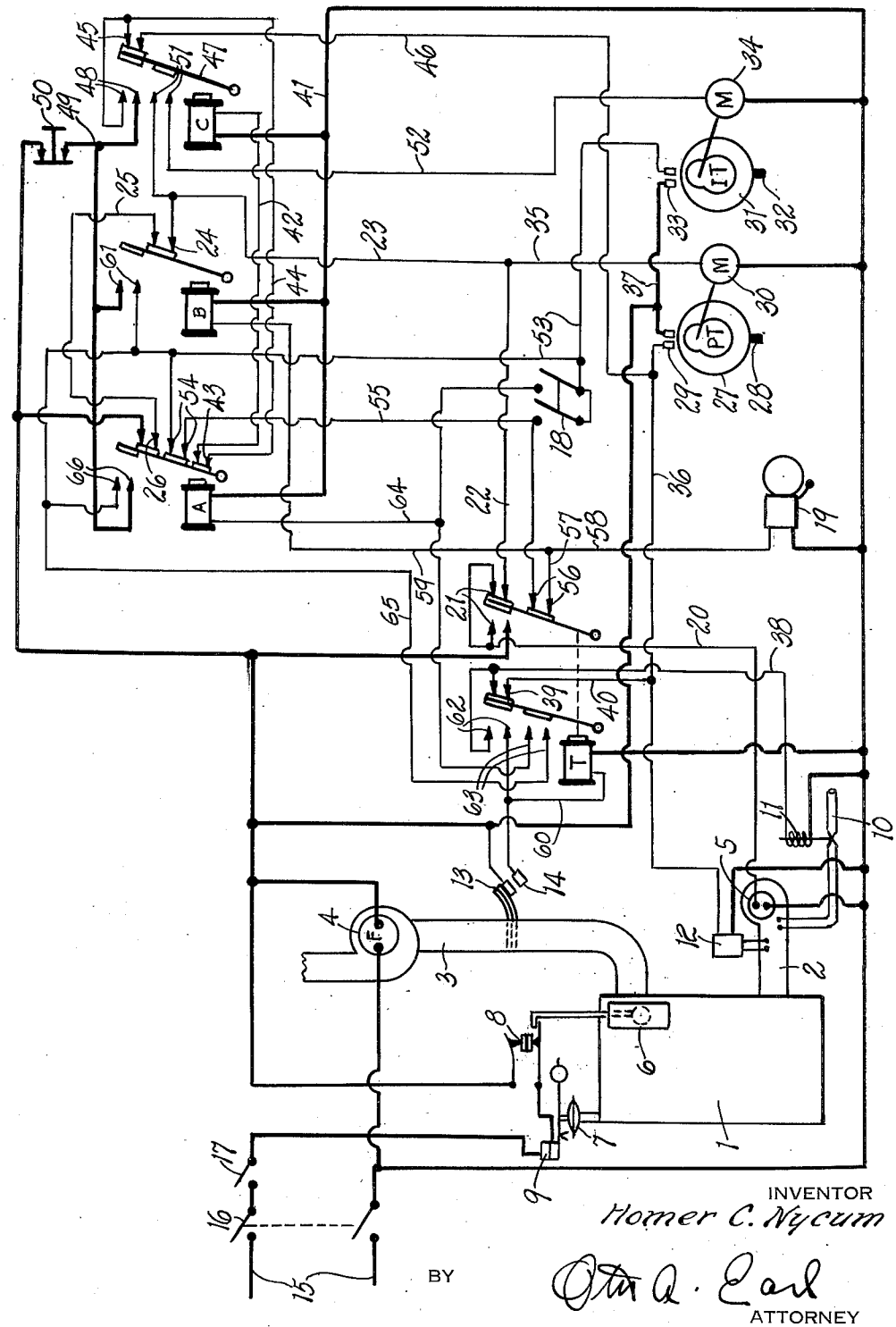
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BURNER SAFETY CONTROL SYSTEM

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BURNER SAFETY CONTROL SYSTEM

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This invention relates to improvements in a burner safety control system.

The principal objects of this invention are:

First, to provide a system of controls for gaseous or liquid fuel burners particularly for boiler furnaces and the like in which the burner cannot be started while there is a dangerous accumulation of fuel in the furnace.

Second, to provide a control system for the burner element of a boiler in which an ignition means is actuated by cycling mechanism arranged to provide a pre-ignition purging period to remove any accumulation of fuel of an explosive character from the furnace before applying the ignition.

Third, to provide a control system for boiler burners and the like which is adaptable to various cycles of operation such as single ignition or automatic repeated ignition depending upon the desired method of operating the boiler.

Fourth, to provide control circuits for starting and igniting the burner mechanism of a boiler in which manual operation of any of the switches in the circuit cannot immediately apply ignition energy to the burner but must first initiate automatic cycling mechanism which in turn will ignite the burner.

Fifth, to provide a control circuit for a boiler or the like in which an alarm or other device indicating the necessity for manual attention may be arranged to be actuated under a plurality of different operating conditions depending upon the desired cycle of operation of the boiler.

Sixth, to provide cyclically operating starter mechanism for a burner arranged to require a complete purging cycle before it will apply ignition energy to the burner so that if the mechanism is de-energized during its purging or ignition periods it will have to return to its starting position before again being effective to start the burner.

Seventh, to provide electrically driven timed switching mechanism for energizing the ignition element of a burner which mechanism is arranged to automatically return to its starting position should the starter mechanism be de-energized during its cycle of operation so that upon re-energization of the starter mechanism it will always start a new cycle including a purging period before being effective to start the burner.

Eighth, to provide a control circuit for the burner of a boiler or the like which positively eliminates the chance of an explosion in the furnace.

Other objects pertaining to the details and advantages of the system will be apparent from a consideration of the following description and claims.

