Aug. 22, 1950 C. W. CRAWFORD 2,519,889

CYCLIC BURNER SAFETY CONTROL SYSTEM

Filed Nov. 28, 1947 2 Sheets-Sheet 1

Fig. 1.

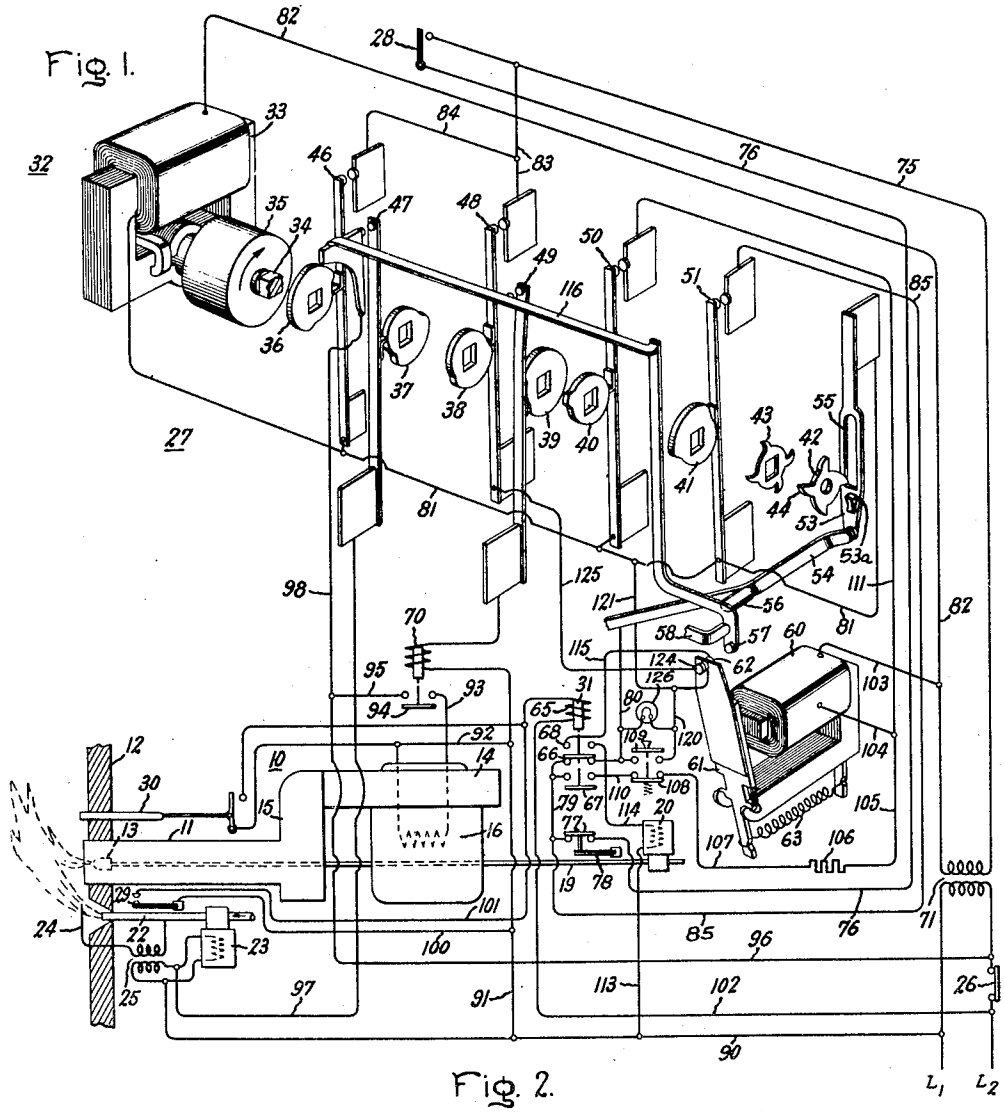
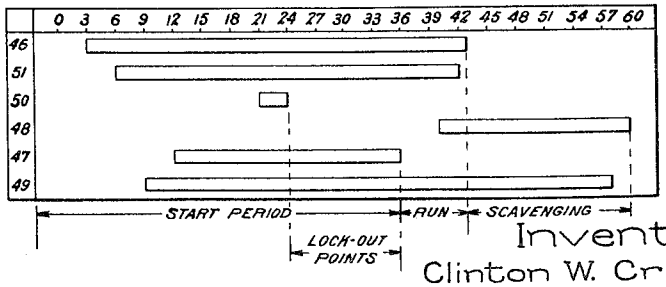


Fig. 2.



