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BURNER CONTROL APPARATUS

Filed Feb. 27, 1964

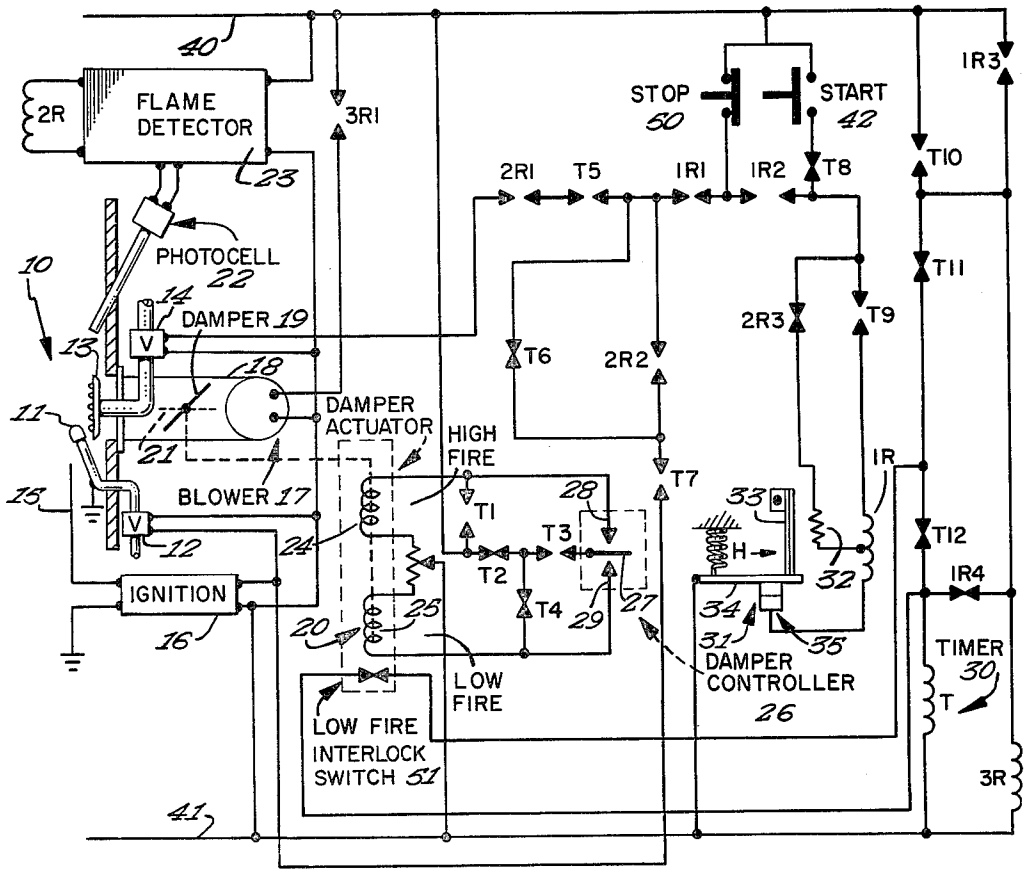

FIG 1

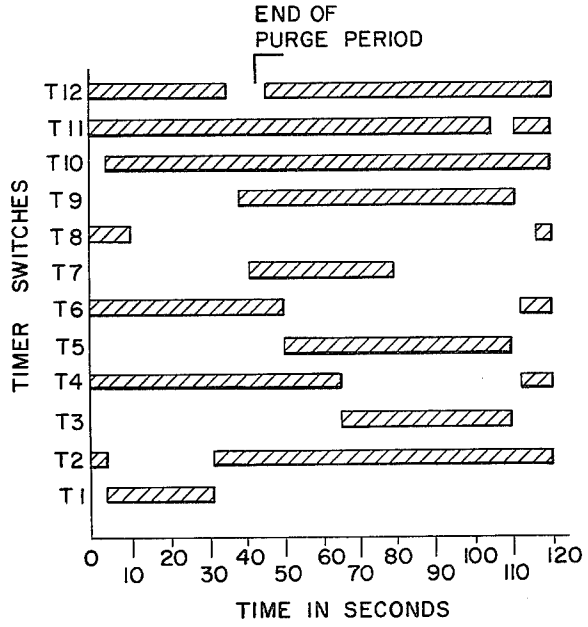

FIG 2

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BURNER CONTROL APPARATUS

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Our invention is concerned with an improved burner control apparatus and particularly with a program type burner control apparatus in which a timer is provided to sequentially control a plurality of electrical switch means, the switch means being adapted to be connected to the components of the fuel burner unit to program the fuel burner unit from a standby condition, through a prepurge period and a trial-for-ignition period, to a run condition. More particularly, our invention is concerned with a unique arrangement for providing an extended prepurge period and for additionally insuring that the ignition period is not instituted until certain components of the fuel burner unit are in a proper condition for optimum trial-for-ignition.

As is well known in the prior art, it is desirable to program large fuel burner installations so as to insure safe transition from a standby to a run condition. In the standby condition, the components of the fuel burner unit are for the most part deenergized and it is necessary to safely bring the burner unit through a transition where a main flame is established at a main burner. Furthermore, in installations of this type, the rate of firing of the main burner may be controlled by means responsive to demand for heat, this means being, for example, a damper controller to control the flow of combustion air to the fire box, and an arrangement to modulate the fuel flow of a main fuel valve to change the supply of fuel to the main fuel burner as the damper is changed, to maintain the proper fuel-to-air ratio. We have chosen to show, in the preferred embodiment of our invention, the control of only a damper. However, it is recognized that it is within the teachings of our invention to utilize a modulating valve to be controlled in much the same fashion as the damper of our preferred embodiment. Considering generally the teachings of the prior art, the prepurge period is initiated by energization of a blower to purge the fire box of fumes or unburned fuel. During this prepurge period the damper is moved to the high fire position allowing the maximum amount of air to flow through the fire box. In some cases it may be desirable to maintain the damper fully open, that is in the high fire position, during the standby period. In any event, the damper is in the high fire position during a portion of the prepurge period.

Immediately following the prepurge period, the program burner control institutes a trial-for-ignition period. In accordance with the teachings of the prior art, the damper is controlled to institute movement to the low fire position during the prepurge period so as to insure that the damper will be at a low fire position prior to the institution of the trial-for-ignition period.