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The drawing illustrates my control system as applied to the burner and auxiliary elements of a boiler and is a schematic wiring diagram of my control system with the boiler and its auxiliary elements illustrated conventionally.

The drawing illustrates a boiler furnace 1 provided with a burner 2 and a smoke flue 3. The flue 3 is provided with an exhaust fan driven by a motor indicated at 4 for inducing a draft through the flue and the burner is provided with a motor indicated at 5. The boiler is provided with a water level gage 6 and a high pressure device 7 for indicating dangerously low water level and dangerously high steam pressure respectively. The water gage 6 is provided with an arm for opening the electrical contacts 8 and the pressure device 7 is arranged to open the contacts 9 when the pressure rises too high. The burner 2 is arranged to be supplied with liquid or gaseous fuel through the pipe 10 and the admission of fuel is controlled by the solenoid operated valve indicated at 11. An ignition device such as a transformer and a spark gap for igniting the fuel is indicated conventionally at 12. The furnace is provided with a device for indicating the presence of the flame in the furnace. In the example illustrated this takes the form of a bimetallic element 13 extending into the flue 3 and arranged to close the electrical contacts 14 upon the establishment of a flame in the furnace. Similar devices such as optically operated switches responsive to the main flame of the burner could be substituted for the bimetallic element 13 and switch 14.

The elements thus far described are operated from a source of electrical energy indicated at 15 and are controlled by a main circuit switch 16. A shutdown switch 17 is provided in one side of the power source for manually shutting down the operation of the boiler and its auxiliary elements. It will be noted that the pressure contacts 9 and water level contacts 8 are connected in series in one side of the power source and that the motor 4 for operating the draft fan is connected directly across the power source so as to be actuated immediately upon closing of the switches 8, 9, 16, and 17. For convenience in desscribing the control circuit and mechanism all of the elements have been connected to one side of the power source which may be referred to as the dead side of the line and are connected through the various circuits to the live side of the line which is the

side controlled by the shut down switch 17. The system is shown in cold, shut down condition

My control mechanism comprises four solenoid operated switches having solenoid coils labeled A, B, C and T and a preignition timer labeled PT and an ignition timer labeled IT. The solenoid A and its associated switches may be referred to as a starting relay. The solenoid B and its associated switches may be referred to as a cut-out relay. The solenoid T and its associated switches may be referred to as a transfer relay. A manually controlled double pole switch for selecting the operating cycle of the system is indicated at 18 and an alarm bell for indicating the need of manual attention of the system is indicated at 19.

The burner motor 5 is connected from the dead side of the line through a conductor 20 to a pair of terminals 21 positioned on either side of a contact carried on one arm of the relay T. In the de-energized position of the relay T as illustrated in the diagram, the terminals 21 are connected to a conductor 22 extending to a conductor 23 having a terminal 24 which is connected to the conductor 25 by one contact of the relay B. The conductor 25 extends to one terminal 26 connected by a contact of the relay A to the live side of the power source. It will thus be seen that upon closing the switches 16 and 17 with the pressure contacts 9 and water level contacts 8 closed as shown the burner motor 5 will immediately be energized through the conductors and terminals thus described.

The preignition timer labeled PT consists of a gear driven disk 27 carrying a weighted lug 28 arranged to be rotated upwardly to close the preignition contacts 29. The disk 27 is gravity operated to automatically return to the unactivated position shown upon de-energizing of the preignition timer motor indicated at 30. The ignition timer labeled IT is of similar construction having a gear driven disk 31 and weighted lug 32 arranged to be rotated to close the ignition timer contacts 33. The ignition timer is driven by the electric motor 34. It will be understood that the preignition timer and ignition timer may be selectively adjusted so that the period beween energization of either of the motors 30 or 34 and closing of the contacts 29 and 33 respectively may be set for any desired interval.

The motor for operating the preignition timer is connected from the dead side of the power source through a conductor 35 to the conductor 23 and from there to the live side of the line through the same circuit which energizes the burner motor 5. It will thus be seen that when the switches 16 and 17 are closed both the burner motor and preignition timer motor will begin to operate and that after a predetermined lapse of time the weighted lug 28 will close the preignition timer contacts 29 and hold the contacts closed so long as the preignition timer motor 30 is energized.

The first consequence of closing the contacts 29 is to apply electric energy to the ignition device 12 by connecting the conductor 36 through the contacts 29 to one branch of the live side of the power source indicated at 37. Simultaneously with energization of the ignition device 12 the solenoid operated valve 11 controlling the admission of fuel to the burner is energized from the dead side of the line through the conductor 38 and the terminals 39 closed by one arm of the relay T and the conductor 40 to the previously described conductor 36. Thus fuel and igniting energy are supplied to the burner and a flame should be established in the furnace 1. Note that the fan motor 4 has been energized during this preignition period and will have purged the boiler and flue of dangerous accumulations of fuel and gases.

A second consequence of the closing of the preignition timer contacts 29 is to connect the solenoid of relay C across the power source. The circuit for energizing the solenoid of relay C extends from a branch of the dead side of the power source indicated at 41 through the solenoid and a conductor 42 closed by one contact 43 of the relay A. The circuit is returned through the conductor 44 to the terminals 45 connected by one contact of the relay C and from there through the conductor 46 to the conductor 36 which has previously been described as energized by closing of the preignition timer contacts 29.

Energization of the relay C as just described causes the switch arm 47 to be drawn toward the solenoid connecting the terminals 48 which will establish a holding circuit from the conductor 44 to the conductor 49 connected to the live side of the power source through the normally closed push button switch 50. The relay C is thus sealed to the live side of the line and maintained in energized condition. Energizing of the relay also connects the terminals 51 which establish a circuit from the dead side of the power source through the ignition timer motor 34 and conductor 52 to the terminals 24 on the relay B. As was previously described the terminals 24 are connected through the terminals 26 to the live side of the power source so that the ignition timer motor 34 commences to operate and after the pre-determined operating period will close the ignition timer contacts 33.

