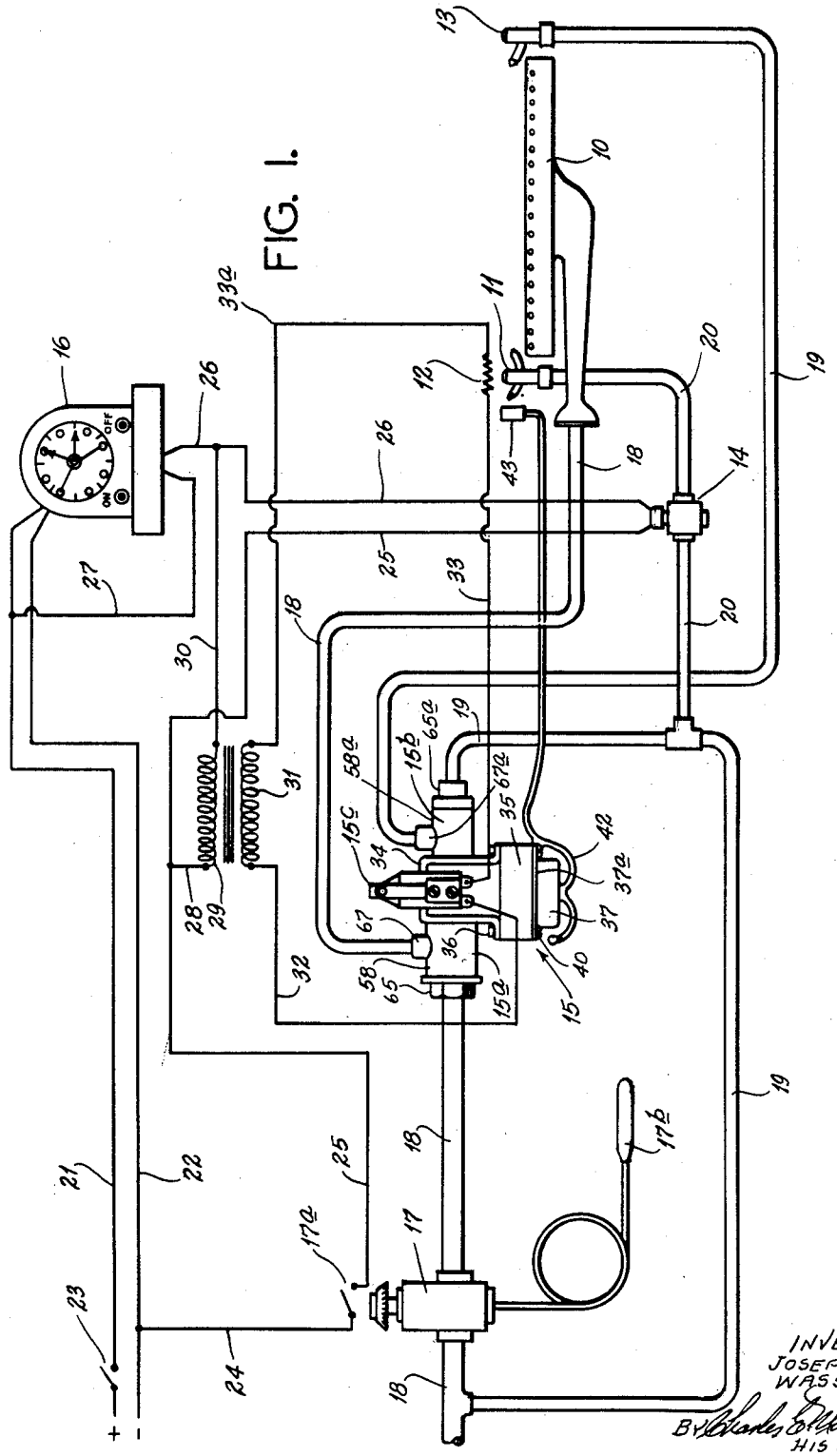
June 16, 1953 J. A. WASSER 2,642,309

TEMPERATURE RESPONSIVE ACTUATOR

Filed July 7, 1950 3 Sheets-Sheet 1

FIG. 1.



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TEMPERATURE RESPONSIVE ACTUATOR

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FIG. 2.

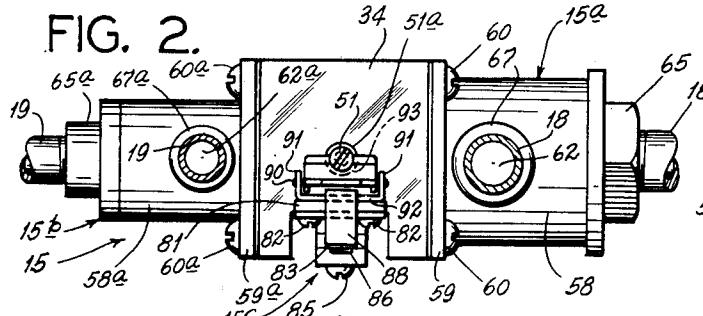


FIG. 11.