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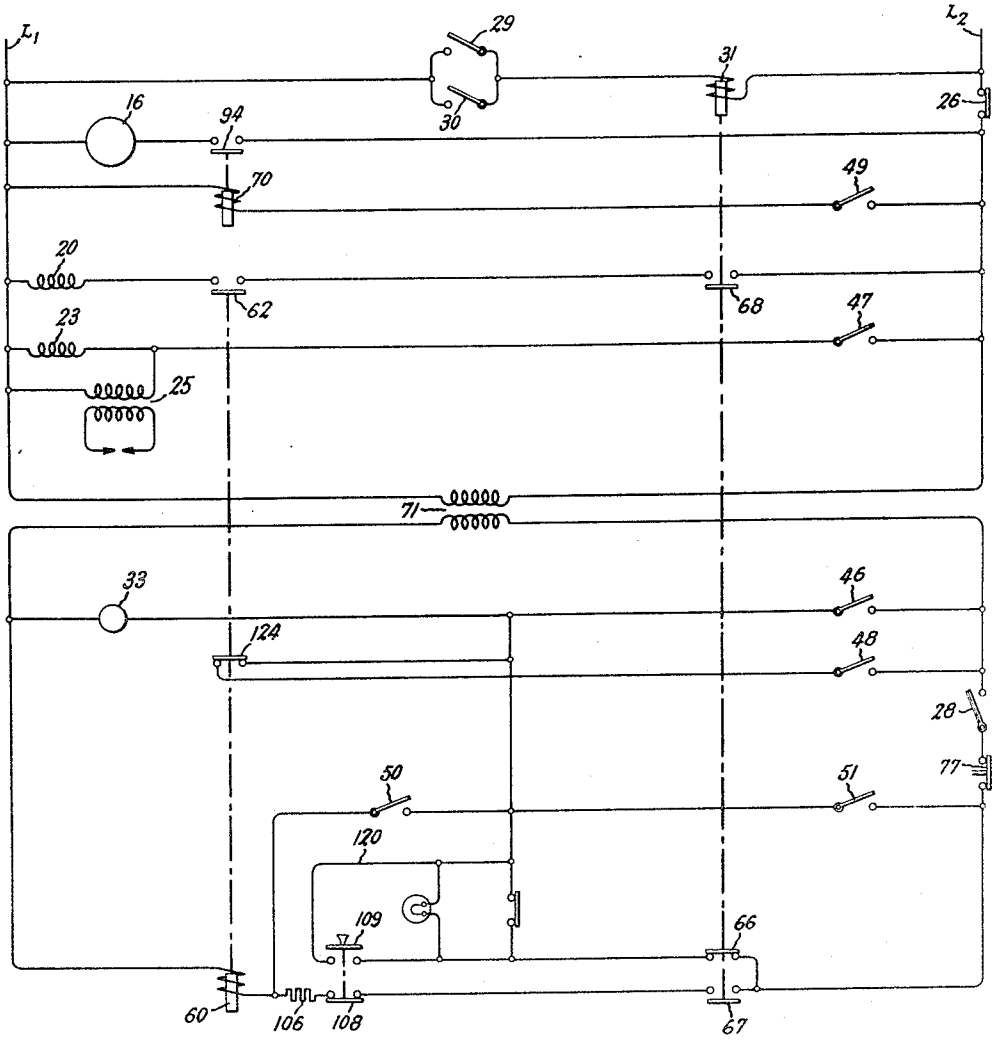
Filed Nov. 28, 1947 2 Sheets-Sheet 2

Fig. 3.



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CYCLIC BURNER SAFETY CONTROL SYSTEM

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14 Claims. (Cl. 158—28)

1

The invention relates to automatic control systems for burners, particularly sequential safety control systems for automatically igniting and controlling the continued operation of oil or other fuel burners.

Such automatic burner control systems usually provide a limited trial starting period under coordinated conditions for igniting the fuel to start combustion. Then the igniter is shut off and the burner flame is normally self-propagating during a continued burner running period under thermostatic safety control that automatically provides for flame failure and power failure recycling and scavenging protection as well as lock-out against further automatic operation of the burner in case any combustion starting trial should fail.

The Eaton Patent 2,278,252 assigned to the present assignee, relates to an improved automatic burner sequential control of the above type and the present invention provides further improvements that although not limited thereto, are particularly advantageous for relatively high oil rate commercial or other burners where special ignition failure protection, double lock-out and "after run" scavenging protection are desirable.

One object is to insure safe operation of the burner by providing an improved automatic sequential control for introducing a preliminary igniter trial period into the sequence and for preventing the supplying of fuel for the subsequent burner combustion starting trial period unless the igniter functions normally during the preliminary igniter trial period.