Our invention is concerned with the particular manner in which the damper motor is controlled as related to the program of the fuel burner unit. Specifically, the inventive concept of our structure resides in the arrangement whereby the damper motor begins its movement to low fire position immediately prior to the end of a particular program period, for example, the prepurge period. The damper motor requires a given time interval to move from the high fire to the low fire position and, as we control the damper motor, it will not be at the low fire position at the end of the prepurge period. Therefore, we provide an arrangement to interrupt the programming of the burner and to reinstitute the programming of the burner, to move into the trial-for-ignition period, only

when the damper motor has reached the low fire position. In this manner, we not only insure that the damper motor must be at the low fire position before the trial-for-ignition period can be instituted, but we likewise obtain an extended prepurge period in which the damper is fully open for the major portion of the prepurge period, and in which the time of the prepurge period is determined not only by the program burner control, but also by the movement of the damper actuator, the damper actuator itself acting as a timer as it moves the damper from the high fire position to the low fire position.

In the preferred embodiment of our invention, we show a program burner control of the type having a plurality of cam operated switches. These cam operated switches are controlled from a small synchronous motor which drives a cam shaft at a uniform speed, the cam shaft carrying a number of cams. In order to obtain accurate switching by virtue of the cams, it is necessary that the cam rotate at an optimum rate. This optimum rate determines, to a practical extent, the prepurge time which can be provided. If too long a prepurge time is attempted by use of this structure, then the switching which follows the prepurge time takes place with a relatively small rotation of the cams and the required switching is difficult to achieve with accuracy and reliability. With the construction of our invention, since we rely on the timing of the damper actuator itself, we are able to select cam contours and rotation speeds of the cam to provide the optimum in reliable and accurate switching of the switches which are effective to program the fuel burner unit.

While we have chosen to use the terms "high fire" and "low fire" to describe a full open or a full closed condition, it is within the teachings of our invention to utilize an arrangement in which the condition may not be full open or full closed, and define conditions at the ends of a range of conditions.

