Jan. 19, 1965 T. P. FLEER 3,166,248

BURNER CONTROL SYSTEM

Filed Jan. 27, 1961

FIG. 1

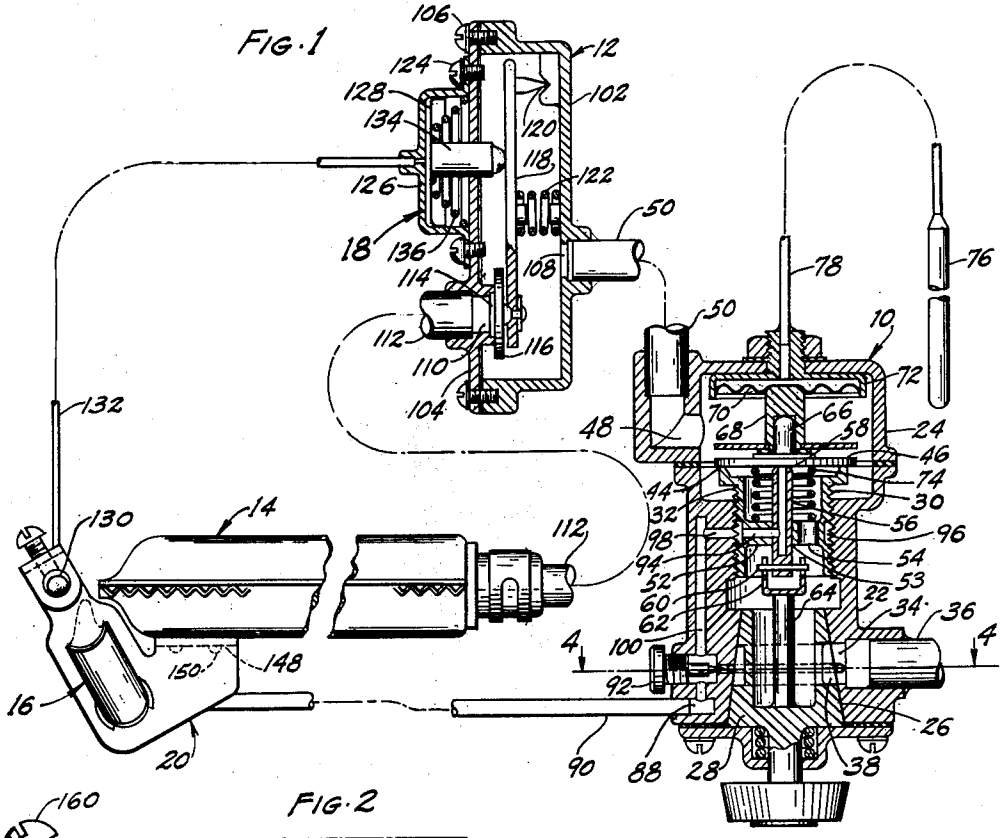


FIG. 2

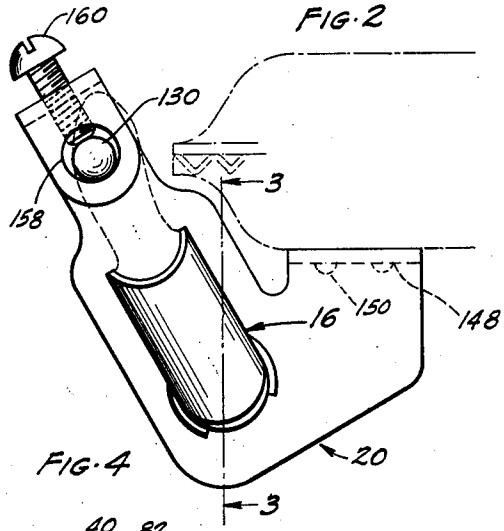


FIG. 3

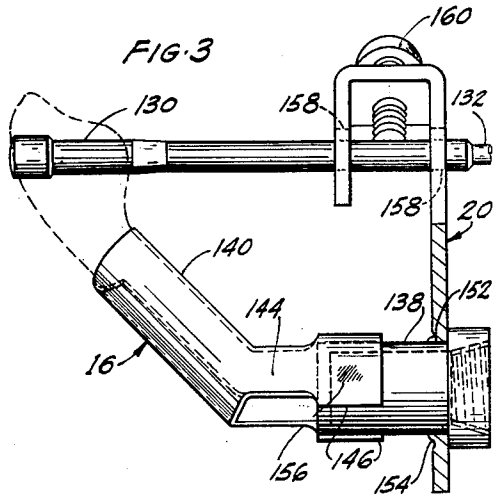
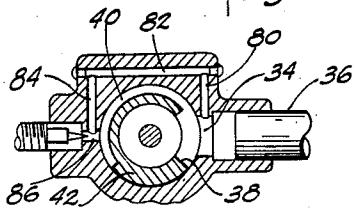


