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BURNER CONTROL APPARATUS

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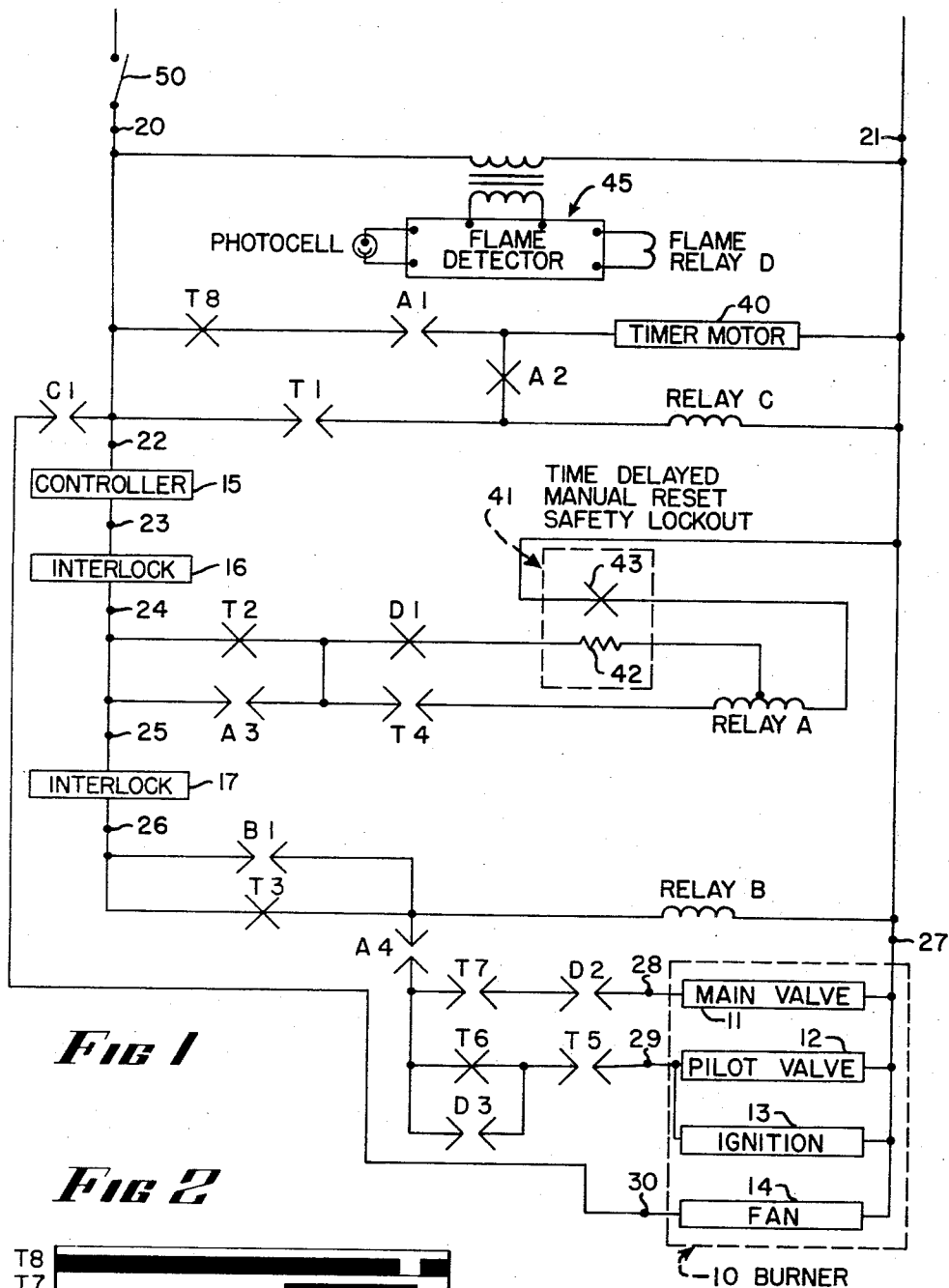
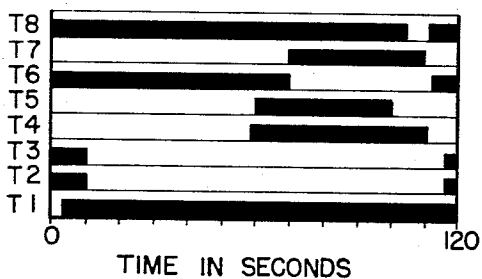


Fig 1

Fig 2



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BURNER CONTROL APPARATUS

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My improved burner control apparatus utilizes a timer to provide a program of operation of a fuel burner, including a prepurge period followed by a trial-for-ignition period. The apparatus is used with first and second interlocks and is effective to differentiate between operation of these interlocks.

