

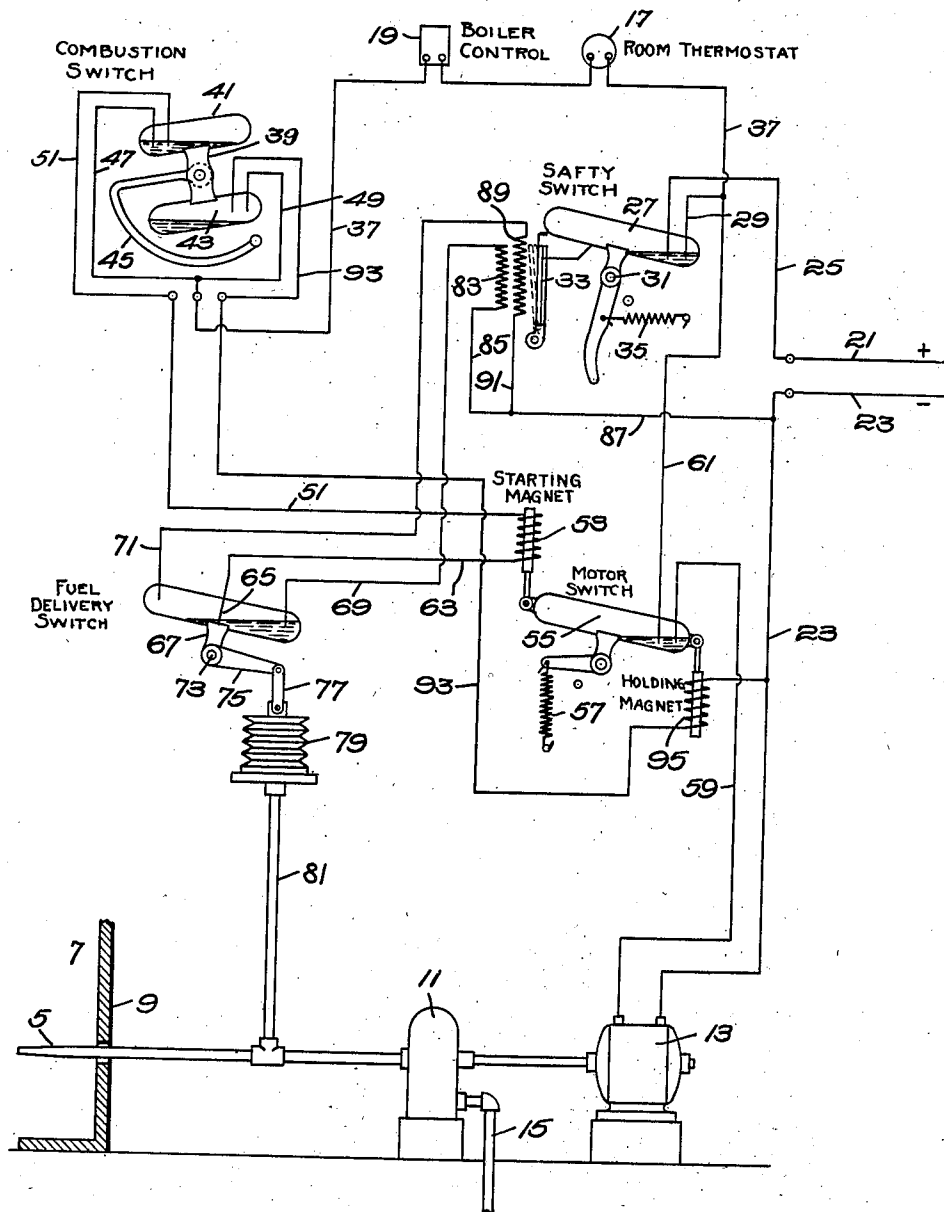
June 19, 1934.

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1,963,771

BURNER CONTROL

Filed Oct. 1, 1930



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UNITED STATES PATENT OFFICE

1,963,771

BURNER CONTROL

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Application October 1, 1930, Serial No. 485,792

12 Claims. (Cl. 158—28)

This invention relates to liquid fuel burners, being intended to provide means for increasing the certainty of operation of such burners under varying conditions of use.