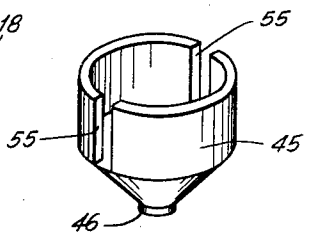


FIG. 3.

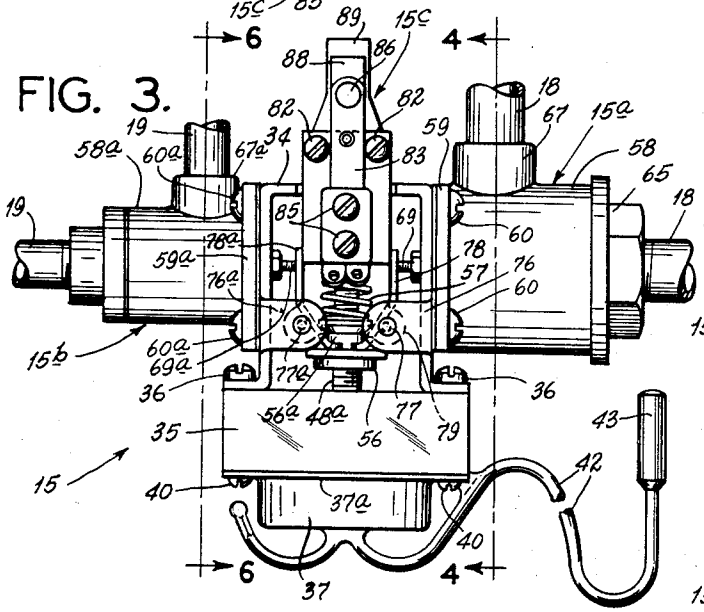


FIG. 4.

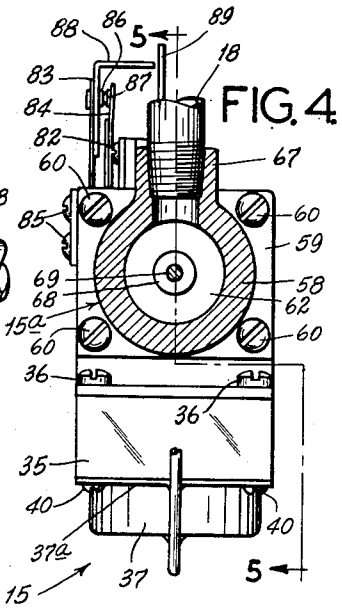


FIG. 5.

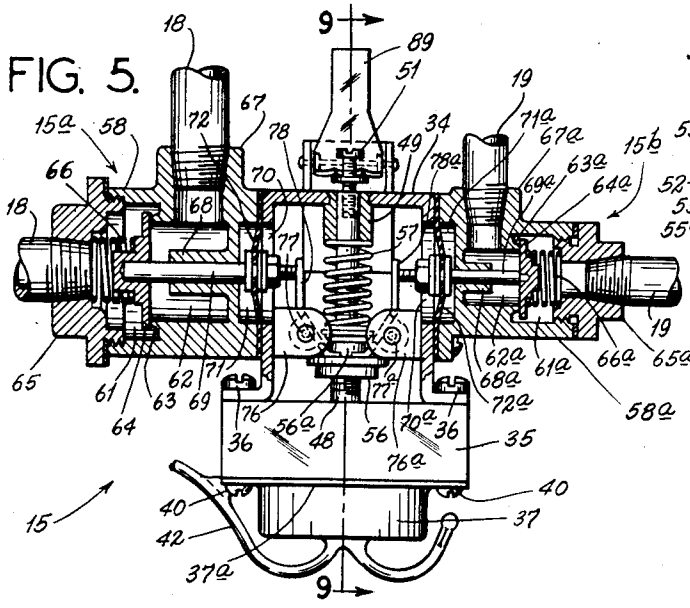
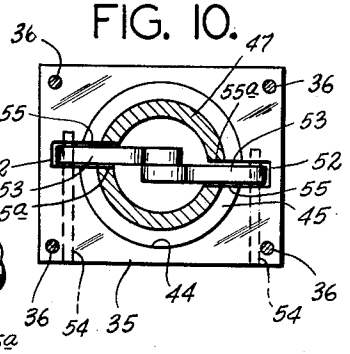


FIG. 10.



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TEMPERATURE RESPONSIVE ACTUATOR

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FIG. 6.