The interlocks are usually self-resetting switches and are associated with the fuel burner to monitor the presence of physical conditions associated with the fuel burner, for example, low fuel pressure, high fuel pressure, combustion air flow, high temperature, etc. The first interlock is exemplary of a class of interlocks which monitor a physical condition whose temporary absence does not preclude safe recycle of the fuel burner. The second interlock, however, monitors physical conditions whose temporary absence is critical in that safe recycle of the fuel burner may not occur and, as a result, safety lockout should be provided.

My invention discriminates between operation of the first and second interlocks and provides safety lockout with no recycle upon temporary operation of the second interlock, and provides this function during the entire burner program, with the exception of a short period at the beginning of the program.

This is accomplished by means of a first control relay which is controlled by the first interlock and which energizes the timer to institute the burner program. A second relay is controlled by both the first interlock and the second interlock and is initially energized by means which includes a normally closed timer switch. After a short period of timer energization, this timer switch opens and the second relay is maintained by a switch of the second relay. Subsequently, should the first interlock operate, the burner recycles. However, if the second interlock operates, only the second relay is deenergized and the burner does not recycle.

The trial-for-ignition portion of the burner installation is controlled by the second relay and by the timer to admit fuel to the burner only when the second relay is energized and when the timer has reached the end of the prepurge period. A flame detector is associated with the burner to detect the presence of flame and the flame detector controls a manual reset safety lockout to cause lockout in the event flame does not appear during the trial-for-ignition period. Thus, should the second interlock operate during the prepurge period, the second relay is deenergized and remains deenergized to prevent the presence of flame and lockout occurs.

FIGURE 1 is a schematic showing of my invention and a fuel burner installation, and

FIGURE 2 is a graph showing the sequence of operation of the timer switches of FIGURE 1.

Referring to FIGURE 1, reference numeral 10 designates, schematically, a burner having a main valve 11, a pilot valve 12, an ignition means 13 and a fan 14. Fan 14, when energized, moves combustion air to the burner. Pilot valve 12 and ignition means 13, when energized, establish a pilot flame which is associated in igniting relationship to a main burner, main valve 11 controlling the flow of fuel to the main burner.

Operation of the burner is controlled by a controller 15. Controller 15 may be a manual switch or a switch controlled by a condition, such as temperature. Closing of

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the controller switch signifies the need for operation of burner 10.

Also associated with the burner are a first interlock 16 and a second interlock 17. Interlocks 16 and 17 are associated with the burner to monitor first and second physical conditions, such as temperature, pressure, low and high fuel pressure, combustion air flow, and the like. These interlocks monitor physical conditions of generally different nature in that interlock 16 monitors a physical condition the momentary absence of which does not preclude the safe recycle of the burner in an attempt to further establish flame thereat. However, interlock 17 monitors a physical condition of a nature such that recycle of the burner is unsafe and safety lockout should occur.

The apparatus of my invention achieves this function and monitors interlocks 16 and 17 during approximately the entire program of the burner.

My improved burner control apparatus, which is adapted for use with burner 10, controller 15, and interlocks 16 and 17, is provided with terminals 20 and 21, adapted to be connected to a source of voltage, not shown. Terminals 22 and 23 are adapted to be connected to the controller whereas terminals 23, 24, 25 and 26 are adapted to be connected to interlocks 16 and 17. Terminals 27, 28, 29 and 30 are adapted to be connected to burner 10.

The burner control apparatus of my invention includes a timer motor 40. This timer motor, when energized, is effective to rotate a shaft which carries a number of cams, not shown. The cams are associated with switches to sequentially control the operation thereof. The switches are designated by the suffix "T," as switches T1 through T8. The sequence of operation is shown in the graph of FIGURE 2 and in the following table, wherein, as an example, the designation "C4" indicates that switch T1 closes four seconds after initial energization of timer motor 40 and "O120" indicates that T1 opens after 120 seconds of motor energization.

T1-----	C4	O120
T2-----	O10	C116
T3-----	O10	C116
T4-----	O58	O111
T5-----	C60	O100
T6-----	O70	C112
T7-----	C70	O110
T8-----	C105	C111

A first control means is designated as relay A, and includes a winding and switches A1, A2, A3, and A4.

A second control means is designated as relay B, and includes a winding and switch B1.

A relay C includes a winding and a switch C1.

Reference numeral 41 designates a time delayed manual reset safety lockout having an actuator 42 and a normally closed switch 43. Lockout 41 may be a conventional bimetal operated device which is latched in a lockout condition with switch 43 opening after a period of operative energization of heater 42.