FIG. 4



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BURNER CONTROL SYSTEM

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This invention relates to control systems for gas burners, and particularly to a system in which a single pilot burner functions under conditions of minimum operation as a constant stand-by pilot to obviate the necessity of providing automatic ignition means and under conditions of higher fuel flow operation to control the flow of fuel to the main burner.

An object of the invention is to provide a burner control system having a safety pilot device comprising a single pilot burner and an associated temperature responsive actuator for actuating the main burner fuel supply valve, and means for supplying fuel at a high rate and at a low rate to the pilot burner; in which the pilot burner is so constructed and disposed with relation to the temperature sensitive element of the actuator that the actuator is caused to respond to supply fuel to the main burner when the single pilot burner is operated at a high rate, but when the pilot burner is operated at a low rate as a stand-by ignition means, the response of the actuator is not effected.

A further object is to provide a safety pilot device for control of the main burner fuel supply comprising a single pilot burner associated with the main burner and a temperature responsive main burner valve actuator including a temperature sensitive element associated with the pilot burner; in which the sensitive element of the actuator consists of a bulb containing a high temperature liquid having a boiling point above 600° Fahrenheit, which liquid is required to be evaporated, at least in part, to effect the actuation of the main burner valve, and in which the pilot burner is so constructed and disposed with relation to the temperature sensitive element that, when operated on a relatively high rate of fuel flow, flame will impinge the bulb and effect evaporation of the liquid therein, and when operated on a relatively low rate of fuel flow as a stand-by igniter, the flame is safely diverted as well as diminished, so as not to impinge the bulb or effect evaporation of the liquid therein.

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

In the drawing:

FIG. 1 is a schematic view of a burner control system constructed in accordance with the present invention;

FIG. 2 is an enlarged front elevational view of the pilot burner, the temperature sensitive element of the temperature responsive, main burner fuel valve actuator, and the mounting bracket for mounting the pilot burner and sensitive element in fixed relationship with each other and with a main burner;

FIG. 3 is a side elevational view of the pilot burner, the temperature sensitive element, and the mounting bracket taken on line 3—3 of FIG. 2; and

FIG. 4 is a cross-sectional view taken along line 4—4 of the regulator device in FIG. 1

Referring to FIG. 1, the system includes as primary elements a temperature responsive, fuel flow regulating device generally indicated at **10**, a main burner fuel cut-off device generally indicated at **12**, a main burner generally indicated at **14**, and a pilot burner generally indicated at **16**, a temperature responsive actuator for actuating the main burner fuel valve generally indicated at **18**, and a mounting bracket for mounting the pilot burner and the temperature sensitive element of the

temperature responsive actuator in fixed relationship with each other and with the main burner, generally indicated at **20**.

The regulator **10** comprises a lower valve body member **22** and an upper body member **24** suitably secured to the lower body member.

The lower body member **22** has an axial passageway therethrough consisting of a lower, tapered portion **26** which receives a hollow, open-ended, tapered plug valve **28** and an upper, threaded portion **30** which receives in threaded engagement a hollow, cylindrical, valve seat member **32**. A transverse fuel inlet passage **34** in the lower body member intersects the tapered portion of the axial passageway. The inlet passage **34** has a counterbore which receives a fuel conduit **36**. The hollow plug valve **28** has a port **38** in the wall thereof which, when in registry with passage **34**, admits fuel from conduit **36** to the interior of hollow, open-ended plug **28** and, therefore, to the axial passageway in the lower valve body member. The plug valve **28** is also provided with partial annular recess **40** in the external surface thereof which maintains communications between inlet passage **34** and the interior of plug valve **28** as the plug is rotated clockwise (with reference to FIG. 4) through the greater part of a revolution. As clockwise rotation of the plug **28** is continued, however, the remaining unrecessed portion **42** of its periphery will be brought into registry with inlet passage **34** and communication with the interior of the plug valve will be cut off.