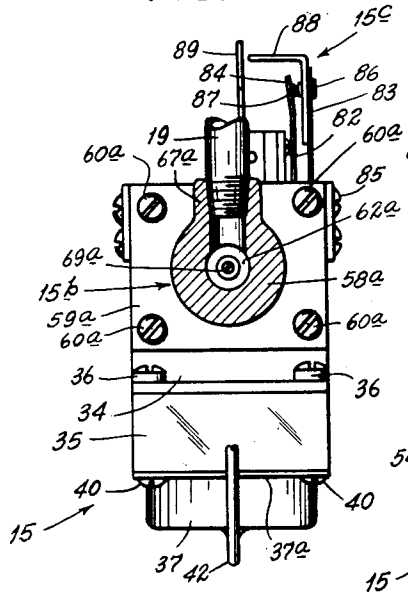


FIG. 7.

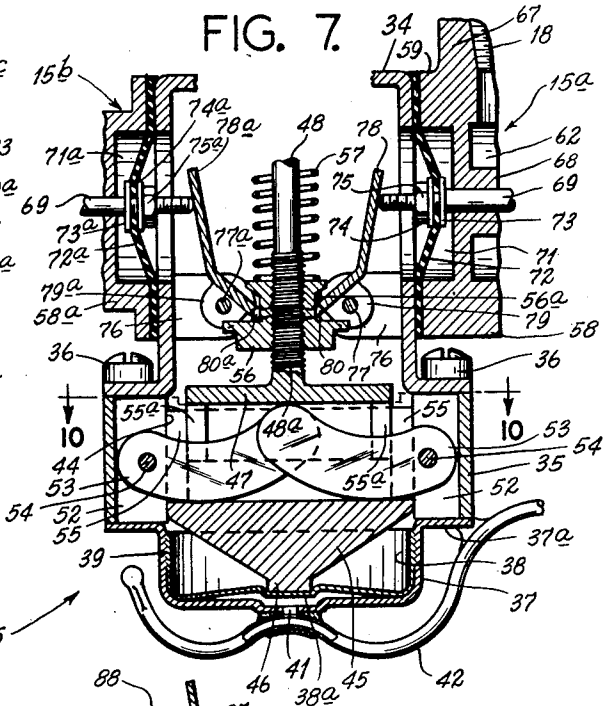


FIG. 9.

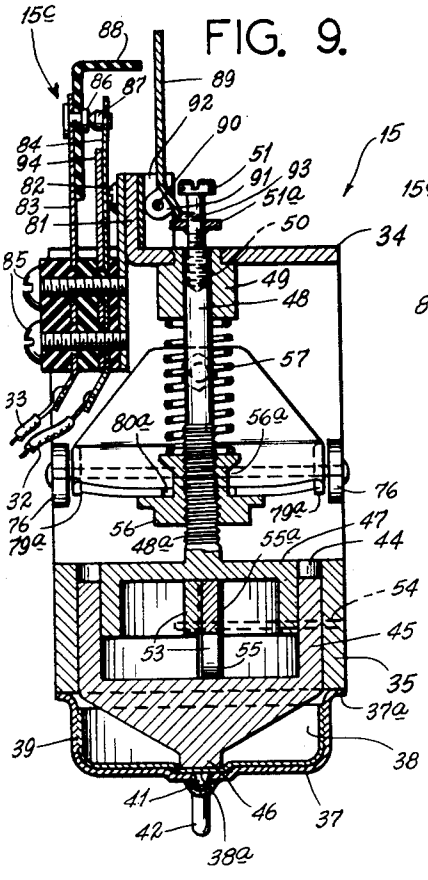
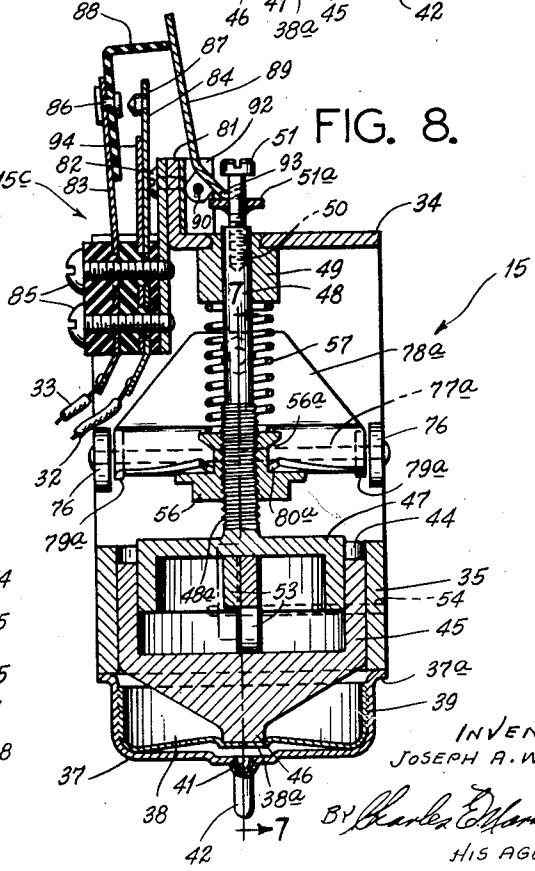


FIG. 8.