It is common practice to equip automatically operated burners with safety devices responsive to conditions of combustion in the combustion chamber or furnace such that, in the absence of combustion or substantial combustion at the burner for a definite interval immediately or at any time after the burner has been started, as through a room thermostat, the burner is cut out of operation until the cause of its failure to produce combustion has been ascertained and remedied. The primary purpose of such devices is to prevent the danger which follows the delivery of unignited liquid fuel to and its accumulation in the furnace. In burners of large capacity this permissible safety interval must necessarily be much shorter than in burners of small capacity where the rate of discharge is relatively slow.

In the operation of burners where delivery of the fuel to a fuel distributor from a source of supply must take place before combustion can occur, it sometimes happens that a more or less indeterminate time interval elapses after starting and before the liquid fuel reaches the distributor even with the fuel delivery devices in normal working condition. This interval may overlap the interval to which the safety devices are adjusted, thereby resulting in stopping the operation of the burner before any fuel is delivered to the distributor, despite the fact that the failure may be due to a natural lag or delay incidental to the character of fuel employed, such as some of the heavier fuel oils, or to other conditions retarding the initial delivery of fuel on starting, but indicative of no faulty operation or lack of available fuel.

One of the objects of the present invention is to so control a liquid fuel burner that an adequate time interval may be provided after starting to take care of any lag in the delivery of fuel to the distributor, while providing means to stop the operation of the burner if such interval becomes excessive or such as to indicate failure or stoppage of the fuel or other faulty conditions which require to be remedied.

This and other objects of the invention will be best understood by reference to the following description when taken in connection with the accompanying illustration, while its scope will be more particularly pointed out in the appended claims.

The drawing shows in more or less diagrammatic form one embodiment of the invention in which one form of the control features is applied to a liquid fuel burner.

Referring to the drawing and to the illustrated embodiment of the invention, there is shown an oil burner comprising a fuel distributor 5 in the form of a nozzle, by means of which liquid fuel is discharged into the combustion chamber of the furnace 9 where it is ignited by any of the usual ignition devices (not shown). The fuel is delivered by the pump 11 driven by the electric motor 13, the pump drawing its liquid fuel from a tank or other source of supply (not shown) through the supply pipe 15. These elements are merely shown to exemplify any type of automatic burner and any type of heater to which it may be employed, the invention herein embodied being applicable to a wide range of varying types of liquid fuel burners and heaters.

For descriptive purposes the fuel is herein referred to as oil, although the invention is applicable to burners employing liquid fuel other than oil. In the illustrated embodiment of the invention the burner is controlled by starting or stopping the electric motor 13 by means of electric control circuits in conjunction with controlling devices hereinafter described, the latter including the usual room thermostat 17 in controlling relation to the motor circuit, and preferably a control device 19 responsive to conditions in the heater, where the latter is in the form of a hot water or steam boiler, as in the illustrated embodiment.

Referring to the specific arrangement of controlling circuits, power is supplied through the mains 21 and 23 which, for identification, may be referred to as positive and negative respectively. The negative main 23 is connected directly to one terminal of the motor. The positive main 21 is connected to a conductor 25 which leads to a normally closed switch 27 through which it is connected to a conductor 29.

The switch 27 is of the type commonly employed in the control of oil burners and comprises a sealed glass tube containing a small body of mercury and pivotally mounted, as at 31, so that it may be tipped to an inclined position where (as shown in the drawing) the mercury electrically connects two terminals, the latter being sealed in the tube at one end thereof but externally connected to the conductors 25 and 29. When tilted to a reverse inclination,

the mercury flows to the opposite end of the tube thereby opening the circuit.

The switch 27, which for descriptive purposes may be termed the lock-out or safety switch, is intended to be opened only on the development of conditions which indicate some failure of the burner properly to function and is normally held in closed position. To that end it is provided with a detent 33 which normally holds it closed against the counter or opening action of the spring 35, the detent being composed of a strip of bi-metallic thermostatic metal so that when heated, through the action of cooperatively related heating devices hereinafter described, it is caused to become warped or deflected, moving towards the dotted line position, releasing the switch and permitting it to be moved by the spring to an open position.

