

Aug. 18, 1942.

E. D. SCHNEIDER

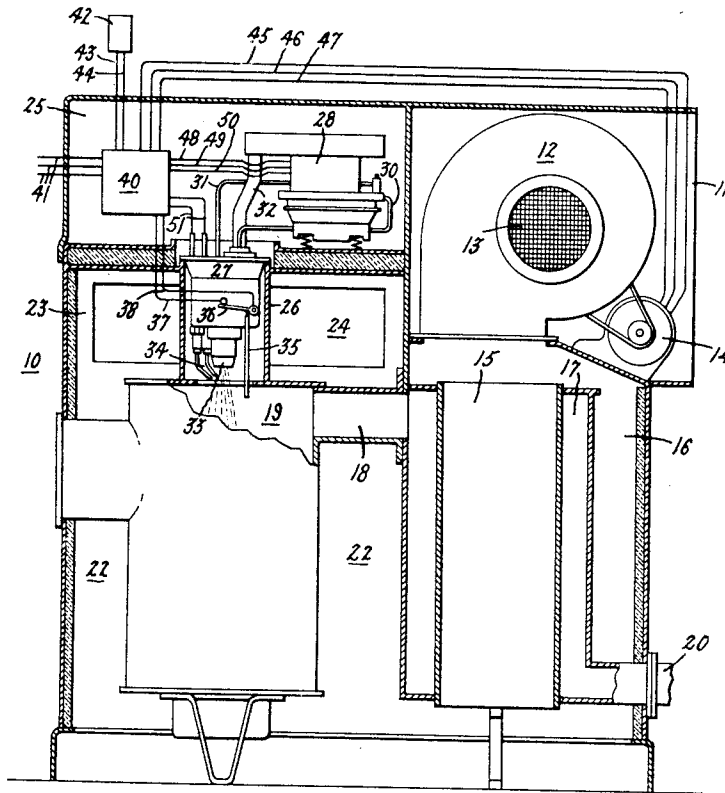
2,293,474

CONTROL FOR AUTOMATIC HEATING SYSTEMS

Filed April 20, 1940

2 Sheets-Sheet 1

Fig. 1.