Another object is to provide an improved double lock-out sequential burner control system effective to automatically lock-out in case of failure of an automatically lighted gas pilot or other suitable igniter to function normally during the preliminary igniter trial period as well as to lock-out automatically in case combustion is not subsequently established during the normal fuel combustion starting trial period prior to the continued burner running period.

Another object is to provide for the energization of a signal lamp upon the opening of the lock-out switch to indicate that a lockout of the automatic control has occurred.

Another object is to provide an improved burner control system having a cycle timer provided with sequential control elements for operating the burner combustion air blower for a fixed period during the time cycle and for operating the igniter and fuel supply means during a trial period intermediate the blower operating period together with automatic combustion responsive means for stopping the timer to provide a continued burner running period intermediate the fixed blower operating period provided the igniter operation is normal and combustion is successfully established.

2

Another object is to enable the automatic burner sequential control to provide an "after-run" scavenging period during which the air supply is continued with the fuel shut off to insure combustion of any residual fuel in the burner as well as to "purge" the fuel supply nozzle. With an oil burner this materially reduces carbonization and servicing.

Further objects and advantages of the invention will appear in the following description of the accompanying drawing in which Fig. 1 is a schematic perspective view of the improved sequential control system for an oil burner having an automatically ignited gas pilot for igniting the oil; Fig. 2 is a sequence chart showing the starting sequence for the cam operated timer switches in the control shown in Fig. 1; and Fig. 3 is a simplified circuit diagram of the high voltage burner and igniter control circuits and the low voltage sequential control circuits involved in the oil burner control system of Fig. 1.

As shown in Fig. 1 the oil burner 10 is of a conventional type having an air tube 11 projecting through the furnace wall 12 with an inner oil atomizing nozzle 13. The combustion air is supplied to the air tube 11 from the blower 14 through conduit 15 upon energization of a suitable blower driving motor 16 indicated schematically. Oil is supplied under pressure to the nozzle 13 through the oil supply pipe 19 upon energization of the electromagnetically operated oil supply control valve 20.

The gas pilot burner 22 is shown extended through the furnace wall 12 to project a gas flame adjacent the outlet of the oil burner air supply tube 11 and the oil atomizing nozzle 13 so as to ignite the combustible mixture of air and oil projected into the furnace. Gas is supplied to the pilot burner 22 when the electromagnetic operated pilot burner gas control valve 23 is energized and is ignited by means of the spark elec-

trode 24 connected to the high voltage secondary of the ignition transformer 25, that is energized simultaneously with the gas supply control valve 23.

The improved automatic sequential control system indicated generally by the reference character 27 and embodying the improvements of the present invention starts the operation of gas pilot burner 22 and provided gas combustion is normally established then the oil valve 20 is opened to supply oil for ignition by the gas flame. The operation of the sequential control 27 is initiated by a suitable automatic starting device 28 that may be a conventional room temperature responsive thermostat or other master controller and the gas pilot burner combustion responsive switch 29 and the oil burner combustion responsive switch 30 together with relay 31 controlled thereby cooperate with the master controller 28 in controlling the sequential operation of the burners under both normal and abnormal combustion conditions.

The burner starting cycle timer 32 is operated by a self-starting synchronous motor 33 that drives, through suitable speed reducing gearings within the case 35, the cam shaft 34 to rotate a series of sequential switch operating cams 36, 37, 38, 39, 40, 41 as well as a relatively rotatable multi-fingered stop member 42 that is frictionally driven by spring washer 43 and serves to lock out the control upon failure of either the gas pilot burner combustion or the oil burner combustion becoming established at the proper time in the starting sequence. The rotating cams 36 to 41 inclusive sequentially operate the corresponding switch members 46 to 51 inclusive and the lock out stop member 42 can be angularly positioned to arrest the movement of the lockout switch member 53 towards the cooperating lockout switch member 54 so as to open the starting circuit controlled thereby. The pair of lockout switches 53 and 54 are normally in circuit closing engagement and are biased to bodily move together as a unit toward the rotatable stop member 42 which thus may have one of the fingers 44 thereof received into the opening 55 formed in member 53 depending upon the angular position of the stop member 42. When any one of the fingers 44 is received in opening 55 as shown in Fig. 1, the lock out switch members 53 and 54 are then free to move together as a unit to engage the insulating spacer 56 carried by member 54 with the movable contact 57 that in turn is biased into engagement with a fixed stop 58.

An electromagnetic power failure responsive relay 60 upon energization thereof, operates the armature 61 to carry contact 62 into engagement with movable contact member 57 and thereby exert force through the insulating spacer 56 to move the lock out contacts 53 and 54 as a unit away from the rotatable stop member 42 and in this way permit rotation by the friction drive washer 43. The combustion responsive relay 31 having its winding 65 energized under the separate and joint control of the gas pilot combustion responsive switch 29 and the oil burner combustion responsive switch 30 positions the contacts 66 and 67 to cooperate with the timer 32 and relay 60 in controlling the sequential starting of the burners. The relay 70 serves to control the energization of the blower driving motor 16.