Our invention will be apparent to those skilled in the art upon reference to the following specification, claims, and drawings, of which:

FIGURE 1 is a schematic representation of our invention, and

FIGURE 2 is a bar graph showing the manner of operating the cam operated timer switches.

Referring to FIGURE 1, reference numeral **10** designates generally a fuel burner unit having a pilot burner **11** with its associated pilot valve **12**, a main burner **13** with its associated main valve **14**, an ignition electrode **15** connected to an ignition transformer **16**, and a blower **17** connected to an air flow conduit **18** having a damper **19**, the damper position being controlled by a damper actuator **20**. The damper is shown in the low fire position, the dotted position **21** being the high fire position allowing maximum air flow to the fire box. Flame within the fire box is detected by a photocell **22** connected to the input of a flame detector **23**, whose output constitutes a flame relay designated 2R. Flame 2R is provided with three switches designated 2R1, 2R2, and 2R3.

Damper actuator **20** includes a pair of coils **24** and **25** which are connected in an electrical energizing circuit arrangement, such that with coil **24** energized damper **19** moves to the high fire position and with coil **25** energized, as shown in FIGURE 1, the damper moves to the low fire position. Energization of coils **24** and **25** is effected, during the running period of the fuel burner unit, by means of a damper controller **26**. This damper controller includes a movable switch blade **27** movable between fixed contacts **28** and **29** to energize the coils **24** and **25** respectively. Energization of the coils **24** and **25** is also programmed by means of the timer switches T1, T2, T3 and T4.

Reference numeral **30** designates a timer T. Timer T is a synchronous motor which is connected to rotate, at

a uniform speed, a plurality of contoured cams, each of the switches of the timer having a cam surface to control the timer switch in the manner disclosed in FIGURE 2. Timer T is provided with **12** switches, labeled T1 through T12 inclusive.

Also associated in an electrical circuit arrangement to control fuel burner unit **10** is a main burner relay **1R** having the switches **1R1**, **1R2**, **1R3** and **1R4**.

In circuit with relay **1R** is a saftey cutout device **31** having a heater **32** and a bimetal actuator **33**. As is well known, a timer period of energization of heater **32** is effective to cause the bottom end of bimetal **33** to warp to the right to thus release a switch blade **34** to open and latch in the open position a normally closed switch **35**. Safety cutout device **31** may be manually reset, by means not shown.

A further relay **3R** is provided having a single switch **3R1**. This relay functions to control energization of blower **17**.

Referring now specifically to the operation of the apparatus of FIGURE 1, the apparatus is shown in the standby condition wherein operating voltage is applied to power line conductors **40** and **41**. Damper **19** is in the low fire position by virtue of energization of coil **25** by way of a circuit which can be traced from conductor **41** through coil **25**, timer switch T4 and timer switch T2 to conductor **40**.

A call for operation of fuel burning unit **10** is evidenced by closing of start switch **42**. The closing of this switch completes an energizing circuit for relay **1R**, this energizing circuit being traced from conductor **41** through switch **35** of a cutout device **31**, the lower portion of the winding of relay **1R**, heater **32**, switch **2R3**, timer switch **T8**, and start switch **42** to power line conductor **40**. Energization of relay **1R** causes its associated switches to be actuated.

Closing of switch **1R3** completes an energizing circuit for relay **3R**, thus causing an energizing circuit for blower motor **17** to begin the purge period. It will be noted that at this time damper **17** is in the low fire position.

The closing of switch **1R3** also completes an energizing circuit for timer **30** through the timer operated switches **T11** and **T12**. Thus, the programmed operation of burner unit **10** begins as timer **30** causes rotation of the cams controlling the various timer switches.

Upon reference to FIGURE 2 it can be seen that the first switching occurs at the three second interval when the timer switch T1 closes and timer switch T2 opens. The closing of timer switch T1 completes an energizing circuit for the high fire winding **24** of damper actuator **20**. This circuit can be traced from power line conductor **41** through winding **24** and switch T1 to power line conductor **40**. The opening of switch T2 opens the energizing circuit for winding **25**, above traced, and thus damper **19** begins its movement from the low fire position to the high fire position. Therefore, the quantity of air passing through the fire box to purge the fire box increases to a maximum value as the damper is positioned at the high fire position.