With the manually operated cycle selecting switch 18 in open position as shown, closing of the contacts 33 will connect the live branch 37 of the power source through the conductor 53 to the terminals 54 which are connected by one contact of the relay A in de-energized condition of that relay. The terminals 54 are connected through the conductor 55 to the terminals 56 closed by one contact of the relay T in the de-energized condition of the relay T. One of the terminals 56 is connected to a conductor 57, one branch 58 of which extends to the bell 19. The other branch 59 of the conductor 57 extends to the solenoid of the relay B. It will thus be seen that if the relay T remains in the de-energized condition illustrated, after the closing of the preignition timer contacts 29 and ignition timer contacts 33, circuits will be established through the terminals 54 and 56 to energize the alarm bell 19 and the relay B. This condition will exist if no flame has been established in the furnace to close the flame operated contacts 14 and energize the solenoid of the relay T through the conductor 60.

The immediate consequence of energizing the relay B as just described is to open the terminals 24 and close the terminals 61. Opening of the terminals 24 breaks the previously described circuits to the burner motor 5, preignition timer motor 30 and ignition timer motor 34 so that these motors are de-energized. The gravity operated disks 27 and 31 immediately open the contacts 29 and 33 thus de-energizing the ignition device 12 and the solenoid valve 11 to cut off the supply of fuel to the burner. Opening of the ignition timer contacts 33 also breaks the circuit through which the solenoid of relay B was origi-

nally energized but it will be noted that the closing of the terminals 61 by the relay B establishes a circuit from the live conductor 49 through the terminals 54 of relay A, conductor 55 and terminals 56 of relay T to the conductor 59 and solenoid of relay B to hold the relay B in energized position.

With the system in the condition thus described an attempt has been made to establish a flame in the boiler and this attempt having failed, the burner motor is deenergized by the opening of the terminals 24 of relay B. The solenoid fuel valve and ignition device are de-energized and the preignition and ignition timer motors are de-energized. The alarm bell is energized indicating the need for manual attention of the system. The operator may then operate the manual control button 50 which breaks the connection to the live branch 49 de-energizing the live side of terminals 48 and 61. This de-energizes the alarm bell, the relay C and the relay B so that the circuit reassumes the position illustrated in Fig. 1. If the shutdown switch has remained closed throughout the initial ignition attempt, the system will again proceed through the previously described cycle applying first, a purging period as determined by the preignition timer PT during which any accumulation of fuel in the boiler or flue is removed by the fan 4 prior to the energization of the ignition device 12.

Assuming that upon the closing of the preignition timer contacts 29 and the establishing of the ignition circuit as previously described that the flame is properly lighted in the furnace, the bimetal element 13 will be heated and close the flame operated contacts 14 prior to the closing of the contacts 33 by the ignition timer IT, it being the function of the ignition timer to establish and limit the period of time during which fuel and ignition may be supplied to the burner without the establishment of a flame. As previously described the solenoid of the relay T will then be energized through the conductor 60 and the relay will be operated from the de-energized position shown in Fig. 1. The first consequency of operation of the relay T is to connect the conductor 38 from the solenoid operated fuel valve 11 through the terminals 62 to the conductor 60, contacts 14 and the live side of the power source to hold the solenoid operated fuel valve in open energized position. Simultaneously the connection 20 will be transferred by the terminals 21 from the conductor 22 directly to the live side of the power source to continue energization of the burner motor 5. Opening of the terminals 56 by the relay T will break the connection between the alarm bell 19 and relay B to the live side of the line preventing these elements from being energized so long as the relay T is energized. The terminals 63 of the relay T will be closed and connect the relay A through the conductor 64 to the conductor 65 and the terminals 66 of the relay A.

The previously described operations having taken place practically instantaneously, the subsequent closing of the ignition timer contacts 33 will establish a circuit from the live branch 37 of the power source through the conductor 53 to the conductor 65, terminals 63 and conductor 64 to energize the relay A instead of the relay B whose circuit has been broken at the terminals 56 as previously described. Energization of the relay A will immediately close the terminas 65 so that the relay A is sealed to the live side of the line through the branch conductor 49 and push button switch 50 and so that the terminals 26, 54, and 43 are all opened.

Opening of the terminals 26 breaks the circuit to the preignition timer motor 30 and ignition timer motor 34 which immediately open the contacts 29 and 33 respectively. Opening of the terminals 43 breaks the circuit to the relay C and returns that relay to its de-energized position illustrated in Fig. 1. The system then comes to rest in operating condition with the burner motor and fuel valve energized through the relay T and flame controlled contacts 14 directly to the live side of the line. The ignition device, alarm bell, preignition timer motor and ignition timer motor are all deenergized as are the relays B and C and the burner will continue to operate so long as the pressure contacts 9, water lever contacts 8, shut down switch 17 and main switch 16 are closed.

Assuming now that the live side of the power source is broken either by intentional shut down of the switch 17 or normal operation of the pressure switch 7 or abnormal operation of water level contacts 8, or by external power failure, the entire control circuit will be de-energized and assume the position illustrated in the diagram from which position the system will automatically proceed through a lighting cycle as first described upon the closing of the switch which originally broke the circuit. If everything functions correctly, the flame will be re-established in the furnace without manual attention and without sounding the alarm bell. If, however, the relight attempt is not successful, the control circuits will establish the alarm and condition themselves for manual operation of the relight button 50.