Operation

Electric power is supplied for energizing the blower motor 16, the oil control valve 20, and the gas control valve 23 and gas ignition transformer 25 and relay 70 from conventional supply lines L1 and L2 while low voltage power is supplied to energize the timer motor 33 and the relays 60 and 65 from the secondary of the transformer 71. The improved sequential igniter and oil burner control 27 is started into operation upon closure of the contacts of the master control or room thermostat 28. This will establish an energizing circuit for the timer motor 33 extending from the secondary of the transformer 71 through conductor 75, the contacts of master controller 28, conductor 76, the contact 77 of the thermostat 78 responsive to the temperature of the oil (in case an oil preheater is used), conductor 79, contact 66, conductor 80, the normally closed lock out contacts 54 and 53, conductor 81, the energizing winding of the timer motor 33, and conductor 82 to the other terminal of the secondary of transformer 71. In this way the timer motor 33 is energized to start rotation of the cam shaft 34 to operate cams 36 to 41 and thereby close the corresponding switches 46 to 51 in the timed sequence indicated in the diagram of Fig. 2. Thus cam 36 will close contact 46, 3 seconds after the energization of timer motor 33 thereby establishing a circuit through conductors 83 and 84 for maintaining the energization of the timer motor 33 independently of the master control 28 as more clearly indicated in Fig. 3. At the 6 second point cam 41 closes contact 51 to effectively shunt or bypass both the master controller 28 and the contact 77 of the oil preheat responsive thermostat 78 as indicated in Fig. 3. At the 9 second point cam 39 closes contact 49 to energize motor relay 70 through conductors 90, 91, contact 49, conductor 116, 98 and 96 and thereby start operation of the blower motor 16. The energizing circuit for motor 16 likewise extends from supply line L1 through conductors 90, 91, and 92 motor 16 conductor 93 contact 94 of relay 70 and conductors 95 and 96 to supply line L2. As a result air under pressure is supplied from the blower 14 to the burner tube 11 and into the combustion chamber of the furnace 12 to provide a preignition scavenging action.

The operation of the gas pilot igniter 22 is started at the 12 second point upon closure of the switch 47 by the cam 37 to complete a circuit for jointly energizing the gas valve 23 and the gas pilot ignition transformer 25 with the circuit extending from supply line L1 through conductor 90, the primary of the transformer 25 and the operating winding of valve 23 in parallel, conductor 97, switch 47, conductors 98 and 96 to supply line L2. The resulting opening of gas valve 23 to supply gas to burner 22 and the operation of ignition transformer 25 to ignite the gas should normally produce combustion of the gas pilot burner 22. When gas combustion is established, the resultant response of the gas combustion responsive switch 29 to close its contacts energizes relay 31. The energizing circuit for relay 31 extends from supply line L1 through conductors 90, 91, and 100, the closed contacts of the gas combustion responsive device 29, conductor 101, the operating winding 65 of relay 31 and the conductor 102 to the supply line L2.

Thus upon successful establishment of the gas pilot combustion, relay 31 is energized by closure of the gas combustion responsive switch 29 to open relay contact 66 and close relay contacts 67 and 68. The opening of contact 66 interrupts the starting circuit through which the timer motor 33 was initially energized and the closing of contact 67 completes a holding circuit for re-

lay 60 that will only become effective however upon energization of the relay. This holding circuit extends from conductor 82 through conductor 103 the winding of relay 60, conductors 104 and 105, the holding current limiting resistor 106 that serves to maintain the current in the holding circuit below the value required to attract the relay armature 61 against the opening bias of spring 63, conductor 107 the normally closed conductor 108 of the manual reset switch 109, conductor 110, contact 67 of relay 31 in its closed position and then by conductor 76, master control 28, and conductor 75 to the other side of the secondary of transformer 71. Due to the current limiting action of resistor 106 relay 60 remains ineffectively energized even though the holding circuit is completed.

The operation of the blower 14 by motor 16 to provide a pre-combustion scavenging period continues until the 21 second point is reached. Thereupon as indicated in Fig. 2 cam 40 temporarily closes contact 50 in order to effect full and effective energization of relay 60 with the circuit extending from conductor 82 through conductor 103, the energizing winding of relay 60, conductors 104 and 111, switch 50 and then through conductor 81, switch 46 and conductors 84, 83 and 75 to the other side of the transformer secondary. The resulting effective energization of relay 60 attracts the armature 61 to a position in which the limited current through the previously traced holding circuit becomes effective to maintain the relay energized under the control of the combustion responsive relay 31.