It should be mentioned that it may be desirable to control damper **19** in a manner to cause the damper to be at the high fire position during the standby period. In this case, the prepurge period is instituted with the damper fully open.

Again upon reference to FIGURE 2, it can be seen that at the four second interval timer switch **T10** closes. The closing of timer switch **T10** provides a shunt circuit around switch **1R3**, and since timer switch **T10** remains closed until the end of the time period of operation provided by timer **30**, relay **3R** will remain energized and switch **3R1** will remain closed to maintain continuous operation of blower motor **17**.

At the 10 second interval, switch **T8** opens. The opening of this switch opens the starting interlock which insures that the program for fuel burner unit **10** may not begin unless the timer motor **30** is in the start position wherein switch **T8** is closed. Operation of the burner control apparatus is maintained through the stop button **50** and through the switch **1R2**.

At the 32 second interval, timer switch T1 opens and timer switch T2 closes. The operation of these switches again energizes the low fire winding **25** of damper actuator **20** to begin the movement of the damper from the high fire position to the low fire position. As shown in FIGURE 2, the end of the purge period is at the 40 second interval and thus it can be seen that return of the damper motor to the low fire position is instituted eight seconds prior to the end of the purge period. Thus, a purge period is provided wherein the damper is maintained in the high fire position for a major portion of the purge period. Furthermore, the majority of the damper motor actuators require longer than eight seconds to return from the high fire to the low fire position. Normally, these motors require from 15 to 60 seconds to drive the damper between its two positions. As is apparent, operation of damper actuator **20** is effective as a second timing means to extend the purge period.

At the 35 second interval, timer switch **T12** opens. Timer switch **T12** is in series with the energizing circuit for timer motor **30** and therefore timer motor **30** is now deenergized. Thus, the program of the burner unit is interrupted and will not be reinstituted until the low fire interlock switch **51** associated with the damper actuator **20** is closed. This switch is closed only when the damper is in the low fire position and the additional time required for the damper actuator to move the damper to the low fire position extends the prepurge period, thus contributing to additional safety in the programming of the fuel burner unit from its standby condition to its run condition.

While we have chosen to show our invention in the environment of a complete program burner control apparatus, the detailed timer and switch construction provided to safely program the burner control form no part of our invention. As we have stated, our inventive concept is concerned with the manner of insuring that the damper is at the low fire position before the fuel burner unit can be programmed into the trial-for-ignition period, and to also accomplish this result in a manner which extends the purge period, the damper actuator additionally functioning as a timer to extend the actual purge period.

Completing the explanation of the apparatus of FIGURE 1, at the 38 second interval timer switch **T9** closes and this switch is effective to operatively energize the heater **32** of safety cutout device **31**, this energization taking place only after the program has been reinstituted by the closing of switch **51**.

At the 42 second interval, switch **T7** closes and this switch energizes pilot valve **12** and ignition transformer **16** to begin the trial-for-ignition period.

At the 46 second interval, switch T12 again closes. At the 50 second interval, switch **T6** opens and switch **T5** closes. The opening of switch **T6** is effective to deenergize pilot valve **12** and ignition transformer **16**, but only in the event that the pilot flame has not been detected. Normally, pilot flame is detected and relay **2R** is energized to close switches **2R1** and **2R2**. Switch **2R1** is in series with main valve **14** and the closing of timer contact **T5** provides an energizing circuit for this valve so that a main flame may be established at main burner **13**. Energization of flame relay **2R** also causes a switch **2R3** to open to deenergize heater **32** of safety cutoff device **31**.

At the 65 second interval switch **T3** closes and switch **T4** opens. These switches are connected in the circuit of damper actuator **20** and actuation of these switches places the damper actuator under control of damper controller **26**.

At the 80 second interval, switch **T7** opens to deenergize pilot valve **12** and ignition transformer **16**. At the 105 second interval, switch **T11** opens and this switch is

effective to deenergize timer 30, thus establishing the beginning of the run period. The run period continues until stop button 50 is actuated.

Opening of stop button 50 is effective to deenergize relay 1R and to deenergize main valve 14 of fuel burner unit 10. Deenergization of relay 1R closes its switch 1R4 and completes an energizing circuit for timer motor 30 such that this motor begins to program the fuel burner unit back to the standby condition.