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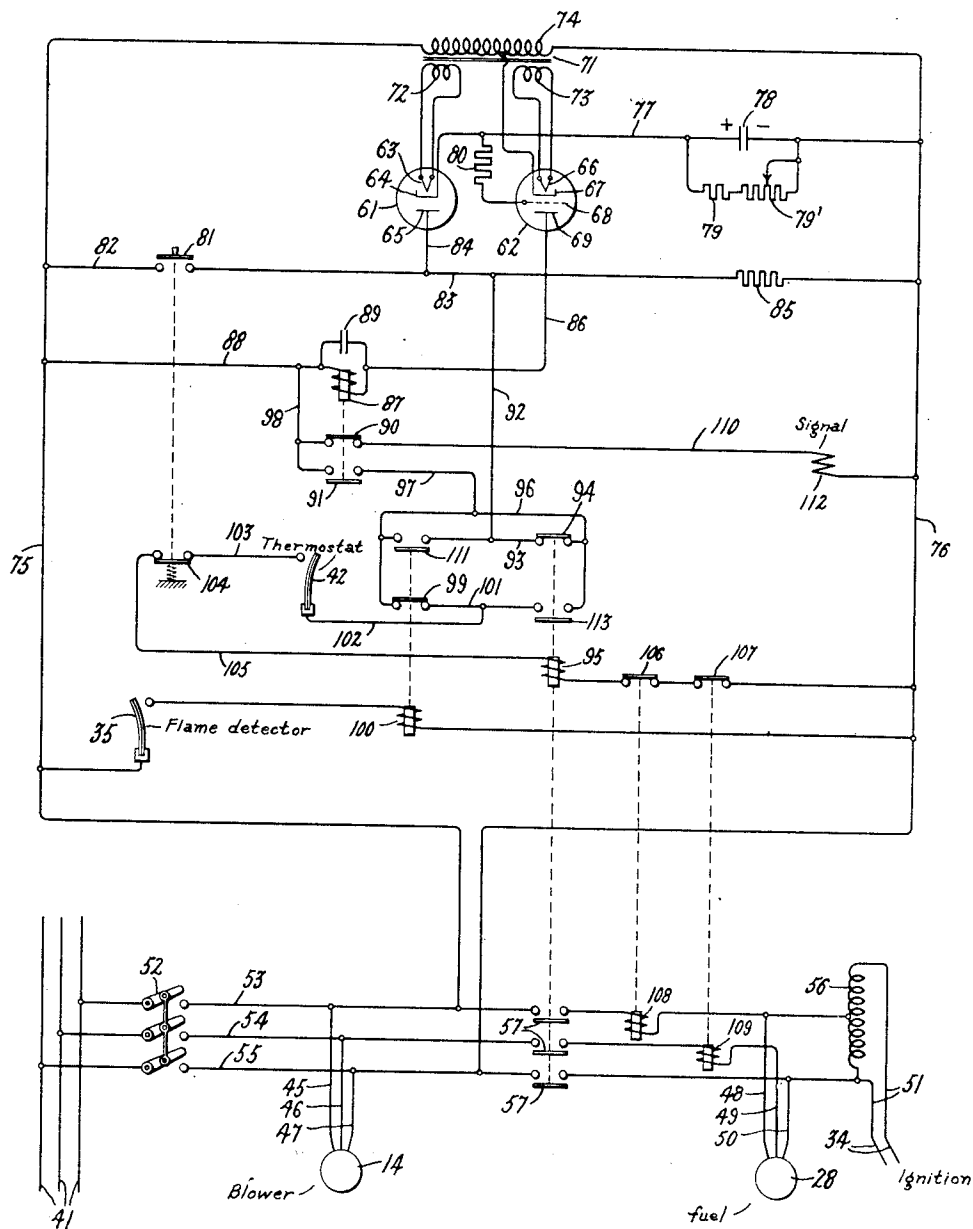
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2 Sheets-Sheet 2

Fig. 2.



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UNITED STATES PATENT OFFICE

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CONTROL FOR AUTOMATIC HEATING SYSTEMS

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11 Claims. (Cl. 158—28)

My invention relates to heating system controls, and more particularly to controls for heating systems provided with automatic fuel feeding means.

It is an object of my invention to provide improved control means for automatic heating systems such that the control means is responsive to substantially all operating contingencies that may arise.

It is a further object of my invention to provide improved control means embodying electric valve circuits which is reliable in operation and which is responsive to failure of any part of the control means or heating system to insure discontinuance of operation of the heating system.

In the accompanying drawings, Fig. 1 is an elevational view of a warm air heating unit employing my control, and Fig. 2 is a wiring diagram of a control embodying my invention.

Referring to Fig. 1, by way of illustration I have shown my invention applied to a warm air heating system 10 of a well-known construction; it is provided with an air inlet 11 through which a suitable heating medium, such as air, is admitted either from the space being conditioned or from outdoors, or in part from each. Within the inlet is positioned a blower 12 provided with intakes 13 (only one of which is shown) and suitably driven by a fan motor 14. The air is directed downwardly from the discharge of the blower to a secondary heat exchanger consisting of concentric air passages 15 and 16 and an intermediate flue passage 17. The latter is connected near its upper end by means of a passage 18 to a combustion chamber 19 and near the lower end is connected to a chimney, or the like, through an outlet 20. After air passes through the secondary heat exchanger it is deflected by the bottom of the furnace and directed upwardly around the combustion chamber 19 through a passageway 22 to a plenum chamber 23 from which it is supplied to the space being conditioned through a pair of warm air outlets 24 (only one of which is shown).

Above the plenum chamber is provided a compartment 25 for the various controls and operative parts of the furnace. The compartment is connected to the combustion chamber by a downwardly extending cylindrical portion 26 suspending a burner head 27 of the type illustrated in the Letters Patent No. 2,048,495, Eaton and Lum, granted July 21, 1936, and assigned to the assignee of the present application.