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2,642,309

UNITED STATES PATENT OFFICE

2,642,309

TEMPERATURE RESPONSIVE ACTUATOR

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Application July 7, 1950, Serial No. 172,547

2 Claims. (Cl. 297—9)

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This invention relates to control devices for gaseous fuel burners, and more particularly to control devices for this purpose which respond to a change from flame to no-flame and vice versa at a controlling pilot burner to automatically control the fuel supply to the main burner.

In burner control devices of this character, there is an appreciable lag in the closing of the main burned fuel valve following the extinguishing of the flame at the controlling pilot burner. This lag is due in part to the high temperatures which usually exist ambient to the pilot burner, and in part to the inherent thermal inertia which characterizes any suitable type of temperature responsive actuator which would ordinarily be employed for the actuation or the control of the main burner fuel supply valve.

In burner control systems for domestic gas range ovens, for example, which employ control devices of this type together with the usual manual shut-off cock by which the fuel supply to both the main and pilot burners may be shut off or turned on at will, there is the possibility that hazardous accumulations of unburned gas may occur in the oven chamber. These accumulations may occur if the manual shut-off cock is first closed, for any reason, thereby extinguishing the main and controlling pilot burners, and then opened again before the temperature responsive actuator has had time to close the automatically operated main burner fuel valve.

In order to preclude this possible hazard it has been proposed to provide an auxiliary or standby pilot burner, at which flame may be maintained under any conditions as long as any fuel is capable of passing the automatically operated main burner fuel control valve. The standby pilot burner having a fuel supply conduit which bypasses the usual manual shut-off cock and includes a control valve which is coordinated with that of the automatically operated main burner fuel supply valve so as to open and close substantially at the same time.

Such burner control systems may further include automatic ignition devices for igniting the controlling pilot burner, and it is desirable that such ignition devices operate only for an interval sufficient to insure ignition of the controlling and standby pilot burners and main burner, in order to prolong the service life of the igniter device.

The present invention has for an object the provision of a generally new and improved burner control device which is responsive to the condition of a controlling pilot burner for separately

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controlling the flow of fuel to the main burner and to an auxiliary or standby pilot burner, and for controlling the operation of an intermittent pilot ignition device so as to permit its operation only for a period sufficient to insure ignition of all burners.

It is a further object to provide a control device of the above character having a flame sensitive actuator and a pair of control valves arranged to be opened and closed substantially simultaneously by the actuator, and a switching device arranged to be operated to an open circuit position by the actuator upon further movement of the actuator after the valves have been moved to their full open positions.

A further object is to provide a control device as above in which the operative relationship between the switching device and the control valves is conveniently adjustable.

A further object is to provide a particularly compact and dependable temperature responsive actuator employing a relatively small quantity of a high boiling point thermally expansible fluid such as mercury and an expansible chamber having a flexible metal diaphragm of relatively limited movement, thereby to provide a relatively small, though substantially positive, movement in response to a small economical pilot flame, and having novel means for substantially multiplying the actuating movements of the flexible diaphragm and for transmitting the multiplied movements in a direction substantially perpendicular to and coincident with the center of the diaphragm for the actuation of control members.

Other objects and advantages will become apparent upon reading the following complete description in connection with the accompanying drawings.

In the drawings:

Fig. 1 is a schematic illustration of the burner control system incorporating a burner control device constructed in accordance with the principles of the present invention;

Fig. 2 is a plan view of the burner control device shown in Fig. 1;

Fig. 3 is a side elevation of the burner control device shown in Fig. 1;

Fig. 4 is a view taken on line 4—4 of Fig. 3;

Fig. 5 is a view taken on line 5—5 of Fig. 4;

Fig. 6 is a view taken on line 6—6 of Fig. 3;

Fig. 7 is an enlarged part sectional view taken on line 7—7 of Fig. 8;

Figs. 8 and 9 are different operative views shown in enlarged section and are taken on line 9—9 of Fig. 5;

Fig. 10 is a sectional view taken on line 10—10 of Fig. 7; and

Fig. 11 is a perspective view of the diaphragm follower member.

Referring more particularly to the drawings, the burner control system schematically illustrated in Fig. 1 is particularly adapted to the control of a domestic gas range oven burner. The system includes as primary elements a main oven burner 10, a controlling pilot burner 11, a pilot igniter 12, an auxiliary or standby pilot burner 13, an electromagnetically actuated valve 14 for controlling the supply of fuel to the controlling pilot burner, a thermostatically actuated control device generally indicated at 15 having a valve 15*a*, a valve 15*b*, and a switch 15*c* for controlling the supply of fuel to the main burner and standby pilot burner and for controlling the igniter device, a timer actuated switch device 16, and a modulating control valve 17 having incorporated therein a manual shut-off cock and a pilot control switch 17*a*. The modulating valve 17 is of the conventional type which regulates the supply of fuel to the main burner in accordance with requirements in order to maintain a preselected oven temperature and it is provided with the usual fluid filled temperature sensitive bulb 17*b* which is located in the oven chamber so as to be sensitive to the temperatures therein.