From any shut down condition of the system, ignition energy cannot be supplied to the ignition device 12 without the fan motor 4 operating through the predetermined purge period as established by the preignition timer PT and contacts 29. It will thus be seen that my control circuit will automatically relight a boiler burner under normal operating conditions as when the pressure in the boiler rises too high through light load conditions or as when the shut down switch 17 is operated at the end and start of a work day. Similarly, the burner will be automatically relighted after correction of abnormal power failure or low water level conditions. The system will require no manual attention so long as the auxiliary elements of the boiler are functioning properly. However, if some element fails to function properly and a flame is not established my circuit will disconnect the fuel and ignition sources from the burner and actuate the alarm bell indicating the need for manual attention.

Considering now the operation of the control circuit shown in the diagram with the switch 18 in closed position, conductors 53, 55, 64, and 65 are all electrically connected and function as a single conductor. With the various automatic switches in the positions shown and upon closing of the power switches 16 and 17, the fan motor 4 and burner motor 5 and preignition timer motor 30 will be energized in the same manner as previously described applying a purging period to the boiler while the preignition timer moves to close the contacts 29. Closing of the contacts 29 will apply energy to the ignition device 12, fuel valve 11 and relay C as previously described and the relay C will be energized to close the terminals 48 and 51. Closing of the terminals 48 will transfer the relay C to the live side line at 49 and closing of the terminals 51 will apply energy to the ignition timer motor 34 as previously de-

scribed. During the period of operation of the ignition timer motor 34, a flame should be established at the burner 2 and close the flame operated contacts 14 to energize relay T.

Assuming now the situation when no flame is established prior to closing of the ignition timer contact 33. When these contacts are closed a circuit will be established through the branch 37 of the live side of the line, contacts 33, conductor 53, switch 18, terminals 56 and conductors 57 and 58 to alarm bell 19 and relay B immediately indicating the failure of the burner to light. Simultaneously a circuit will be established from the switch 18 through the conductor 64 to the relay A energizing the relay from the position illustrated to open the terminals 26, 43, and 54 and close the terminals 66. Closing of the terminals 66 will connect the branch 49 of the live side of the line through the push button switch 50 to the conductors 65, 53, and switch 18. Opening of the terminals 26 will break the circuit to the ignition timer motor 34 and preignition timer motor 30 which will immediately open the contacts 29 and 33. Opening of the terminals 43 de-energizes the relay C so that it returns its switch to the position illustrated in Fig. 1 further breaking the circuit to the ignition timer motor 34. Closing of the terminals 66 will establish a holding circuit for the relay A through the conductors 53, switch 18 and conductor 64 to hold the relay in an energized position. Relay B is energized through 59, terminals 56 and switch 18. The system then comes to rest with the relays C and T de-energized and with the burner motor 5, ignition device 12, fuel valve 11, pre-ignition timer and ignition timer de-energized. The fan will continue to operate so long as the pressure switch and water lever switch are closed and the alarm bell will be actuated through the terminals 56, switch 18, conductor 53 and terminals 66.

The operator may then manually open the push button switch 50 breaking the circuit to the branch 49 of the live side of the line so that the holding circuit for the alarm bell and relays A and B are broken silencing the bell and returning the relays A and B to the position illustrated in Fig. 1. If the shut down switch, pressure switch and water level switch remain closed, the control system will immediately start a succeeding lighting cycle as previously described.

If the lighting or relighting attempt is successful between the closing of the preignition contacts 29 and the ignition timer contacts 33, the flame control contacts 14 will be closed energizing the relay T and moving the switches operated by it from the position shown in Fig. 1. When the ignition timer contacts 33 are closed subsequent to operation of the relay T, a circuit will be completed from the branch 37 to the live side of the line through the contacts 33, switch 18 and the conductor 64 to the relay A. Energization of the relay A is thus effected initially through the ignition timer contact 33 and held through the terminals 63 and 66 upon movement of the switch arm from the position illustrated.

Opening of the terminals 43 by the relay A will de-energize the switch C to open the terminals 51 and de-energize the ignition timer motor 34 and open the ignition timer contacts 33. Opening of the terminals 26 by the relay A will break the circuit to the preignition timer motor 30 and open the contacts 29. Closing of the terminals 62 by the relay T will establish a running circuit for the fuel valve 11 and the terminals 21 will transfer the burner motor 5 directly to the live side of the line and the system will come to rest with the burner operating and with the relays A and T energized and B and C de-energized.

Normal shut down of the system by opening of any of the primary switches 8, 9, 16 or 17 will immediately de-energize all switches and relays and cause them to assume the position illustrated and re-closing of the switches will automatically commence a relight cycle.

Abnormal failure of the flame which opens the flame control switch 14 will de-energize the relay T opening the running terminals 62 to the fuel valve 11 and the terminals 21 to the burner motor 5. De-energization of the relay T will close the terminals 56 energizing the bell 19 and relay B. Relay A will remain energized through the terminals 66, conductors 53, switch 18 and conductor 64. Terminals 26 which energize the preignition timer motor 30 and the ignition timer 34 will therefore remain open and the system will come to rest with relays A and B energized and relays T and C de-energized. The bell will continue to sound indicating the need of manual attention of the system.

After a flame failure as just described the operator may open the manual push button 50 breaking the connection to the branch 49 of the live side of the line and to the terminals 66. This action will de-energize the relays A and B and silence the bell leaving all switches and relays de-energized and ready to automatically commence a relight cycle as described above if the primary controls and switches are closed.

From the foregoing descriptions of the system it will be apparent that the system will automatically start a lighting cycle upon closing of the primary switches 16, 17, 8 and 9 and will sound the alarm 19 if the lighting attempt is a failure whether or not the switch 18 is open. The difference in operation of the system with the switch 18 open or closed results when the flame fails for some reason other than the operation of the primary switches such as a fuel failure or clogging of the burner mechanism or failure of the burner motor 5. With the switch 18 open the system will automatically make one relight attempt without sounding the alarm and if the relighting attempt is successful no manual attention is required. However, with the switch 18 closed and upon failure of the flame for some abnormal reason the system will de-energize the motor, fuel valve and ignition and sound the alarm to call the attention to the failure of the flame. No preferred form of the system is advocated as it is largely a matter of the desire of the user as to which manner of operating his boiler is most advantageous to him.