Reference numeral 45 designates a flame detector having a photocell to sense the presence or absence of flame at burner 10 and having a flame relay D which is energized in the presence of flame. Relay D includes switches D1, D2, and D3.

Considering now the operation of the apparatus of FIGURE 1, it is first necessary to close a line switch 50, applying operating voltage to flame detector 45. At this time there is no flame at burner unit 10 and flame relay D is deenergized. The need for operation of the burner is indicated by controller 15 closing a switch, not shown, causing relay A to be energized through a circuit which includes controller 15, through interlock 16, timer switch T2, flame relay switch D1, heater 42, the winding of relay A, and switch 43 of the safety lockout. The relative impedances

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of the winding of relay A and heater 42 is such that heater 42 is not operatively energized at this time.

Energization of relay A causes its switches to be actuated. The closing of switch A1 completes a circuit to energize timer motor 40 through timer switch T8. The closing of switch A3 completes a circuit in parallel with timer switch T2.

Relay B is also energized through a circuit which includes controller 15, interlocks 16 and 17, and timer switch T3. Switch B1 then closes to provide a short circuit around switch T3.

As seen in FIGURE 2, after four seconds of operation of timer motor 40, switch T1 closes. The timer motor 40 is maintained energized through the circuit including timer switch T8 and relay switch A1.

The closing of switch T1 is effective to energize relay C and its switch C1 is adapted to energize fan 14 to move combustion air to the burner and to begin the purge period. It is within the teachings of this invention to begin this purge period substantially immediately upon closing of controller 15. However, in the preferred embodiment, the purge period begins four seconds after operation of controller 15.

The next timing sequence occurs at 10 seconds when timer switches T2 and T3 open. The opening of switch T2 causes continued energization of relay A to be dependent upon switch A3 remaining closed. The opening of switch T3 causes continued energization of relay B to be dependent upon switch B1 remaining closed.

Relay A is responsive to temporary operation of only interlock 16 or interlock 17. As will be apparent, temporary operation of interlock 16 is effective to cause recycling of the burner whereas temporary operation of interlock 17 provides safety lockout with no recycle.

Subsequently, at 58 seconds, timer switch T4 closes to connect heater 42 of safety lockout 41 in parallel with a portion of the winding of relay A and begins the operative energization of heater 42 which continues so long as flame relay D remains deenergized to maintain switch D1 closed.

At 60 seconds, timer switch T5 closes and a trial-for-ignition period is instituted by energization of pilot valve 12 and ignition means 13. The energizing circuit for these burner components includes relay switch A4 and relay switch B1. Should either of the relays A or B become deenergized, the pilot valve and ignition means are deenergized. However, by virtue of my invention, the burner recycles only if deenergization of the burner is achieved as a result of deenergization of relay A, as by operation of interlock 16. Should deenergization of the burner result from deenergization of relay B, as by operation of interlock 17, then recycle does not occur.

During the period from the closing of switch T5 to the opening of switch T6 at 70 seconds, flame is normally established at the burner and flame relay D is energized to close switch D3 and provide a parallel circuit bypassing switch T6 to maintain the pilot valve and ignition means energized. Furthermore, the opening of switch D1 is effective to operatively deenergize the heater of safety lockout 41.

Timer switch T7 also closes at 70 seconds. The closing of this timer switch completes an energizing circuit for main valve 11 through switch D2 of the flame relay. Thus, fuel is admitted to the main burner if ignition has been established during the trial-for-ignition period.

The next switching action occurs at 100 seconds when switch T5 opens to deenergize the pilot valve and ignition means. Subsequently, at 105 seconds, timer switch T8 opens to deenergize timer motor 40 and establish the run position.

The apparatus of FIGURE 1 is now in the run position, controlled by controller 15, with relays A, B, C and D energized and with timer motor 40 deenergized. At the end of a period of need for operation of the burner, controller 15 opens to deenergize relays A and B. Deenergiza-

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tion of these relays immediately deenergized main valve 11 and reenergizes timer motor 40 through a circuit which includes timer switch T1 and relay switch A2. The timer motor continues to operate until the start position is reached at 120 seconds, this being the "O" second point of the graph of FIGURE 2, whereupon timer switch T1 opens. At this time relay C is also deenergized and switch C1 opens to deenergize the fan.