While we have disclosed what we believe to be the preferred embodiment of our invention, we intend the scope of this invention to be limited solely by the scope of the appended claims.

We claim as our invention:

1. In a program burner control having a motor driven timer to sequentially control a plurality of cam operated switch means adapted to be connected to a fuel burner unit to sequentially program the same from a standby condition through at least a prepurge period and a trial-for-ignition period to a run condition, the fuel burner unit including an air damper having an electrically energizable actuator effective to move the air damper between high fire and low fire positions, the movement between these positions requiring a given time interval, the improvement comprising:

first circuit means controlled by said switch means and adapted to be connected to the air damper actuator to provide a prepurge period with the damper in the high fire position and to institute a return of the air damper to low fire position at a timer prior to the end of the purge period, said time prior to the end of the purge period being less than the given time interval,

and second circuit means controlled by said switch means, and adapted to be controlled by the position of the damper, to interrupt operation of the motor driven timer until such time as the damper is in the low fire position, to thus institute the trial-for-ignition period after a prepurge time as determined by operation of the motor driven timer and by operation of the damper actuator.

2. In a timer driven program burner control for a burner having ignition means, a fuel valve, an air blower, and a slow acting actuator for an air damper which is movable between high fire and low fire positions, the burner control being adapted to provide a sequential program of a purge period for the burner wherein the air blower is energized with the air damper at high fire position, followed by a trial-for-ignition period wherein the air blower is energized with the air damper at low fire position and the ignition means and a fuel valve are energized, the improvement comprising:

first timer controlled means adapted to be connected to the actuator of the air damper to begin movement of the same toward the low fire position immediately prior to the end of the purge period as determined by the burner control,

second timer controlled means connected to interrupt operation of the sequential program at a time subsequent to operation of said first timer controlled means and prior to the end of the purge period as determined by the burner control,

and third means adapted to be controlled by the air damper when in the low fire position to reinstitute the sequential program, the purge time thus being determined by operation of said second timer controlled means followed by an additional time as determined by the air damper actuator.

3. In a program burner control having a timer to sequentially control a plurality of electrical switch means which are adapted to be connected to the components of a fuel burner unit to program the fuel burner unit from a standby condition through a prepurge period and an ignition period to a run condition; the fuel burner unit including an air damper having actuating means requiring a given time interval to move the damper between high fire and low fire position, and having a low fire interlock switch which is actuated when the damper is in the low fire position; the burner control providing a prepurge period with the air damper in a high fire position; the improvement comprising:

first switching circuit means controlled by the timer and adapted to be connected to the air damper actuating means to institute a return of the air damper to a low fire position at a time interval prior to the end of the prepurge period, said time interval being less than the given time interval,

second switching circuit means controlled by the timer to interrupt operation of the timer at a time after the beginning of said timer interval and prior to the beginning of the ignition period,

and third switching circuit means adapted to be controlled by the low fire interlock switch and connected to subsequently energize the timer upon return of the air damper to low fire position.

4. In a program burner control having a timer to sequentially control a plurality of electrical circuit means which are connected to a fuel burner unit to program the fuel burner unit from a standby condition through a prepurge period and an ignition period to a run condition; the fuel burner unit having an air blower and an air damper which is movable between minimum and maximum air flow positions, the movement between these positions requiring a given time interval, the air damper including a low fire interlock switch which is actuated when the air damper is at the minimum air flow position; the control providing a prepurge period wherein the air blower is energized with the damper at the maximum air flow position and the air damper is moved from the maximum air flow position to the minimum air flow position prior to initiation of the ignition period; the improvement comprising:

first circuit means controlled by the timer and effective to institute a return of the air damper to the minimum air flow position at a time interval prior to the end of the prepurge period, the time interval prior to the end of the prepurge period being less than the given time interval,

second circuit means controlled by the timer and effective to interrupt operation of the timer after institution of the return of the air damper to the minimum air flow position,

and third circuit means adapted to be controlled by the low fire interlock switch to subsequently energize the timer upon return of the air damper to the minimum air flow position to thus reinstitute the program of the fuel burner unit.

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JAMES W. WESTHAVER, *Primary Examiner.*