When armature 61 is attracted relay contact 62 is carried into engagement with contact 57 and thereby completes a circuit for energizing the oil valve 20 with the oil valve energization circuit extending from supply line L1 through conductor 90, conductor 113, the operating winding of the oil valve 20, conductor 114, contact 68 of relay 65, conductor 115, contacts 62 and 57 of relay 60, conductors 116, and 98 and 96 to supply line L2. Thus the oil valve 20 is jointly controlled by the automatic combustion responsive device including relay 31 and the gas burner flame responsive switch 29 and the voltage failure responsive relay 60 upon energization of relay 60 while the relay 31 is responsive to establishment of combustion of the pilot gas burner.

Gas pilot flame failure

In case the combustion of the gas pilot 22 should not be established or should fail for any reason, the switch 29 would not be closed to energize relay 31 in the manner previously described. Hence, the oil valve 20 cannot be energized since contact 68 of relay 65 will remain open. In this way, the improved sequential control for the igniter and oil burner insures that no oil can be admitted to the furnace unless the gas pilot burner is operating normally.

Gas pilot failure lock out

When the gas pilot combustion fails and no oil is admitted to the oil burner as just described, the relay 60 remains energized temporarily only during the time that contact 50 is maintained closed by cam 40. This temporary energization of relay 60 serves to move contact 57 and spacer 56 to the right and thereby bodily moved both of the lock out contacts 53 and 54 to the right so as to disengage opening 55 from the finger 44 of lock out stop member 42. This enables the stop member 42 to be rotated by the friction driving member 43 during the relatively short time that the relay 60 is energized by contact 50. Consequently at the end of the temporary energization of relay 60 at the 24 second point, the one of the equally spaced stop fingers 44 of the stop number 42 previously received in the opening 55 will have been rotated sufficiently into the path of movement of contact 53 to prevent the return thereof to the left when relay 60 is de-energized at the 24 second point. Consequently lock out contact 54 will disengage contact 53. When the contact spring 53 thus engages the stop finger 44, a detent 53*a* mounted upon the spring 53 slightly below the lower edge of the slot 55 engages the finger 44, so that no further rotation of the stop member 42 is permitted until the relay 60 is again energized. Such opening of the lockout contacts 53, 54 prevents automatic restarting of the control system. Such lock out will effectively prevent re-energization of both the timer motor 33 and the relay 60, since the master control 28 is rendered ineffective to restart the timer motor until the lock out contacts 53 and 54 are reclosed.

Whenever contacts 53 and 54 are disengaged to lock out the control, the timer 32 will continue in operation until the end of the cycle is reached and the oil burner elements, including the oil valve 20 and the blower motor 16, are deenergized. During such continuance of motor operation, however, the stop member 42 is held by the detent 53*a*, as described above. At the end of the cycle, cam switch 48 opens. If the room thermostat 28 is still calling for operation of the burner, its contact will be closed, thus establishing a circuit extending from the secondary of transformer 71 through conductor 75, room thermostat 28, conductor 76, contact 77, conductor 79, contact 66, and thence through the signal lamp 126, conductor 120, conductor 81, timer motor energizing winding 33, and conductor 82 to the other side of the transformer secondary. As a result, the signal lamp 126 will be lighted to indicate that a lock out of the control has occurred. The resistance of the filament of signal lamp 126 is such that timer motor 32 is not effectively energized even though the circuit extends through winding 33.

Oil combustion failure lock out

When combustion of the gas pilot 22 is successfully established prior to or during the relatively short period that relay 60 is energized by the temporary closure of the cam operated timer contact 50, then the combustion responsive relay 31 will be energized by closure of switch 29 as previously described. As a result, when relay 60 is temporarily energized by timer contact 50, the holding circuit for maintaining relay 60 energized is completed and extends through the current limiting resistor 106 and the contact 67 of relay 31 as previously described. Thus, with the voltage failure relay 60 energized and the combustion responsive relay 31 energized responsively to the successful establishment of the gas pilot combustion, an energizing circuit for operating the oil supply control valve 20 to supply oil for combustion is established as previously described. If, however, for any reason combustion of the oil should not be established before the end of the igniter operating period at the 36 second point, the oil valve 20 will be deenergized and the control then will lock out in the following manner. When the igniter operation is stopped at the 36 second point, switch 29 will respond to de-energize relay 31 and there-

by open contact 68 to interrupt the oil valve energizing circuit. At the same time contact 67 of relay 31 will interrupt the holding circuit for relay 60. Upon the resulting de-energization of relay 60, both of the lock out contacts 53 and 54 will be moved to the left. However, one of the fingers 44 of stop member 42 will be positioned by rotation of the timer cam shaft 34 so as to arrest the movement of lock out contact 53 to the left. As a result separation of contact 54 from contact 53 will occur and thereby prevent automatic restarting of the timer 32, even though the timer continues to operate to the end of its cycle as described hereinafter.