Fuel is supplied to the system through a fuel conduit 18 in which the modulating control valve 17 is connected as indicated. Fuel is conducted to the standby pilot burner 13 through a by-pass conduit 19 which by-passes the valve device 17. A branch 20 leading from the by-pass conduit 19 supplies fuel to the controlling pilot burner 11. The thermostatically actuated control device 15 is connected in the main fuel burner supply line 18 and in the by-pass conduit 19 so as to further automatically control the flow of fuel to the main burner 10 and so as to control the flow of fuel to the standby pilot 13. The branch 20, however, which supplies fuel to the controlling pilot burner, is connected to the by-pass 19 at a point anterior to the device 15 and has the electromagnetic valve 14 connected therein to control the supply of fuel to the controlling pilot burner 11.

Electrical power is supplied to the time operated switch device 16 through a pair of conductors 21 and 22 which are connected to a suitable source of electrical energy. A master control switch 23 is included in the conductor 21. A parallel circuit for the energization of the electromagnetically operated valve 14 is provided and includes the lead 24, connected to the conductor 22, the pilot control switch 17*a*, a lead 25 to the electromagnetic valve 14, a lead 26 to the timer switch 16 and a lead 27 to the conductor 21. Means for energizing the pilot igniter 12 is provided and includes the lead 24, the switch 17*a*, the lead 25, a lead 28, a transformer primary winding 29, a lead 30, the lead 26 to the timer actuated switch 16 and the lead 27 to the conductor 21 completing a primary circuit, and a secondary circuit comprising a secondary transformer winding 31, a lead 32, the switching device 15*c*, a lead 33, the resistance type pilot igniter 12, and a lead 33*a* back to the other side of the secondary winding 31.

From the foregoing it will be seen that the fuel supply to the main burner 10 may be modulated or completely shut off manually at the modulating valve 17 and that it is further controlled by the thermostatically actuated control 15. It will also be seen that the fuel supply to the standby pilot burner 13 is controlled only by the thermostatic control device 15 and that the fuel supply to the controlling pilot burner 11 is, through the energizing circuit for the electromagnetic valve 14, under the control of both the manual switch 17*a* which is associated with the modulating control valve 17 and the timer actuated switch 16 which is in series with the switch 17*a*.

The thermostatically controlled device 15, shown in Figs. 2 to 11 inclusive, includes an inverted U-shaped frame member 34 which is rigidly attached at its lower open ends to a rectangular base member 35 by means of attaching screws 36. Attached to the lower surface of the base member 35 is an expansible chamber comprising a rigid outer cup member 37 and an inner flexible metal cup member 38. The inner cup member 38 is closely fitted in the outer cup member 37 and the side walls of the cup members are continuously connected by welding as indicated at 39. The outer cup element 37 is provided with a flange 37*a* through which pass attaching screws 40 for attachment of the cup to the base member 35.

The bottoms of the inner and outer cup members are normally substantially contiguous as indicated in Fig. 9. The outer cup member has an aperture 41 in the bottom thereof which is in communication with one end of a capillary tube 42. The other end of the capillary tube is connected to a bulb 43. The complete system which comprises the expansible chamber, the capillary tube and the bulb, is filled with liquid mercury and the bulb 43 is disposed with relation to the controlling pilot burner so as to be heated thereby, as indicated in Fig. 1. Upon being sufficiently heated by the controlling pilot burner flame, the liquid mercury is expelled from the bulb 43 and forced in between the bottoms of the inner and outer cup members 37 and 38 which displaces the flexible inner cup member 38 as indicated in Figs. 7 and 8. The volume increase of the expansible chamber between its contracted and expanded positions is sufficient to receive all of the liquid contained in the bulb 43, so that when the bulb 43 is sufficiently heated all liquid mercury may be expelled therefrom and excessive pressures on the thin metallic diaphragm due to continued heating of the bulb are thereby avoided.

The base member 35 is provided with a large circular opening 44 therethrough which receives in sliding fit relationship a lower cup-shaped follower member 45. The bottom of follower member 45 is tapered to a short relatively small diameter cylindrical portion 46 at its center which rests in a shallow accommodating circular recess 38*a* at the center of the inner cup member 38. The lower follower member 45 is therefore moved vertically as the inner cup member or diaphragm member 38 is displaced by the mercury expelled from the bulb 43. Slidably fitted in the cup-shaped follower member 45 is a second inverted cup member 47 having a vertical shaft member 48 extending upwardly from the center of its closed end. The shaft 48 may be formed as an integral part of the closed end of cup 47 as indicated and it is provided with a threaded portion 48*a* near its lower end. The upper end of shaft 48 is slidably received in a guide bushing 49 which is supported in the horizontal leg portion of the U-shaped frame member 34. The upper end of shaft 48 has a longitudinally threaded bore 50 which receives an adjustable

abutment member 51 having rigidly fastened thereon a collar member 51a.