At the lock-out switch the positive side of the circuit is connected through the conductors 29 and 37 to the room thermostat 17 and boiler control device 19, the thermostat being adapted to open or close the circuit thereat, dependent on the temperature of the surrounding atmosphere, and the boiler control to open or close the circuit thereat, dependent on the pressure of steam in the boiler.

From the boiler control the positive circuit leads to a switch 39 which is responsive to conditions of combustion at the burner and, for descriptive purposes, may be referred to as the combustion switch. The latter may be of any suitable type or nature but herein, for illustrative purposes, it is shown as comprising two mercury tube switches 41 and 43 mounted on the same rocking support 39, the latter being operatively connected to some device, such as the conventionally represented thermostatic member 45 so positioned in practice as to be exposed to the heat of combustion in the flue, stack or combustion chamber of the furnace. The arrangement is such that in the absence of combustion or substantial combustion at the burner the switch 41 is tilted to the closed position and the switch 43 to the open position, whereas on and during the occurrence of normal or intended conditions of combustion the switch 41 is tilted to the open position and the switch 43 to the closed position.

At the combustion switch the circuit 37 splits, being connected through the conductor 47 to one terminal of the switch 41 and through the conductor 49 to one terminal of the switch 43. When, therefore, the burner is started, with the furnace cold, the positive circuit is closed at the combustion switch through the mercury tube 41, the circuit extending therefrom through the conductor 51 to a starting magnet 53 operatively connected to the motor switch 55. The latter is also in the form of a tilting mercury tube which is shown in its closed position but is normally thrown to an open position by the spring 57, its sealed-in terminals being connected, one by the conductor 59 to the remaining terminal of the motor 13, and the other by the conductors 61 and 29, the lock-out switch 27 and conductor 25 to the positive side of the circuit. When the starting magnet 53 is energized the motor switch 55 is thrown to the closed position (shown in the drawing), the motor connected to the power circuit and the burner started into operation.

The remaining terminal of the starting magnet 53 is connected through the conductor 63 to a sealed-in terminal 65 at the fuel delivery switch 67, the latter being also of the tilting mercury tube type. In the switch 67, however, the terminal 65 is positioned near the middle of

the tube and the latter is provided with a similar terminal at each opposite end, the arrangement and quantity of mercury being such that, in one inclined position of the tube, the central terminal is electrically connected with one end terminal and disconnected from the other, and in the reversely inclined position it is disconnected from the first mentioned terminal and connected with the other. One end terminal is connected to a conductor 69 and the other to a conductor 71.

The switch 67 is pivotally mounted at 73 and is operatively connected to a device responsive to the delivery of oil to the distributing nozzle such that in the absence of oil delivery it is tilted to one position (that shown in the drawing), closing the circuit through the conductor 69, but on the delivery of oil to the nozzle it is tilted to the opposite position, closing the circuit through the conductor 71.

Any suitable means responsive to fuel delivery may be employed for this purpose, but herein the switch 67 is connected by the lever arm 75 and link 77 to the movable end of a pressure diaphragm or bellows 79, the opposite end of which is fixed and the interior of which is connected through the pipe 81 with the oil delivery pipe between the pump 11 and nozzle 5. The construction and location of the diaphragm is herein shown conventionally only, and in practice it is preferably placed in a position of greatest sensitiveness to the pressure in the delivery pipe. Since the pump delivers liquid fuel only through the delivery pipe, a condition of pressure therein occurs only when the oil is being delivered by the pump to the nozzle.

When the pump is in operation and effective in discharging oil under pressure through the nozzle, the pressure is communicated through the pipe 81 to the interior of the diaphragm 79, expanding the latter and tilting the switch to a position the reverse of that shown in the drawing. If the pump is at rest no pressure is applied to the diaphragm and the switch reverts to the position shown in the drawing. Similarly, if, after starting into operation, the pump fails for an interval to deliver oil to the nozzle, during that interval no pressure is applied to the diaphragm and the switch remains in the position shown, connecting the terminal 65 to the conductor 69.