The upper end of the externally threaded, hollow, valve seat member **32** is formed as a seat **44** with which a disc valve **46** cooperates to control the flow between the lower and upper valve body members. The upper valve body member **24** is provided with an outlet passage **48** which is counterbored and receives one end of a fuel conduit **50**. The hollow, cylindrical, valve seat member **32** has an intermediate, interior partition **52** through which is drilled a central axial bore **53** and a plurality of relatively large, circularly-arranged, axial passages **54**. Fixed as by press-fitting in the central bore **53** is a vertical tube **56** having an upper open end formed as a seat **58** lying in the same horizontal plane as the seat **44** so that the disc valve **46** cooperates with both seats. The lower end of the tube **56** is closed and is provided with a cross pin **60** arranged to be engaged by a yoke **62** fixed on the upper end of a central vertical rod **64** which in turn is fixed at its lower end to the plug valve **28**. The arrangement is such that the hollow, threaded, cylindrical seat member **32** rotates with plug **28** and also moves axially due to its threaded engagement in the lower valve body member, whereby the valve seats **44** and **58** are adjusted vertically with respect to valve **46**.

The disc valve **46** through its short stem **66** and a follower member **68** is biased in an opening direction and against the flexible diaphragm **70** of an expansible chamber **72** by a relatively strong spring **74**. The expansible chamber **72** together with a sensing bulb **76** and a length of capillary tubing **78** forms a sealed system containing a thermally expansible fluid so that, as the temperature to which the bulb **76** is sensitive increases, the valve **46** is moved downward against spring **74** toward its concentric seats **44** and **58**.

The lower valve body member **22** is provided with small diameter passages **80**, **82**, **84**, and **86** (see FIG. 4), which form a bypass around the plug valve **28** to provide a minimum fuel flow to the pilot burner **16** through an outlet passage **88** and a fuel conduit **90** when the plug valve is in a cut-off position. An adjustable needle valve **92** is provided to adjustably vary the flow through this bypass. Additional fuel is supplied to the pilot burner under conditions when plug valve **28** is not in a cut-off position and when valve **46** is not seated on the open end

58 of tube 56. Under these conditions additional pilot fuel passes upward from inlet 34 through the hollow plug valve 28 and valve member 32 to the open end 58 of tube 56, thence downward through tube 56 and outward through a radial passage 94 in the partition 52 to an annular groove 96 formed in the exterior threaded wall of member 32. From groove 96 the fuel flows through a horizontal passage 98 and thence through a vertical passage 100 to outlet passage 88.

Fuel to the main burner 14 passes from the regulator 10 through the conduit 50 to the cut-off device 12. The device 12 comprises a casing 102 having a cover 104 attached thereto by screws 106. Fuel enters the casing 102 through an inlet passage 108 and passes outward through an outlet passage 110 in the cover and thence through a conduit 112 of the burner 14. The outlet passage 110 is formed with an interior seat 114 controlled by a valve 116. The valve 116 is carried on the free end of a lever 118 which is pivoted at its other end at 120. The valve 116 is biased in a closed position by a spring 122. Mounted on the cover member 104 by means of screws 124 is an expansible chamber consisting of an outer rigid cup member 126 and an inner flexible cup member or diaphragm 128. Mounted on the pilot support bracket 20 is a horizontally arranged, elongated bulb 130 which is connected to this expansible chamber by a length of flexible capillary tubing 132. The expansible chamber, the bulb, and the connecting capillary form a sealed system which is filled with a high boiling point liquid, preferably mercury. An actuating rod 134 bearing at one end against the center of diaphragm 128 and at its other end against lever 118 effects the opening of valve 116 against spring 122 when the temperature of bulb 130 reaches the point at which vaporization of mercury occurs. A spring 136 biases the diaphragm member 128 in a returned or contracted position.

The pilot burner 16 is of the non-aerated type and comprises a horizontally disposed, hollow, cylindrical orifice member 138, to the forward end of which is attached an elongated, semicylindrical flame guide 140. The orifice member 138 is provided with a closed forward end through which is centrally bored a metering orifice 142. The rear end of the cylindrical orifice member is of enlarged diameter and is internally threaded to receive a suitable threaded fitting (not shown) for the connection thereto of the pilot fuel conduit 90. The flame guide 140 has a relatively short, horizontal, bifurcated, inner end portion 144 terminating in a pair of arcuate tabs 146 which embrace diametrically opposite peripheral portions of the forward end of the cylindrical orifice member and are fixed thereto as by welding. The main body portion of the flame guide 140 is of semicylindrical form and extends forwardly and upwardly from its bifurcated horizontal portion at an acute angle and is also inclined with respect to a vertical plane passing through the axis of the orifice member for a purpose to be described.