The base member 35 is further provided with a pair of slots 52, see Figs. 7 and 10, each of which receives one end of one of a pair of curved levers 53. The curved levers 53 are pivoted at their outer ends in the base member 35 on horizontal pivot pins 54. The side walls of the follower member 45 as well as the side walls of the inverted cup member 47 are also provided with corresponding slots 55 and 55a respectively so as to receive the curved levers 53 and permit their rotation about their pivots 54. The curved levers 53 bear on their lower curved surfaces against an upper flat bottom surface of follower member 45. The free inner ends of levers 53 are rounded and bear against the flat bottom under surface of inverted cup member 47. As the follower member 45 is moved upward or downward the levers 53 rotate, and their engagement with the bottoms of follower member 45 and inverted cup member 47 is maintained through a smooth rolling and sliding action. It will be understood that the vertical movement of follower 45 is relatively small, in the order of .030 of an inch. The shaft 48 has threaded thereon near its lower end an adjustable collar member 56 having an annular recess 56a. A spring 57 is provided which surrounds the shaft 48 and is biased between the guide bushing 49 and the collar member 56 so as to normally urge the members 45 and 47 together and downwardly against the inner cup member 38. The strength of spring 57 determines the temperature at which the mercury in bulb 43 is expelled and therefore, the temperature at which the control is actuated. The strength of spring 57 is preferably made such that the control actuating temperature is sufficiently higher than anticipated ambient temperatures to insure reasonably rapid response to a change from flame to no flame at the controlling pilot burner.

The valves generally indicated at 15a and 15b in Fig. 1 comprise a relatively large cylindrical valve housing 58 attached to the right vertical leg, Fig. 3, of the frame member 34, and a smaller cylindrical valve housing 58a attached to the left vertical leg of the frame member 34. The valve housings are provided with flanges 59 and 59a respectively through which pass attaching screws 60 and 60a for attachment of the housings to the frame member 34. The valve housings 58 and 58a and their internal valve mechanisms are similar except for size. Each being provided with an inlet chamber 61 and 61a respectively and an outlet chamber 62 and 62a respectively which are formed by longitudinal bores and counter bores, see Fig. 5. Valve seats 63 and 63a respectively are formed at the shoulders between the outlet and inlet chambers and are adapted to be engaged by valves 64 and 64a respectively. The counter bores, which form the inlet valve chambers 61 and 61a, are internally threaded at their outer ends to receive inlet closing plugs 65 and 65a respectively. These inlet closing plugs have internally threaded central openings therethrough which receive in threaded engagement the main fuel line 18 and by-pass line 19. The valves 64 and 64a are normally held in a closed position by valve closing springs 66 and 66a respectively. Laterally projecting hollow outlet bosses 67 and 67a having communication with the outlet chambers 62 and 62a and being internally threaded to receive in threaded engagement the ends of conduits 18 and 19 respectively are also provided.

The valve housings are further provided with longitudinally bored internal guide bosses 68 and 68a which slidably receive and guide the valve stems 69 and 69a. The valve stems are loosely received at one end in central recesses in the faces of the valves 64 and 64a to facilitate assembly, cleaning or inspection of the valves. The valve stems extend inwardly and exteriorly of the valve housings and through relatively large perforations 70 and 70a in the vertical legs of the frame member 34. Recesses 71 and 71a are provided at the inner ends of the valve housings corresponding in size to the perforations 70 and 70a in the frame member, and flexible diaphragm members 72 and 72a clamped at their peripheries between the inner ends of the valve housings and the frame member 34 are provided to seal the valve housings and to permit the reciprocating movement of the valve stems. The valve stems have reduced threaded portions at their inner ends and pass through central perforations in the diaphragms. These central diaphragm perforations, as best seen in Fig. 7, are sealed on one side by washers 73 and 73a which bear against the shoulder formed by the reduction in the diameter of the valve stems, and by washers 74 and 74a on the other side of the diaphragm. The diaphragms being held firmly between the washers and the washers being held firmly against the shoulder by nuts 75 and 75a.