Manual reset

Whenever lock out of the control occurs due either to failure of the gas pilot combustion or failure of the oil combustion as described above, restarting of automatic operation of the control is effected by operation of the manual reset switch 109, preferably after the difficulties causing the lock out have been corrected. The upper reset contact 109 serves to shunt or bypass the lock out contacts 53, 54 as more clearly indicated in Fig. 3, with this shunt or bypass circuit extending through conductors 120, 121, and 81 to contact 53 and conductor 80 to contact 54. Thus the starting circuit for timer motor 33 is again completed upon closure of the manual reset contact 109, and the timer starts rotation of the cam shaft 34. The manual reset contact 109 is maintained closed until the three second point is reached, whereupon cam 36 closes contact 46, to continue operation of the timer 32. Thereupon the manual reset switch 109 must be released in order to reclose contact 108 in the holding circuit of relay 60 so that the control may function normally.

Normal burner operation

Assuming that both gas pilot combustion and oil combustion are successfully established before the end of the igniter operating period at the 36 second point, a normal burner extended operating period will be produced with relay 60 maintained energized under the joint control of the master controller 28 and the combustion responsive relay 31 since the latter is maintained energized due to closure of the oil combustion responsive switch 30. Thus contact 68 of relay 31 and contact 62 of relay 60 will maintain the energizing circuit for oil valve 20 closed, the cam actuated contact 48 will maintain the motor operating relay 70 energized, and the timer motor 33 will be maintained energized until the cam operated contact 46 is opened at the 43 second point in the cycle. Thereupon operation of the timer is stopped in order to provide an extended burner running period under control of master controller 28 with both flame failure and power failure recycling protection.

Power and flame failure recycling with after-run scavengig

If during such extended burner running period a power failure should occur, the power failure relay 60 will respond to open the oil valve energizing circuit. Likewise in case a combustion failure occurs, relay 31 will respond to open the oil valve energizing circuit. Under either condition, the control will recycle sequentially to restart the igniter 22 and the burner 16 in the manner previously described but only after a scavenging period has occurred. To accomplish this result, timer motor 33 is restarted and operated to provide the scavenging period upon de-energization of relay 60 through a special circuit jointly controlled by cam operated contact 48 and the relay contact 124 that is normally closed when relay 60 is de-energized. This timer scavenging period operating circuit may be traced from the secondary of transformer 71 through conductor 75, conductor 83, cam operated contact 48, conductor 125, the normally closed relay contact 124, conductor 121, conductor 81, the energizing winding 33 of the timer 32, and conductor 82 to the other side of the transformer secondary. The resulting operation of the timer 32 will maintain the blower motor 18 energized until the 57 second point is reached, since the blower operating relay 70 is maintained energized by contact 48. This insures that the forced air supply to the burner is continued after the oil valve is closed to stop combustion, thereby providing an "after-run" scavenging period to purge the burner combustion chamber and nozzle and insure combustion of any residual fuel in the burner. When the 60 second point is reached, if the master controller 28 is closed, the timer motor 33 is maintained energized through the initial starting circuit as previously traced. Thus, the "after-run" scavenging period inherently occurs whenever relay 60 is de-energized during the extended burner running period, whether the relay de-energization is due to voltage failure, flame failure, or the opening of the master control contact 28. This inherent "after-run" scavenging period is obtained due to the fact that the operation of the timer 32 is stopped intermediate the fixed period in its time cycle during which the blower operating contact 48 is maintained closed by the timer cam 38. Hence, whenever the timer is automatically restarted by de-energization of relay 60, the remainder of the blower operating period inherently produces the "after-run" scavenging period.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a burner control system for sequentially operating an igniter and supplying fuel to be ignited thereby, the combination of fuel supply control means having an energizing circuit, a power failure responsive relay having a switch for opening said circuit to prevent the supply of fuel when said relay is deenergized, a device having a second switch connected in series circuit relation with said relay switch, means rendering said device separately responsive to normal operation of the igniter and combustion of the fuel to close said second switch thereby to complete said circuit to supply fuel during joint energization of said relay and response of said device, and means including a timer having circuit control elements for sequentially operating the igniter for a limited period and energizing said relay temporarily during said period to start the supply of fuel upon response of said device to normal operation of the igniter during said temporary energization of said relay.