It should be evident to persons skilled in the art that various modifications of the above described circuit will be possibly depending upon the degree of automatic control and type of operation desired. Thus the circuit for energizing the fan motor 4 could be carried through terminals arranged to be opened by energization of the relay B so that upon failure of the flame heat would be retained in the furnace instead of being exhausted through the flue 3. Other controls or auxiliary elements of the boiler and furnace may be added as desired such as additional fuel valves where the burner is arranged to use heavy oil mixed with light or gaseous fuel for igniting purposes. The circuit illustrated and described is intended to be an example only of the operation of my control system with the contacts 8, 9 and 17 representing a class of primary

controls which are more or less normal to the operation of most boilers.

I have thus described a highly practical form of my control circuit which is adaptable in various forms to boilers generally. The several solenoid switches and timer switches are commercially available so that the system may be assembled at a minimum of expense and without special parts.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. Cycling mechanism for obtaining a purging period and ignition period in a burner control system comprising a pair of control switches biased to open position, electrically operated time delay means for successively closing said switches and holding them closed only so long as said means are energized, a circuit for energizing said means including a solenoid operated switch, a second energizing circuit for energizing the solenoid of said solenoid operated switch to control said first energizing circuit and including a second solenoid operated switch and the second of said pair of switches, a third energizing circuit for energizing said second solenoid switch including a switch responsive to the existence of a flame at said burner, and an electrically operated ignition device connected to be energized by closing of the first of said control switches.

2. Control mechanism for the burner of a furnace comprising an electrically operated ignition device for igniting said burner, an ignition switch connected in series with said ignition device and biased to open position, a motor driven device arranged to effect the closing of said ignition switch after a predetermined purging period following the energization of the motor of said device, a circuit for energizing said motor driven device, a solenoid operated switch in said last mentioned circuit and arranged to de-energize said motor driven device after a predetermined period of operation of said device, said device being biased to immediately return to its starting position whenever the motor thereof is de-energized, and a time delay switching device connected to be actuated by the closing of said ignition switch, the switch of said time delaying device being connected to energize the solenoid of said solenoid operated switch.

3. Control apparatus for the burner of a boiler furnace comprising, a primary control element for indicating a functional condition of said boiler, a switch operated by said element and connected to de-energize the remainder of said apparatus upon the establishment of an undesirable condition in said boiler, a transfer relay, an energizing circuit for said transfer relay including a switch closed upon the establishment of a flame in said burner, an electrically operated fuel valve for said burner, a running circuit for said fuel valve having contacts closed by said transfer relay in the energized position thereof, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including an ignition switch, a starting circuit for said fuel valve connected by said transfer relay in the de-energized position thereof to said ignition circuit to be energized from said ignition circuit, a motor for said burner having a running circuit energized by a contact closed in the energized position of said transfer relay, electrically operated timed mechanism for closing said ignition switch, said mechanism being biased to ignition switch opening position, a circuit for energizing said mechanism including a pair of switches connected in series, a starting circuit for said burner motor connected to said circuit for energizing said mechanism by said transfer relay in the de-energized position thereof to be energized with said mechanism, a starting relay having a contact arranged to close one of said pair of switches in the de-energized position of said starting relay, a common conductor, an energizing circuit for said starting relay including a switch closed by said transfer relay in the energized position thereof and connected to said common conductor, a cut-out relay having a contact arranged to close the other of said pair of switches in the de-energized position of said cut-out relay, an energizing circuit for said cut-out relay including a switch closed by said transfer relay in the de-energized position thereof and a switch closed by said starting relay in the de-energized position thereof and connected to said common conductor, a time limit switch connected to said common conductor and adapted when closed to energize the same, a second electrically operated timed mechanism for closing said time limit switch, said second mechanism being biased to limit switch opening position, a circuit for energizing said second mechanism connected to said circuit for energizing said first mechanism so as to be de-energized therewith, a third relay having a contact arranged to break said energizing circuit for said second mechanism in the de-energized position of said third relay, an initial energizing circuit for said third relay including a contact closed in the de-energized position of said starting relay and a contact closed in the de-energized position of said third relay, said last mentioned contact being connected to said ignition circuit for energization therewith, a self-operated holding contact on said third relay closed in the energized position thereof and connected to said circuit for energizing said third relay to energize the same after initial energization by said ignition circuit, a holding contact closed by said starting relay in the energized position thereof and connected to said common conductor, a third holding contact closed in the energized position of said cut-out relay and connected to said common conductor, a manually controllable switch for de-energizing the circuits through said holding contacts, and a selectively operable element for shunting said switch closed by said transfer relay in said energizing circuit of said starting relay to said common conductor and for shunting said contact closed by said starting relay in said energizing circuit for said cut-out relay to said common conductor, said furnace having a gas purging element electrically connected to be energized whenever said apparatus is energized.