Each of the vertical legs of frame member 34 is provided with a pair of inwardly and right angularly formed portions 76 and 76a at their edges, which portions are perforated and receive and support pivot pins 77 and 77a respectively. Mounted for rotation on these pivot pins are a pair of wide levers 78 and 78a having widely spaced angularly formed and perforated ear portions 79 and 79a formed at their edges through which pass the pivots 77 and 77a. The ear portions 79 and 79a are so located on the levers as to form relatively short inner lever leg portions and relatively long outer leg portions. The inner leg portions of the levers 78 and 78a are formed substantially horizontal at their ends and are adapted to engage the lower side of the recess 56a in the adjustable collar member 56. The ends of these horizontal leg portions are provided with arcuate recesses 80 and 80a which generally conform to the diameter of the adjustable collar 56 at the base of its recess 56a, thus permitting the point of engagement between the inner ends of the levers and the adjustable collar to more closely approach the axial center of the shaft 48. The outer longer leg portions of levers 78 and 78a are formed substantially vertically and are adapted to be engaged near their outer ends by the inner ends of the valve stems 69 and 69a. Thus as the shaft 48 is moved upward by expansion of the expansible chamber, the valve stems 69 and 69a are moved outward and the valves 64 and 64a are moved openward, and as the shaft 48 is moved downward upon contraction of the expansible chamber by the spring 57, the valves are closed and the levers are maintained in engagement with the lower side of the recess in the collar 56 by the valve return springs 66 and 66a.

Mounted on an upturned portion 81 of the horizontal leg of the frame member 34, as by attaching screws 82, is the switching device generally indicated at 15c in Fig. 1. The switch comprises a pair of flexible contact carrying blades 83 and 84. The blades are stacked in the usual manner on screws 85 with suitable separating insulators as indicated. The flexible switch blades carry at their outer free ends contacts 86 and 87 and the

blades are so formed that the contacts are normally held in engagement by the inherent resiliency of the blades. The circuit leads 32 and 33 of Fig. 1 which form a part of the pilot igniter circuit are connected to the blades 83 and 84 respectively as indicated. At its outer free end the switch blade 83 has attached thereto a right angularly formed member 88 constructed of insulating material and adapted to be engaged by the outer free end of a switch actuating lever 89. The switch actuating lever 89 is pivoted on a pivot 90 which passes through perforated angularly formed ears 91 at the sides of the lever 89. The pivot 90 is supported at its ends by a U-shaped bracket 92 attached to the upturned portion 81 of the frame 34 by the screws 82.

The pivot point of the switch actuating lever 89 is so located as to provide a short inner lever leg portion and a longer outer leg portion. The inner leg portion of the lever is formed substantially horizontal at its end and is adapted to engage the collar 51*a* of adjustable abutment member 51. The horizontal lever portion is also provided at its end with an arcuate recess 93 which generally conforms with the diameter of the threaded adjustable abutment member 51 thus permitting the point of engagement between the lower horizontal lever portion and the collar 51*a* to more closely approach the axial center of the shaft 48. The outer longer leg of the lever 89 is formed substantially vertical and is adapted to engage the horizontal portion of the insulating member 88. Thus as the shaft 48 is moved upward the lever 89 is rotated counterclockwise, in Figs. 8 and 9, and contacts 86 and 87 are separated and the switch is opened. As the shaft 48 is moved downward the switch again closes due to the resiliency of the switch blades. A rigid stop bar 94 lying alongside of switch blade 84 is provided to definitely limit the leftward travel of this resilient blade as viewed in Fig. 8.

In operation

When it is desired to operate the oven burner for a selected interval to be started at a selected time, the timer actuated switch 16 is adjusted so as to close at the preselected time and remain closed for the preselected interval in the usual manner. The dial of the conventional modulating device 17 is also rotated; first opening the manual cock and closing the incorporated switch 17*a*, and then being further adjusted to the selected temperature to be maintained within the oven chamber during the interval of operation. It will be understood that the master control switch 23 must also be closed. When this has been done and the timer actuated switch 16 closes the circuit at that point, the electromagnetic valve 14 will be energized through a circuit comprising the lead 24 connected to the conductor 22, the switch 17*a*, the lead 25, the lead 26, the timer actuated switch 16 and the lead 27 connected to the conductor 21. When the valve 14 is energized fuel is permitted to flow through the by-pass 19 and the branch 20 to the pilot burner 11. At the same time the igniter 12 will be energized through the primary and secondary circuits described. The primary circuit comprising the lead 24 connected to the conductor 22, the switch 17*a*, the lead 25, the lead 28, the primary winding 29, the lead 30, the lead 26, the timer actuated switch 16, and the lead 27 connected to the conductor 21. The secondary circuit comprising the secondary winding 31, a lead 32 to the normally closed switch 15*c*, the lead 33 to the igniter 12 and the lead 33*a* back to the secondary winding 31. It will be understood that the switching device 15*c* is normally closed when the system is in a cold condition.,

The controlling pilot burner will therefore be ignited and the mercury filled bulb 43 will be heated by the controlling pilot burner flame. When the bulb 43 is sufficiently heated the liquid mercury will be expelled therefrom to deflect the flexible expansible chamber member 38 upwardly causing the valves 64 and 64*a* to be opened. This permits the flow of fuel through the conduit 18 to the main burner 10 and through the conduit 19 to the standby pilot 13. The main burner is then ignited by the controlling pilot burner 11 and the standby pilot burner is ignited by either the main burner 10 or by the controlling pilot burner 11 depending upon the preferred location. When the bottom of the flexible cup member 38 has been deflected upwardly sufficiently to substantially open the valves 64 and 64*a*, the switch 15*c* will be opened, thus breaking the energizing circuit for the igniter 12. Under normal conditions operation of the burner 10 under the modulating control of the device 17 will continue until the timer actuated switch 16 is again opened at the end of the preselected interval.