It will be seen that due to bifurcation of that part of the flame guide immediately adjacent the end of the orifice member combustion air is introduced at that point from the lower side as well as the upper side of the flame guide. It is to be understood that the term "non-aerated" refers to burners having no means for introducing and mixing "primary" air with the fuel prior to combustion. In applicant's pilot burner, combustion is supported entirely by secondary air and progresses from the orifice 142, and the inclined channel-form, flame guide directs the path of burning gas and provides only that measure of delaying turbulence necessary to result in a blue flame at the end of the burner head. Applicant's burner, therefore, among other advantages, is particularly adapted to the present purpose in that a greater extension of flame may be achieved with a fixed orifice for a given head pressure change on the orifice than in a conventional aerated pilot burner in which primary air and fuel are introduced into a mixing chamber or tube prior to combustion.

The support bracket 20 comprises a vertically arranged, flat, metal plate having an upper right angularly formed leg 148 for connection by screws 150 to the lower horizontal surface of main burner 14. The pilot burner may be firmly attached to the bracket 20 in any suitable manner; presently, however, it is preferred to accomplish this by first inserting the smaller diameter portion of the orifice member into a perforation 152 in the bracket and firmly staking it therein by distortion of metal as indicated at 154, and then attaching the burner head 140 in the proper inclined position by spot welding the arcuate tabs 138 to the orifice member as indicated at 156. Referring to FIG. 2, it will be seen that the flame guide is rotated counterclockwise from a vertical position to achieve a suitable inclination thereof. The upper end portion of the bracket 20 is formed with two right angle bends to provide an inverted U, the parallel legs of which are provided with horizontally aligned perforations 158 to receive the bulb 130. The bulb is inserted through these perforations to a position wherein flame issuing from the upper end of burner head 140 under certain operating conditions will impinge a suitable portion of its length. The bulb 130 is held in a fixed position by a clamping screw 160 threadedly engaged in the base of the U-formed portion of the bracket. The perforations 158 lie on the projected axis of the inclined semicylindrical flame guide and therefore the axis of the horizontally arranged bulb 130 intersects this projected axis at a point outward and above the upper end of the burner head.

Operation

In FIG. 1 of the drawings, the regulator 10, the main burner fuel cut-off device 12, and the pilot burner 16 are shown in the operative condition which they assume when sufficient heat has been supplied by the main burner to attain some preselected temperature of, for example, a domestic range oven. Under these conditions the plug valve 28 is in a position to admit fuel to the interior of the lower body member 22 of the regulator 10, but the oven having attained the preselected temperature, the temperature of the regulating sensing bulb 78 is such as to effect the seating of valve 46 on both seats 44 and 58, thereby preventing any further flow of fuel to the main burner via the cut-off device 12 or any fuel to the pilot burner via the tube 56. The flow of fuel to the pilot burner under these conditions is, therefore, only that which flows through the adjustable needle-controlled passage 86, see FIG. 4.

This amount of fuel to the pilot burner is sufficient only to maintain a safe "stand-by," or reignition flame, at the pilot burner, as indicated in FIG. 1. Due to the fact that bulb 130 of the temperature responsive actuator 18 is spaced horizontally as well as vertically from the upper end of the pilot flame guide 140, it is not impinged by a flame sustained by this minimum flow of gas, and as a result, all of the mercury in the bulb 130 is in liquid form and the expansible chamber 126–128 is in a contracted condition permitting spring 122 to close valve 116 of the cut-off device 12.

As the temperature of the space or oven drops slightly due to heat loss, the bulb 78 of the regulator cools correspondingly and the disc valve 46 is lifted from its concentric seats 44 and 58 by return spring 74, thereby permitting fuel to flow to the upper body portion 24 of the regulator and thence to the cut-off device 12 through conduit 50, and thereby also permitting additional fuel to flow to the pilot burner via the tube 56. When the disc valve 46 has lifted sufficiently to permit sufficient additional fuel to the pilot burner, the flame issuing from the pilot burner will be extended along the projected axis of the inclined semicylindrical flame guide due to increased velocity through the orifice 142 and will also lift vertically due to natural causes and impinge a substantial portion of the length of the mercury-filled bulb 130. Due to impingement by this extended flame pattern, a portion of the mercury in bulb 130 is caused to vaporize and the