In order to consider the operation of my invention, it must be assumed that interlocks 16 or 17 operate. At any time after the opening of timer switch T2 (10 seconds) the momentary operation of interlock 16 is effective to deenergize both relays A and B. The deenergization of relay A is effective to maintain energization of timer motor 40 (or to reenergize this timer motor should interlock 16 open during the run period) to cause the timer motor to operate to the start position (120 seconds). If controller 15 is still indicating a need for operation of the burner, then recycling occurs and the above described operation continues through the purge period and the trial-for-ignition period.

If interlock 17 operates at any time after the opening of switch T3 (10 seconds) then only relay B is deenergized. Deenergization of relay B insures that a flame will not be established at burner unit 10 when deenergization occurs during the prepurge or the trial-for-ignition period, or insures that a flame will be interrupted at the burner when deenergization occurs during the run period. In either event, flame relay D is deenergized and heater 42 of safety lockout 41 is energized through a circuit which includes timer switch T4 and flame relay switch D1. The timer motor does not progress beyond the 105 second running interval and remains in this position with switch T4 closed until safety lockout occurs. The opening of switch 43 of safety lockout 41 causes relay A to be deenergized and the timer motor is energized to return to the start position at 120 seconds, at which time switch T1 opens.

I claim as my invention:

1. A burner control apparatus for use with a burner installation having a fan, a fuel valve, first and second interlock means to monitor first and second physical conditions, and a controller responsive to the need for operation of the burner installation, the control apparatus comprising:

timer means to time a prepurge operating period of the burner installation,

first control means adapted to be controlled by the controller and the first interlock means to actuate said first control means upon a need for operation of the burner installation and upon the absence of the first physical condition such that the subsequent temporary presence of the first physical condition is effective to interrupt the actuation of said first control means followed by a recycling of said first control means,

means operable upon actuation of said first control means to actuate said timer means and adapted to actuate the fan to begin the prepurge period,

second control means controlled by said timer means for a first time period shorter than the prepurge period, and adapted to be controlled by the controller and both of the first and second interlock means to actuate said second control means upon a need for operation of the burner installation and upon the absence of the first and the second physical condition, means operable upon actuation of said second control means to maintain actuation of said second control means after said first time period independent of said timer means, such that the subsequent temporary presence of the first physical condition is effective to interrupt the actuation of said second control means followed by a recycling of said second control means,

and a subsequent momentary presence of the second

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physical condition is effective to interrupt the actuation of said second control means with no recycle, means adapted to open the fuel valve and controlled by said second control means and said timer means to initially open the valve at the end of the prepurge period, and to maintain the valve open upon continuous actuation of said second control means, flame detecting means adapted to detect flame at the burner installation, and latching safety lockout means controlled by said flame detecting means effective to assume a latched lockout condition upon the absence of flame after the end of prepurge period.

2. A burner control apparatus as defined in claim 1 wherein said first control means is additionally controlled by said timer means for a second time period shorter than the prepurge period and upon actuation of said first control means is maintained self-actuated after said second time period independent of said timer means; and wherein said means operable to actuate said timer means is additionally controlled by said timer means and by said first control means when not actuated, to cause recycle of said timer means upon the temporary presence of the first physical condition.

3. A burner control apparatus as defined in claim 2 wherein said timer means has a start condition which is maintained for said second time period after actuation of said timer means, and wherein said first control means is additionally controlled for said second time period by said timer means when in said start condition to initially actuate said first control means.

4. A burner control apparatus as defined in claim 1 wherein said timer means has a start condition which is maintained for said first time period after actuation of said timer means and wherein said second control means is controlled by said timer means in said start condition to initially actuate said second control means.

5. A burner control apparatus as defined in claim 4 wherein said first control is additionally controlled for a second time period by said timer means when in said start condition to initially actuate said first control means.

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6. A burner control apparatus as defined in claim 1 wherein said timer means includes a plurality of switches which are actuated in a programmed sequence upon actuation of said timer means, said programmed sequence including a start position, a prepurge period, a trial-for-ignition period, and a run position;

wherein said first control means is additionally controlled by a first of said timer switches which is closed when said timer means is in said start position and is opened early in the prepurge period, and wherein actuation of said first control means provides a circuit shunting said first timer switch so long as said first control means remains actuated;

wherein said second control means is additionally controlled by a second of said timer switches which is closed when said timer means is in said start position and is opened early in the prepurge period, and wherein said means operable upon actuation of said second control means provides a circuit shunting said second timer switch so long as said second control means remains actuated,

wherein said lockout means includes an actuator which is controlled by a third of said timer switches and by said flame detecting means to cause said lockout means actuator to be energized when said timer means is operating in said trial-for-ignition period or said run position and to be deenergized upon the detection of flame; and

wherein said timer means is actuated to return to said start position only upon an interruption in the actuation of said first control means.

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