4. Control apparatus for the burner of a boiler furnace comprising, a primary control element for indicating a functional condition of the boiler of said furnace, a switch operated by said element and connected to de-energize the remainder of said apparatus upon the establishment of an undesirable condition in said boiler, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, an electrically operated fuel valve for said burner, a running circuit for said fuel valve having contacts closed by said transfer relay in the flame operating position thereof, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including an ignition switch, a starting circuit for said fuel valve electrically

connected to said ignition circuit by a contact on said transfer relay in the no flame position of said transfer relay, a motor for said burner having a running circuit energized through a contact closed in the flame operating position of said transfer relay, electrically operated timed mechanism for closing said ignition switch, said mechanism being biased to ignition switch opening position, a circuit for energizing said mechanism including a pair of switches connected in series, a starting circuit for said burner motor electrically connected to said circuit for energizing said mechanism by a contact of said transfer relay in the no flame position thereof, a starting relay having a contact arranged to close one of said pair of switches in the de-energized position of said starting relay, a common conductor, an energizing circuit for said starting relay including a contact closed by said transfer relay in the flame operating position thereof and connected to said common conductor, a cut-out relay having a contact arranged to close the other of said pair of switches in the de-energized position of said cut-out relay, an energizing circuit for said cut-out relay including in series a contact closed by said transfer relay in the no flame position thereof and a contact closed by said starting relay in the de-energized position thereof and said common conductor, a signal device connected in parallel with said cut-out relay to be energized therewith, a time limit switch connected to said common conductor and adapted to energize the same, a second electrically operated timed mechanism for closing said time limit switch, said second mechanism being biased to limit switch opening position, a circuit for energizing said second mechanism connected to be energized and de-energized concurrently upon the closing and opening of said ignition switch, a holding contact closed by said starting relay in the energized position thereof and connected to said common conductor, a second holding contact closed in the energized position of said cut-out relay and connected to said common conductor, and a manually controllable switch for de-energizing the circuits through said holding contacts, said furnace having a purging element electrically connected to be energized whenever said first mechanism for closing said ignition switch is energized.

5. Control apparatus for the burner of a boiler furnace comprising, an electrically operated fuel valve for said burner, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including an ignition switch, a circuit for energizing said fuel valve connected to said ignition circuit by a contact on said transfer relay in the no flame position of said transfer relay, a motor for said burner having a running circuit energized by a contact closed in the flame operating position of said transfer relay, electrically operated timed mechanism for closing said ignition switch, said mechanism being biased to ignition switch opening position, a circuit for energizing said mechanism including a pair of switches connected in series, a starting circuit for said burner motor connected to said circuit for energizing said mechanism by a contact on said transfer relay in the no flame position thereof, a starting relay having a contact arranged to close one of said pair of switches in the de-energized position of said starting relay, a common conductor, an energizing circuit for said starting relay including a contact closed by said transfer relay in flame operating position of said transfer relay and connected to said common conductor, a cut-out relay having a contact arranged to close the other of said pair of switches in the de-energized position of said cut-out relay, an energizing circuit for said cut-out relay including in series a switch closed by said transfer relay in the no flame position thereof and a contact closed by said starting relay in the de-energized position thereof and said common conductor, a signal device connected in parallel with said cut-out relay to be energized therewith, a time limit switch connected to said common conductor and adapted to energize the same, a second electrically operated timed mechanism for closing said time limit switch, said second mechanism being biased to limit switch opening position, a circuit for energizing said second mechanism connected to be energized concurrently with the closing of said ignition switch and to be de-energized concurrently with said circuit for energizing said first mechanism, a holding contact closed by said starting relay in the energized position thereof and connected to said common conductor, a second holding contact closed in the energized position of said cut-out relay and connected to said common conductor, and a manually controllable switch for de-energizing said holding contacts, and a selectively operable element for shunting said switch in said circuit for energizing said starting relay and for shunting said switch in said circuit for energizing said cut-out relay and operated by said starting relay.

6. Control apparatus for the burner of a furnace, said burner having an electrically operated auxiliary element coacting with the burner in sustaining combustion, comprising, electrically driven timed switching mechanism having an energizing circuit, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, a running circuit for said auxiliary element having contacts closed by said transfer relay in the flame operating position thereof, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including a contact closed by said mechanism, a starting circuit for said auxiliary element connected to be energized from said ignition circuit by a contact closed in the no flame position of said transfer relay, a starting relay having a contact arranged to break the energizing circuit to said mechanism in the energized position of said starting relay, a circuit for energizing said starting relay including a switch closed in the flame operating position of said transfer relay and a common conductor, a cut-out relay having a contact arranged to break said circuit for energizing said mechanism in the energized position of said cut-out relay, a circuit for energizing said cut-out relay including in series a switch closed in the no flame position of said transfer relay and said common conductor, a second electrically driven timed switching mechanism having an energizing circuit and having a switch operative when closed to energize said circuit for energizing said cut-out relay, said second mechanism being arranged to be energized by closing of said contact closed by said first mechanism, a holding contact closed in the energized position of said starting relay and connected to said common conductor, a second holding contact closed in the energized position of said cut-out

relay and connected to said common conductor, and a manually controllable switch for de-energizing the circuits through said holding contacts.

7. Control mechanism for a burner comprising, an electrically driven timed switching device having an energizing circuit, a transfer relay including a switch responsive to the establishment of a flame in said burner, an electrically operated ignition element for said burner, a circuit for energizing said ignition element including a contact closed by said device and arranged to be open during the first portion of the cycle of said device, a solenoid opened valve for supplying fuel to said burner, a circuit for energizing the solenoid of said valve and having a running contact closed by said transfer relay in the flame operating position thereof, a starting relay having a contact arranged to break the circuit for energizing said device in the energized position of said starting relay, a circuit for energizing said starting relay including a switch closed in the flame operating position of said transfer relay, a cut-out relay having another contact arranged to break said energizing circuit to said device in the energized position of said cut-out relay, a circuit for energizing said cut-out relay including a switch closed by said transfer relay in the no flame position thereof, an alarm device connected to be energized with said cut-out relay, and an electrically driven time delay switch mechanism arranged to close a switch to apply energy to said circuits energizing said starting relay and said cut-out relay, said time relay mechanism being connected to be energized by closing of said contact closed by said timed switching device.