2. In a burner control system for sequentially operating an igniter and supplying fuel to be ignited thereby, the combination of fuel supply control means having an energizing circuit, a power failure responsive relay having a switch for opening said circuit to prevent the supply of fuel when said relay is deenergized, a device having a second switch connected in series with said relay switch, means rendering said device

separately responsive to normal operation of the igniter and combustion of the fuel to close said second switch thereby jointly to complete said circuit to supply fuel upon joint response of said device and energization of said relay, means including a timer having circuit control elements for sequentially operating the igniter for a limited period and energizing said relay temporarily during said period to start the supply of fuel upon response of said device to normal operation of the igniter during said temporary energization of said relay, and means including said device for maintaining said relay energized to continue the supply of fuel upon combustion of the fuel.

3. In a sequential control system for an igniter and a fuel burner ignited thereby, the combination of fuel supply means, a power failure responsive relay for preventing the supply of fuel upon power failure, control means including an electro-responsive device separately operable upon failure of the igniter and failure of combustion for separately preventing the supply of fuel independently of said relay, said control means being responsive separately and jointly to normal operation of the igniter and establishment of combustion for maintaining said relay energized to continue the supply of fuel under the joint control of said relay and said device, and means including a timer having sequential control elements for operating the igniter for a limited period and energizing said relay for a temporary period intermediate said limited period to start the supply of fuel for combustion upon response of said device to normal operation of the igniter during said temporary period.

4. A sequential control system for an igniter and a fuel burner ignited thereby having in combination an automatic control device and means for effecting response thereof to normal operation of the igniter and to combustion of the fuel, a control relay having holding means rendered effective only upon response of said control device for maintaining said relay energized upon energization thereof, a timing device having sequential control elements for operating the igniter for a predetermined period and energizing said relay temporarily intermediate said period, and burner fuel control means jointly dependent upon response of said control device and energization of said relay for supplying fuel for combustion.

5. A sequential control system for an igniter and a fuel burner ignited thereby having in combination, an automatic starting control element, an automatic control device and means for effecting response thereof both to normal operation of the igniter and to combustion of the fuel, a control relay having holding means rendered effective upon energization of said relay for control by said automatic starting control element jointly with said automatic control device upon response thereof for maintaining said relay energized, a timing device started into operation under joint control of said automatic starting control element and said control device and having sequential control elements for operating the igniter for a predetermined period and energizing said relay temporarily intermediate said period, and fuel supply control means jointly dependent upon response of said control device and energization of said relay for supplying fuel for combustion.

6. In a sequential control system for an igniter and a fuel burner ignited thereby, the combination of fuel supply means, a power failure responsive relay for stopping the supply of fuel upon power failure, control means including a device operable both upon failure of the igniter and failure of combustion to prevent the supply of fuel, said control means being responsive to operation of the igniter and establishment of combustion for maintaining said relay energized to continue the supply of fuel under the joint control of said relay and said device, means including a timer having automatic starting means controlling the initiation of operation of said timer and having sequential control elements for operating the igniter for a predetermined period and energizing said relay temporarily intermediate said period to supply fuel for combustion upon response of said device to operation of the igniter, and lockout means under joint control of said timer and said relay for rendering said automatic starting means ineffective upon deenergization of said relay at the end of said temporary energization thereof and at the end of said predetermined period.

7. A sequential control system for an igniter and a burner ignited thereby having in combination an automatic control device and means for effecting response thereof both to normal operation of the igniter and to combustion of the burner, a control relay having holding means effective upon response of said control device for maintaining said relay energized upon energization there, automatic means including a timing device having sequential control elements for operating the igniter for a predetermined period and energizing said relay intermediate said period, fuel supply control means jointly dependent upon response of said automatic device and energization of said relay for supplying fuel for combustion, and lock-out means under joint control of said timing device and said relay for preventing automatic reenergization of said relay upon both deenergization thereof at the end of said temporary energization thereof and at the end of said predetermined period.

8. A sequential control system for an ignition burner and a main burner ignited thereby having in combination an electro-responsive device, separate combustion responsive means for energizing said device upon combustion at said main burner or said ignition burner, a relay having holding means including said electro-responsive device and effective upon energization of said device, means for maintaining said main burner in operation upon energization of both relay and said device, a combustion starting timing device having automatic starting means and sequential control elements for operating the ignition burner for a predetermined period and energizing said relay temporarily intermediate said period, said relay and said electro-responsive device jointly initiating operation of said main burner in response to combustion at said ignition burner and said main burner continuing in operation in response to combustion at said main burner, and lockout means under joint control of said timing device and said relay for rendering said automatic starting means ineffective upon both deenergization of said relay at the end of said temporary deenergization thereof and at the end of said predetermined period.