The conductor 69 is associated with an electrically actuated timing means, herein in the form of a timing actuator comprising a resistor or heating element 83 operatively related to the thermostatic detent 33 at the lock-out switch 27, the circuit thence extending through conductors 85 and 87 to the negative main 23 thereof, completing the circuit through the heating element in the initial starting stage of the burner. The resistor 83 is adapted after the lapse of a predetermined time interval following the closure of the circuit and the passage of heating current therethrough to actuate the detent 33 and trip the lock-out switch, thereby cutting out the motor.

The conductor 71 at the fuel delivery switch 67 is connected to a second heating or actuating element 89, connected in turn to the negative main 23 through conductors 91 and 87. The heating or actuating element 89 is similar in nature to the heating element 83 and is also operatively related to the detent 33 and adapted to trip the lock-out switch after the lapse of a predeter-

mined time interval following the closure of its circuit.

Accordingly, when the room thermostat 17 acts to start the burner, the motor switch is thrown to a closed position, starting up the motor and the pump, this being effected through the action of the starting magnet 53, the circuit of which passes through the safety switch, room thermostat, boiler control, mercury tube 41 at the combustion switch, starting magnet 53, fuel delivery switch 67 and heating coil 83. The drawing shows the motor switch 55 closed and the fuel delivery switch 67 tilted to close the circuit through the coil 83, that is to say, in the positions occupied during its initial starting period, immediately after the action of the thermostat 17 and before the actual delivery of fuel to the nozzle 5. If the time interval to which the heating element 83 is adjusted elapses without the delivery of fuel to the nozzle 5, indicating failure of fuel supply or some fault requiring attention, the heating element 83 acts to trip the lock-out switch, opening the motor circuit and stopping further operation of the burner. If, however, within that time interval oil is delivered to the nozzle, then pressure is applied to the diaphragm 79, causing the latter to tilt the fuel delivery switch 67, breaking the connection between the terminal 65 and the conductor 69, cutting out the heating element 85. At the same time, however, the reverse movement of the fuel delivery switch connects the terminal 65 to the conductor 71, closing the circuit through the heating coil 89. Oil is then being delivered to the nozzle 5. If, during the time interval for which the heating element 89 is adjusted, the oil fails of ignition, or the combustion which occurs is insufficient to actuate the thermostat 45 and move the combustion switch, the circuit through the heating element 89 remains closed and at the end of that interval will similarly act to trip the safety switch and open the motor circuit, the tripping of the safety switch through the action of either of the heating elements 83 or 89 also serving to open the circuit through the starting magnet 53 and permit the motor switch to tilt to its open position.

On the other hand, if the normal or intended combustion takes place during the time interval for which the heating element 89 is adjusted, the thermostat 45 will act to reverse the position of the mercury tubes 41 and 43 at the combustion switch, cutting out of circuit both heating elements 83 and 89 and simultaneously closing the circuit through a holding magnet which holds the motor switch closed, so long as the intended combustion persists and the circuit remains closed at the room thermostat 17 and boiler control 19.

When the combustion switch is thus actuated the mercury tube 41 is tilted to break the connection between the conductors 47 and 51, and at the same time the mercury tube 43 is tilted to connect the conductor 49 with a conductor 93, the latter being connected through the holding magnet 95 to the negative main 23. The holding magnet is operatively connected to the motor switch 55 and so long as energized serves to hold closed the motor switch. The running control circuit thus established is from the positive main through the safety switch, room thermostat, boiler control, mercury tube 43 and holding magnet 95.

If, at any time during the running period, the normal or intended combustion ceases, the com-

bustion switch will be thrown back to its reverse position, or that shown in the drawing, temporarily maintaining the motor switch closed however through the starting magnet 53. If combustion failure is due to the interruption of the fuel supply, the pressure diaphragm 79 will at the same time reverse the position of the fuel delivery switch, throwing it back to the position shown in the drawing, again cutting into circuit the heating element 83, and if the delivery of fuel does not occur within the time interval to which that element is adjusted, the motor will be cut out of operation. If fuel delivery takes place within that time interval the control will again function as in starting; that is to say, the position of the fuel delivery switch will be reversed, cutting out of circuit the heating element 83 and cutting into circuit the heating element 89. If the combustion switch then operates during the time interval for which the heating element 89 is adjusted, the burner will again resume its normal operation. If the combustion switch is not actuated within that time interval the burner will be cut out of operation.