8. Control mechanism for a burner having a motor comprising, an electrically driven timed switching device having an energizing circuit, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, a circuit for said motor and having a running contact closed by said transfer relay in the flame operating position thereof, an electrically operated ignition element for said burner, a circuit for energizing said ignition element including a contact closed by said device and arranged to be open during the first portion of the cycle of said device, a solenoid controlled valve for supplying fuel to said burner, a circuit for energizing said solenoid to open valve and having a running contact closed by said transfer relay in the flame operating position thereof, a starter circuit for said motor connected to said circuit for energizing said device in the no-flame position of said transfer relay by a contact thereon, a starting relay having a contact closed in the deenergized position of said starting relay and arranged to energize said energizing circuit to said device, a circuit for energizing said starting relay including a switch closed in the flame operating position of said transfer relay.

9. Control mechanism for the burner of a furnace comprising, a motor driven time delay switching device having an energizing circuit for the motor thereof, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, a motor for said burner having an energizing contact closed by said transfer relay in the flame operating position thereof, an electrically operated ignition element for said burner, a circuit for energizing said ignition element including a contact closed by said device and arranged to be open during the first portion of the cycle of said device, a solenoid operated control valve for supplying fuel to said burner, a circuit for energizing the solenoid to open said valve and having a running contact closed by said transfer relay in the flame operating position thereof and a starting contact connected to said ignition device by said transfer relay in the no flame position thereof, a starter circuit for said burner motor connected by a contact on said transfer relay to said device energizing circuit in the no flame position of said transfer relay, a starting relay having a switch in said energizing circuit to said device and closed in the de-energized position of said starting relay, a circuit for energizing said starting relay including a switch operated by said transfer relay and closed in the flame operating position thereof, a motor driven timed cut-out device having an energizing circuit for the motor thereof and a cut-out switch biased to open position, a cut-out relay having an energizing circuit connected to be energized by said cut-out switch and having a contact in circuit to open said energizing circuit to said delay switching device when said cut-out relay is energized, said circuit for energizing the motor of said cut-out device being connected through said first energizing circuit for said time delay switching device to be de-energized therewith.

10. Control apparatus for the burner of a furnace comprising, electrically driven time delay switching mechanism having an energizing circuit and an ignition switch, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, a power circuit for said burner and having a running contact closed by said transfer relay in the flame operating position thereof, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including said ignition switch and arranged to be open during the first portion of the cycle of said mechanism, a solenoid control valve for supplying fuel to said burner, a circuit for energizing the solenoid to open said valve and having a running contact closed by said transfer relay in the flame operating position thereof, a starting circuit for the solenoid of said valve connected to said ignition circuit by said transfer relay in the no flame position thereof, a starting relay having a contact to break the energizing circuit to said mechanism in the energized position of said starting relay, a circuit for energizing said starting relay including a switch closed by said transfer relay in the flame operating position thereof, a cut-out relay having a contact arranged to break said energizing circuit to said mechanism in the energized position of said cut-out relay, a circuit for energizing said cut-out relay including a switch closed in the no flame position of said transfer relay, a manually operable element for shorting out said switches in said circuits for energizing said starting relay and said cut-out relay, an alarm device connected to said circuit for energizing said cut-out relay, said time delay switching mechanism being biased to move to open position when de-energized, and a second time delay switching mechanism connected to be actuated by closing of said ignition switch and arranged to energize said either of said circuits for energizing said starting and cut-out relays depending on the position of said transfer relay.

11. Control mechanism for the burner of a fur-

nace comprising, a time delay switching device having an energizing circuit and an ignition switch, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, a motor for said burner and having a running contact closed by said transfer relay in one position thereof, an electrically operated ignition element for said burner, a circuit for said ignition element including said ignition switch and arranged to be open during the first portion of the cycle of said device, a solenoid controlled valve for supplying fuel to said burner, a circuit for energizing the solenoid of said valve and having a running contact closed by said transfer relay in said one position thereof and a starting contact connected to said ignition device by said transfer relay in the other position thereof, a starter circuit for said burner motor connected to said energizing circuit of said device by said transfer relay in said other position thereof, a starting relay having a contact in series in energizing circuit to said device and closed in the de-energized position of said starting relay, a circuit for energizing said starting relay including a switch closed by said transfer relay in said one position thereof, a motor driven timed cut-out device having a cut-out switch, a cut-out relay having an energizing circuit connected to be energized by said cut-out switch and having a contact in series in said energizing circuit to said delay switching device to open said circuit when said cut-out relay is energized, and a circuit for energizing said cut-out device and connected through said circuit for energizing said delay switching device to be de-energized therewith.

12. Control apparatus for the burner of a furnace comprising, electrically driven time delay switching mechanism having an energizing circuit and an ignition switch, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, an energizing circuit for said burner and having a running contact operated by said transfer relay, an electrically operated ignition device for said burner, a circuit for said ignition device including said ignition switch and arranged to be open during the first portion of the cycle of said mechanism, a starting circuit for said burner connected by said transfer relay to said energizing circuit for said mechanism in one position of said transfer relay, a starting relay having a contact in series with the energizing circuit to said mechanism, a circuit for energizing said starting relay including a switch closed by said transfer relay in a second position thereof, a cut-out relay having a cut-out contact in series in said energizing circuit to said mechanism, a circuit for energizing said cut-out relay to open said cut-out contact including a switch closed by said transfer relay in said one position of said transfer relay, timed switch means for energizing said circuits to said starting and said cut-out relays at a predetermined time after the closing of said ignition switch, and a manually operable element for shorting out said switch in said circuit for energizing said starting relay.