When the timer actuated switch is opened at the end of the selected interval, the energizing circuit for the electromagnetically actuated valve 14 is broken and the valve 14 closes extinguishing the controlling pilot burner. Following the loss of flame at the controlling pilot burner the bulb 43 will begin to cool and the shaft 48 and element 38 will move downward under the urging of the spring 57, thereby first permitting the closing of the ignition controlled switch 15*c* and then the closing of the valves 64 and 64*a*. The time required for the bulb 43 to cool sufficiently to permit closing of valves 64 and 64*a* will vary to some extent with the temperature at which the oven is being operated at the time the controlling pilot burner is extinguished, but in any event sufficient time will elapse to permit the flow of a considerable amount of gas from the main burner.

Under normal conditions of operation, when the controlling pilot burner is extinguished by the opening of the timer actuated switch, the main burner would continue to burn until the valve 64 closed. However, if without the provision of the standby pilot burner this normal sequence of operation is interrupted by manipulation of the valve device 17, a hazardous accumulation of gas within the oven chamber could occur. For example, if during a period of automatically controlled burner operation, an operator thoughtlessly or for any reason manipulates device 17 so as to close the shut-off cock and open the switch 17*a* which is incorporated therewith thereby cutting off the supply of fuel to the main burner and the controlling pilot burner, and then again for any reason immediately reverses the manipulation so as to open the shut-off cock and permit fuel to again flow to the main burner, a volume of unburned gas would accumulate in the oven chamber during the interval required for the bulb 43 to cool sufficiently to permit closing of the thermostatically operated valve 64. With the provision of the standby pilot burner 13, however, a flame for the ignition of any gas flowing from the main burner is maintained so long as the thermostatically actuated valve 64*a* remains open.

The thermostatically actuated control 15 is so constructed that the valve 64 and 64*a* are simultaneously opened and closed. The time of open-

ing and closing of the pilot igniter control switch 15c with relation to the opening and closing of the valves 64 and 64a is variable by reason of the adjustable abutment member 51. The abutment member 51 is however preferably adjusted so that the igniter energizing circuit is broken slightly after the valves reach their full open position and is again closed before the valves reach their full closed positions.

It will be seen from the foregoing that I have provided a particularly compact and dependable safety control device for use in a burner control system as described, for controlling the supply of fuel to a main and a standby pilot burner and for controlling a pilot igniter device. It will also be seen that the valves 15a and 15b are each complete and sealed individual units detachably mounted on the frame member 34, and that the valve 15b may be omitted from the control without in any way affecting the operation of the main burner fuel control valve 15a or the igniter control switch 15c. By this arrangement the control is rendered readily adaptable to uses in other systems not requiring a second or standby pilot control valve by merely omitting the valve 15b, and the economy of wider usage is thereby achieved.

The foregoing description of the device is intended to be illustrative and not limiting the scope of the invention being set forth in the appended claims.

I claim:

1. In a device of the class described, a temperature responsive actuator including a cup-shaped expansible chamber having a displaceable inner bottom wall, a base member for supporting said cup-shaped chamber at its open end and having a bore therethrough concentric with said chamber, a cup-shaped follower member slidably fitted in said bore and adapted to engage said displaceable wall, an actuating member having an inverted cup-shaped portion slidably received in said cup-shaped follower member in telescopic relationship, and a pair of levers lying between the bottom walls of said follower member and said actuating member portion, said levers extending laterally through the side walls of said follower member and said actuator member portion and being pivotally mounted at their outer ends in said base member, and said levers being slightly curved so as to be engaged at one side by the bottom of said follower member at a point intermediate of their ends and so as to engage the bottom of said cup-shaped actuator member portion at a point near their free ends.

2. In a device of the class described, a temperature responsive actuator including an expansible chamber having a flexible wall, an actuating member adapted to move in a path perpendicular to and coincident with the center of said flexible wall, a follower member between said actuating member and said flexible wall, said actuating member and said follower member having adjacent surface portions which are parallel to and coextensive with said flexible wall, a plurality of curved levers lying between said actuating member and follower member, said levers being arranged so as to extend outward from the center of said surfaces beyond the periphery of said surfaces, and means for pivotally supporting said levers at their outer ends, said levers having rounded inner ends and said levers being curved so as to engage the surface of said actuating member at their rounded inner ends and so as to be engaged at a point intermediately of their inner and pivoted ends by said follower member surface, whereby a smooth sliding and rolling movement of the levers on the surfaces occurs as linear motion of the follower member is multiplied and transmitted to the actuator member.

JOSEPH A. WASSER.

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