If combustion fails for other causes than failure of fuel delivery, the fuel delivery switch will remain in its running position and the reversal of the combustion switch will connect the heating element 89 directly into circuit, causing it to function as already described.

It will be seen that the time interval to which the heating element 89 is adjusted may be selected with reference to considerations of safety, dependent on the interval which may be allowed without danger between the fuel delivery and combustion. The time interval to which the heating element 83 is adjusted, however, may be selected without reference to such considerations, but with reference only to the time which may be properly allowed for the oil to reach the nozzle after the starting of the burner under the peculiar conditions which may pertain in the particular installation in question.

Although the time interval for the element 83 may bear any desired relation to that of the element 89, and may be the same, greater or less than that of the latter element, it will ordinarily be adjusted to a greater time interval to allow a suitable time to elapse for fuel delivery, during which time, of course, no oil is being discharged into the furnace and no danger incurred from the accumulation of unignited oil. This permits the controls to be adjusted to the particular requirements of the burner. By way of illustration, if the burner is of large capacity, burning, for example, from ten to thirty gallons of oil an hour, and therefore having a relatively high rate of delivery, and the fuel employed is a relatively heavy oil, the delivery of which will tend to lag after the pump has started into operation, it may be desirable to adjust the heating element 89 to trip the switch at the close of some relatively short interval, such as thirty seconds, while the element 83 is set to trip the switch at a relatively long interval, such as four or five minutes, these periods, however, being merely illustrative.

It will be seen that the motor circuit extends directly between the supply mains through the safety switch and motor switch, while the controlling circuit is in shunt relation to the motor, the controlling circuit extending through the safety switch, thermostat, boiler control and combustion switch. The latter in turn controls the two branches, one of which passes through

the starting magnet and fuel delivery switch and the other through the holding magnet 95, while the branch circuit passing through the fuel delivery switch is itself sub-divided into two branches under the control of that switch, one of which branches includes the heating element 83 and the other the heating element 89.

While I have herein shown and described for the purposes of illustration one specific embodiment of the invention and have described the same in detail, it is to be understood that extensive deviations may be made therefrom and various forms of controlling devices and circuits may be employed and that the essential features of this controlling system may be employed for burners of widely varying types, all without departing from the spirit of the invention.

I claim:—

1. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, a room thermostat in controlling relation to the motor circuit, timing means effective on action of the thermostat to cut out the motor after the lapse of a predetermined interval in the absence of fuel delivery through the distributor, timing means effective on fuel delivery to cut out the motor after the lapse of a predetermined interval in the absence of combustion, means operable by fuel delivery to render the first timing means ineffective and the second timing means effective and means responsive to combustion at the burner to render both of said timing means ineffective.
2. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, a plurality of timing devices adapted each when effective to cut out the motor after the lapse of the time interval for which it is adjusted, means effective during the operation of the motor and in the absence of combustion at the burner to render one or the other of said timing devices effective dependent on the delivery or the absence of the delivery of fuel to the distributor, and means responsive to occurrence of combustion at the burner to render both said timing devices ineffective.
3. In a liquid fuel burner, the combination with a distributor, of means for delivering fuel thereto, a burner motor for said means, an electrically heated device adapted to open the motor circuit, a second electrically heated device also adapted to open the motor circuit, circuit changing devices responsive to the delivery of fuel to the distributor adapted to place the first device in circuit and cut out of circuit the second device in the absence of fuel delivery and to cut the first device out of circuit and the second device into circuit on the occurrence of fuel delivery, and circuit changing means responsive to combustion at the burner adapted to cut out of circuit both heating devices.
4. In a liquid fuel burner, the combination with a distributor, of means for delivering fuel thereto, a burner motor for said means, an electrically actuated timing device adapted to cut out the motor on the passage of current therethrough for a predetermined interval, a second electrically actuated timing device also adapted to cut out the motor on the passage of current therethrough for a predetermined time interval, means responsive to the delivery of fuel to the distributor for placing said first device in circuit and for cutting out of circuit said second device dur-

ing the absence of fuel delivery and for cutting out of circuit said first device and into circuit said second device on the occurrence of fuel delivery, and means responsive to combustion at the burner for cutting out of circuit both said devices.

5. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, an electrically actuated timing device adapted to cut out the motor after the lapse of a predetermined interval in the absence of fuel delivery, an electrically actuated timing device rendered effective on fuel delivery and adapted to cut out the motor after the lapse of a predetermined interval in the absence of combustion at the burner, means operable by fuel delivery to render said first timing device ineffective and said second timing device effective and means responsive to combustion to cut out of circuit both said devices.

6. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, a power supply circuit, a motor circuit, a shunt circuit having two branches and electrically actuated time limit cut-out means for opening the motor circuit having an actuator in each branch and adapted to cut out of operation the motor on the passage of current through either of said actuators for its own predetermined interval, means responsive to the presence and absence of combustion at the burner to close said shunt circuit on the absence of combustion and to open the same on the occurrence of combustion, and means responsive to the delivery of fuel to the distributor to place in the shunt circuit one of said actuators in the absence of fuel delivery and to place therein the other of said actuators on the occurrence of fuel delivery.

7. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, a power supply circuit, a room thermostat in controlling relation to the motor, a motor circuit, a motor switch for opening and closing said circuit, electro-magnetic means adapted on the closing action of the room thermostat to close said motor switch, a controlling circuit including said electro-magnetic means, a safety switch in said motor circuit and said controlling circuit, a plurality of electrically actuated timing devices in said controlling circuit and operatively related to said safety switch, said devices being adapted each to open the safety switch on the passage of a current therethrough for a predetermined interval thereby to stop the motor, means responsive to the delivery of fuel to the distributor to place in circuit one of said timing devices in the absence of fuel delivery and to place in circuit the other of said timing devices on the occurrence of fuel delivery, and means responsive to combustion at the burner to cut out of circuit both of said timing devices on the occurrence of combustion.

8. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, a burner motor for said means, a room thermostat in controlling relation to the motor, a motor circuit, a motor switch, means responsive to the room thermostat for opening and closing the motor switch, a safety switch for the motor circuit, a plurality of electrically actuated timing devices each operatively related to the safety switch to open the latter on the passage of current therethrough for a predetermined interval circuit changing means responsive to fuel delivery at the

distributor to place one of said elements in circuit on delivery of fuel and the other of said elements in circuit in the absence of fuel delivery, and circuit changing means responsive to combustion at the burner to cut said timing elements out of circuit on occurrence of combustion.

9. In a liquid fuel burner, the combination with a fuel distributor, of a pump for supplying fuel thereto, a motor for said pump, a plurality of electrically actuated timing means each adapted to cut said motor out of operation, a switch adapted to cut one of said means into circuit and the other out of circuit, and vice versa, and means responsive to the pressure of the fuel delivered to said distributor for controlling said switch.

10. In a liquid fuel burner, the combination with a fuel distributor, of fuel delivery means therefor, a motor for said means, a plurality of timing actuators with means operatively related thereto for stopping the motor, means for rendering one of said timing actuators effective and the other ineffective and vice versa dependent respectively on the absence of delivery or on the delivery of fuel by the fuel delivery means, and means operable in response to combustion to render ineffective the timing actuator which is rendered effective on fuel delivery.

11. In a liquid fuel burner, the combination

with a fuel distributor, of fuel delivery means therefor, a motor for said means, a plurality of timing actuators with means operatively related thereto for stopping the motor, one of said actuators being effective and the other ineffective on motor starting, means operable on fuel delivery to render said one of said actuators ineffective and the said other effective, and means operable on the occurrence of combustion in the burner to render said other actuator also ineffective.

12. In a liquid fuel burner, the combination with a fuel distributor, of means for delivering fuel thereto, an electric motor for said means, a switch for the motor circuit, a plurality of timed electric actuators for said switch effective to open the same, means to energize one of said actuators to render it operable to open said switch on the absence of fuel delivery for a predetermined time interval after motor energization, said last named means on occurrence of fuel delivery being operable to deenergize the one and energize the other of said actuators to render the other actuator operable to open said switch on the occurrence of fuel delivery but on failure of combustion for a predetermined time, and combustion responsive means to deenergize the said other actuator.

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