9. In a sequential control system for an igniter burner and a main burner ignited thereby, the combination of fuel supply control means for the main burner, means including a power failure responsive relay for controlling said fuel supply control means to prevent the supply of fuel

when said relay is deenergized, means including a holding circuit for said relay for deenergizing said relay responsively to failure of combustion of both the igniter and main burners, said last-named means including a switch for separately controlling said fuel supply control means to prevent the supply of fuel to the main burner independently of said relay and to permit said fuel supply under control of said relay in response to combustion in either of said burners, and control means including a rotary cycle timer having rotating sequential control elements, one for operating the igniter burner for a limited period and another for energizing said relay temporarily during said period to supply fuel to the main burner only after response of said switch to combustion of the igniter burner and another for locking out said control means upon deenergization of said relay at the end of said temporary energization thereof and at the end of said period.

10. A sequential control system for an ignition burner and a main burner ignited thereby having in combination means responsive to the combustion of each burner, means including a relay for maintaining the main burner in operation after combustion thereof is started, relay holding means actuated by said combustion responsive means and effective upon energization of said relay, a combustion starting timing device having automatic starting means and sequential control elements for operating the ignition burner for a predetermined period and energizing said relay temporarily intermediate said period, means jointly dependent upon response of said combustion responsive means to combustion of the ignition burner and temporary energization of said relay for starting operating of the main burner, and lock-out means having a movable control element operated by said relay and a plurality of interlocking elements operated successively by said timing device into the path of said control element for rendering said automatic starting means ineffective upon both deenergization of said relay at the end of said temporary energibation thereof and at the end of said predetermined period.

11. A sequential control system for an ignition burner and a main burner ignited thereby having in combination a combustion responsive relay and separate control elements for operating said relay responsively to the combustion of each burner, an electromagnetic relay having a holding circuit under control of said combustion responsive relay, means controlled jointly by said electromagnetic relay and said combustion responsive relay for maintaining the main burner separately in operation after combustion thereof is started, an electric motor operated timing device having automatic starting means and sequential rotary cam controlled elements for operating the ignition burner for a predetermined period and energizing said electromagnetic relay temporarily intermediate said period, means jointly dependent upon response of said combustion responsive relay to combustion of the ignition burner and temporary energization of said electromagnetic relay for starting operation of the main burner, and lock-out means having a rotary stop member operated by said timing device and a cooperating switching element operated by said electromagnetic relay for preventing automatic restarting of said timing device only upon deenergization of said electromagnetic relay at the end of said temporary energization thereof and at the end of said predetermined period.

12. A sequential control system for an ignition burner and a main burner ignited thereby having in combination a combustion responsive relay and separate control elements for operating said relay responsively to the combustion of each burner, an electromagnetic relay having a holding circuit under control of said combustion responsive relay, means controlled jointly by said electromagnetic relay and said combustion responsive relay for maintaining the main burner separately in operation after combustion thereof is started, an electrical timing device having automatic starting means and sequential control elements for operating the ignition burner for a predetermined period and energizing said electromagnetic relay temporarily intermediate said period, means jointly dependent upon response of said combustion responsive relay to combustion of the ignition burner and temporary energization of said electromagnetic relay for starting operation of the main burner, and lock-out means having an element operated by said timing device and a cooperating element operated by said electromagnetic relay having a movable control element operated by said relay and a plurality of interlocking elements operated successively by said timing device into the path of said control element for preventing automatic restarting of said timing device only upon deenergization of said electromagnetic relay at the end of said temporary energization thereof and at the end of said predetermined period.

13. A burner control system having in combination an electrically operated cycle timer having a blower operating switch closed thereby during the major part of the cycle, means including a fuel supply control relay temporarily energized by said timer to provide a limited combustion trial period while said blower operating switch is closed, means including combustion responsive switching means for maintaining said relay energized to continue combustion after said trial period, and energizing circuit connections for said timer under the joint control of said relay and said timer for stopping said timer to maintain said blower operating switch closed while said relay is maintained energized after said trial period and for restarting said timer to open said blower operating switch at the end of a scavenging interval after said relay is deenergized to stop combustion.

14. A burner control system having in combination an electrically operated cycle timer having a blower operating switch closed thereby during the major part of the cycle, a starting circuit for said timer including a master switch and combustion responsive switching means, means including a fuel supply control relay temporarily energized by said timer to provide a limited combustion trial period while said blower operating switch is closed and independently maintained energized under control of said master switch and said combustion responsive switching means upon response thereof to continue combustion after said trial period, and running circuit connections for said timer under the joint control of said relay and said timer for stopping said timer to maintain said blower operating switch closed while said relay is maintained energized after said trial period and for re-starting said timer to open said blower operating switch at the end of a scavenging interval

after said relay is deenergized to stop combustion.

CLINTON W. CRAWFORD.

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