resulting large volume increase will effect the expansion of expansible chamber 126–128 and the opening of valve 116 of the cut-off device 12. This permits the flow of gas from the upper body member of regulator 10 to the main burner 14 via conduit 50, the cut-off device 12, and conduit 112, where it is ignited by the extended pilot flame. As the temperature again rises in the oven due to operation of the main burner, the temperature of bulb 78 will rise correspondingly and effect the closing of valve 46 on both seats 44 and 58, which will cut off operation of the main burner and reduce the fuel flow to the pilot burner to its minimum. The resulting retraction of the pilot burner flame will result in condensation of the vaporized mercury in bulb 130 and valve 116 of the cut-off device 12 will again close.

It will be understood that the lag or time required to heat the bulb 130 enough to open the cut-off valve 116 is sufficient to permit valve 46 to continue its opening movement to a point wherein an adequate flow to effect proper ignition at the main burner is established before cut-off valve 116 opens. Also, when the regulator bulb 76 is satisfied and valve 46 moves toward a closed position, the thermal inertia of the regulator bulb 76 completes the closing of valve 46 and provides an interval sufficient for the vaporized mercury in bulb 130 to condense and effect the closing of cut-off valve 116. Proper ignition of the main burner when bulb 76 calls for heat is thereby provided, and objectionable hunting as the bulb 76 approaches a satisfied condition is thereby obviated.

While the mercury in bulb 130 has a boiling point of 675° Fahrenheit at atmospheric pressure, it will ordinarily require a temperature in the order of 800° Fahrenheit, or higher, to evaporate sufficient mercury against the increasing pressure in the system to effect opening of the cut-off valve. Due to this high operating temperature it requires more time at extended pilot burner operation to heat the bulb 130 sufficiently to effect opening of valve 116 than is required for the bulb to cool and effect closing of the valve when the pilot flame is retracted. This characteristic admirably adapts the mercury-filled system to the instant application.

Moreover, appreciable advantage is realized when applicant's particular single "high-low" pilot burner is used in combination with a sensing bulb containing mercury required to be evaporated and condensed to effect actuation of a control means. Because of the relatively high and relatively narrow operating temperature range of the mercury-filled device substantial impingement of the bulb by pilot burner flame is required to effect operation, and the device is not, therefore, operationally affected by a mere proximity of pilot flame as would occur in other commonly-employed, temperature responsive devices. This permits a more compact construction and results in a more reliable safety device in which the difference in the flame pattern of applicant's pilot burner between "high" and "low" may be considerably reduced and is considerably less critical.

To cut off operation of the main burner the plug valve 28 of the regulator 10 is rotated clockwise with respect to FIG. 4 until the unrecessed portion 42 thereof registers with inlet passage 34. To initiate operation of the main burner the plug valve 28 is rotated counterclockwise sufficiently to admit fuel to the interior of the plug valve.

Continued counterclockwise rotation of the plug valve retracts the externally threaded valve seat member 32 downward from the valve 46, thereby requiring further downward movement of valve 46 to engage its concentric seats. This results in maintaining a higher space or oven temperature so that as the plug valve is progressively rotated counterclockwise progressively higher temperatures are maintained. Stop means for limiting the rotation of the plug valve in both directions and indicia for indicating space or oven temperatures corresponding to the angular position of the plug valve may be provided.

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

I claim:

In a burner control system having a main burner, a normally closed main burner fuel control valve, a main burner valve actuator including an elongated bulb containing a high boiling point liquid which when evaporated effects opening of said main burner valve, a pilot burner which when operated at a high fuel input rate heats said bulb sufficiently to effect evaporation of the liquid therein but when operated at a low fuel input rate is ineffective to do so, and temperature responsive means controlling the fuel flow to the pilot burner; the improvement which consists in the provision of a support member having a portion thereof adapted for attachment to a main burner, the provision of a non-aerated pilot burner construction comprising a horizontal fuel orifice member mounted on another portion of said support member and an upwardly open, elongated, channel-formed flame guide attached at its lower end to said orifice member and extending upwardly therefrom at an acute angle, said channel-form flame guide also being inclined with respect to a vertical plane parallel with and through the axis of said orifice member, and in the provision of means on another portion of said support member attaching the elongated actuator bulb in a horizontal position and in outward spaced relationship with the upper end of said flame guide with the longitudinal axis of said bulb substantially intersecting a longitudinal axis through said channel-form flame guide.

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