13. Control apparatus for the burner of a furnace having electrically operated auxiliary elements coacting to sustain combustion, said apparatus comprising, electrically driven timed switching mechanism having an energizing circuit and an ignition switch, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, running circuits for said auxiliary elements having contacts closed by said transfer relay in its flame operating position, an electrically operated ignition device for said burner, a circuit for said ignition device including said ignition contact, a starting circuit for one of said auxiliary elements connected to said ignition circuit by said transfer relay in the no flame position thereof, a starting relay having a contact in series in the energizing circuit to said mechanism, a circuit for energizing said starting relay, a cut-out relay having a contact in series in said circuit for energizing said mechanism and closed in the de-energized position of said cut-out relay, a circuit for energizing said cut-out relay connected to said circuit for energizing said starting relay and including a switch closed by said transfer relay in the no flame position thereof, a second electrically driven timed switch mechanism having an energizing circuit and having a cut-out switch arranged to energize said circuits for energizing said cut-out relay and starting relay, an energizing circuit for said second mechanism being connected to be energized responsive to the closing of said ignition switch, an alarm device connected to said circuit for energizing said cut-out relay, a holding contact closed by said starting relay in its energized position to hold said starting relay in energized position, a second holding contact closed by said cut-out relay in its energized position to hold said cut-out relay in energized position, and a manually controllable switch for de-energizing the circuits through said holding contacts.

14. Control apparatus for the burner of a furnace comprising, electrically driven time delay switching mechanism having an energizing circuit and an ignition switch and cut-out switch, said switches being biased to open position, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in said burner, an energizing circuit for said burner and having a running contact closed by said transfer relay in the flame operating position thereof and a starting contact connected to said circuit for energizing said mechanism by said transfer relay in the no flame position thereof, an electrically operated ignition device for said burner, a circuit for energizing said ignition device including said ignition switch, a starting relay having a contact arranged in series in the energizing circuit to said mechanism and closed in the energized position of said starting relay, a circuit for energizing said starting relay including a switch closed by said transfer relay in the flame operating position thereof and said cut-out switch, a self operated holding contact on said starting relay, a cut-out relay having a cut-out contact in series in said circuit for energizing said mechanism, a circuit for energizing said cut-out relay including a switch closed by said transfer relay in the no flame position thereof and said cut-out switch on said mechanism, a self operated holding contact on said cut-out relay, a manually operable switch for de-energizing the circuits through said holding contacts, and a selectively operable element for directly connecting said cut-out switch on said mechanism to said circuit for energizing said starting relay to by-pass the switch on said transfer relay in the said circuit.

15. Control apparatus for the burner of a furnace comprising electrically driven time delay switching mechanism having an energizing

circuit and an ignition switch biased to open position, an electrically operated ignition device for said burner, a circuit for said ignition device including said ignition switch and arranged to be open during the first portion of the cycle of said mechanism, a starting relay having a contact in series to break the energizing circuit to said mechanism in the energized position of said starting relay, a circuit for energizing said starting relay including a second switch operated by said mechanism and arranged to close at a predetermined time after closing of said ignition switch, a self closed holding contact on said starting relay, a transfer relay, an energizing circuit for said transfer relay including a switch responsive to the establishment of a flame in burner, a cut-out relay having a contact in series to break said circuit for energizing said mechanism, a circuit for energizing said cut-out relay including a switch closed by said transfer relay in the no flame position thereof and said second switch on said mechanism, a self closed holding contact on said cut-out relay, and a manually operable switch for de-energizing the circuits through said holding contacts.

16. Control apparatus for the burner of a furnace comprising electrically driven time delay switching mechanism having an energizing circuit and an ignition switch biased to open position, said mechanism being arranged to close said switch at a predetermined time after the start of the cycle of said mechanism, an electrically operated ignition device for said burner, a circuit for said ignition device including said ignition switch, a starting relay having a contact arranged in series to break the energizing circuit to said mechanism in the energized position of said starting relay, a circuit for energizing said starting relay including a second switch operated by said mechanism and arranged to close at a predetermined time after closing of said ignition switch, a self closed holding contact on said starting relay, and a manually operable switch for de-energizing the circuit through said holding contact.

17. Mechanism for obtaining a purging period and ignition period in a burner control system comprising, a pair of power supply switches biased to open position, electrically operated means for effecting a successive timed closing of said switches and operative to immediately release said switches as soon as said means is de-energized, an alarm circuit, an electrically operated ignition device in series with the first of said switches to be closed and arranged to be energized thereby, a pair of relays each having a switch in series with said electrically operated means and operative in the energized condition of its relay to de-energize said means, a pair of energizing circuits one for each of said relays, a switch responsive to the establishment of a flame in said burner and having contacts alternatively operative in the flame operating and no flame positions of said flame responsive switch, said contacts being connected in series in said energizing circuits to alternatively render one of said energizing circuits inoperative, said alarm circuit being connected to one of said energizing circuits to be energized therewith, and a common connection from the second of said pair of switches to said contacts on said flame responsive switch whereby closing of said second switch will alternatively energize either of said relays depending upon the position of said flame responsive switch.

18. Mechanism for obtaining a purging period and ignition period in a burner control system comprising, a pair of power supply switches biased to open position, electrically operated means for effecting a successive timed closing of said switches and operative to immediately release said switches as soon as said means is de-energized, an electrically operated ignition device in series with the first of said switches to be closed and arranged to be energized thereby, a pair of relays each having a switch in series with said electrically operated means and operative in the energized condition of its relay to de-energize said means, a pair of energizing circuits one for each of said relays, a switch responsive to the establishment of a flame in said burner and having contacts alternatively operative in the flame operating and no flame positions of said flame responsive switch, said contacts being connected in series in said energizing circuits to alternatively render one of said energizing circuits inoperative, and a common connection from the second of said pair of switches to said contacts on said flame responsive switch whereby closing of said second switch will alternatively energize either of said relays depending upon the position of said flame responsive switch.

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