The burner head is supplied with fuel and air

by a motor compressor 28 resiliently mounted within the compartment 25, the fuel being supplied to the burner head through conduit 30, the atomizing air through conduit 31, and the secondary combustion air through conduit 32. The resulting combustible mixture is directed downwardly into the combustion chamber 19 by a nozzle 33 and ignited by ignition electrodes 34 extending into the path of flow of the mixture. The burner head also comprises a suitable flame detector, for example, a thermal responsive element 35 extending into the combustion chamber and a switch arm 36 actuatable thereby upon occurrence of combustion, into engagement with a contact connected to a conductor 37, the switch arm being connected to a conductor 38. Conductors 37 and 38 lead to a master controller 40 which is supplied with electrical energy from any suitable source of supply indicated by the conductors 41.

The operation of the furnace is controlled in response to requirements of the space being heated by means of a thermal responsive device 42 positioned within that space and connected by conductors 43 and 44 to the control means. The blower motor 14 is connected to the master controller by conductors 45, 46, 47; the motor compressor 28 is connected to the master control by conductors 48, 49 and 50; and the ignition electrodes 34 are connected to the master controller through conductors 51.

Upon a call for heat by the enclosure thermostat 42, the master controller 40 will effect energization of the compressor motor 28 and the ignition electrodes 34 for a predetermined time. As soon as combustion takes place within the combustion chamber, which will normally take place within the predetermined time, the thermal responsive element 35 will move switch 36 to the closed circuit position thereby locking the master controller 40 in the energizing condition. However, in the event that for some reason or other, combustion should not take place in the chamber within the predetermined period, the master controller will be locked in deenergizing position; the furnace will therefore automatically shut down and a suitable signal will be given. The means by which the controller functions to accomplish these various results will now be described.

Referring to Fig. 2, the master controller is shown in diagrammatic form connected in circuit together with the elements of the furnace to the power lines 41 supplying alternating cur-

rent. Supply of power to this assembly is controlled by a suitable switch 52 which when closed energizes conductors 53, 54 and 55. The latter, in turn, feed the master controller and heating unit. The conductors 45, 46 and 47 feeding the blower motor are connected directly to conductors 53, 54 and 55, respectively. The blower is customarily operated in response to conditions other than those which control the operation of the fuel burner alone and hence has been shown, by way of illustration, separated from the particular control for the burner. Conductors 48, 49 and 50 connect the compressor motor 28 to the feed lines 53, 54 and 55 and the ignition electrodes 34 are likewise connected to the feed wires 53 and 55 through a high voltage auto-transformer 56. However, energization of the compressor motor and ignition transformer is dependent upon closure of contactors 57 which, in turn, are controlled by the master controller 40 and associated thermostat 42.

The master controller 40 embodies a pair of electric discharge devices 61 and 62, the device 61 being a rectifier of any suitable type having a heater element 63, a cathode 64, and a current collecting anode 65. The electric discharge device 62 is a grid controlled valve, preferably of the gas-filled type, having a heater element 66, a cathode 67, a control electrode or grid 68, and an anode 69. The heater elements 63 and 66 are adapted to be energized from a transformer 71 through secondary windings 72 and 73, respectively. The transformer primary winding 74 is adapted to be energized from the source of supply 41 through lines 75 and 76 which connect with lines 53 and 55, respectively. The cathode 64 of tube 61 is connected by line 77 to power line 76 through a capacitor 78 shunted by a current limiting resistor 79 in series with variable resistance 79', while the control grid 68 of the electric valve 62 is connected to the line 77, at a point between the cathode 64 and capacitor 78, through a current-limiting resistor 80.

This electric valve circuit forms the energizing source of the master controller for operating the various relays and the electric discharge devices are energized continuously as long as the fuel burner and master controller are in proper operating condition. Energization of the electric valves is effected by momentarily depressing a manual push button switch 81 connected across power lines 75 and 76 by lines 82 and 83. The anode 65 of the rectifying tube 61 is connected to switch 81 and line 83 by a line 84 and to power line 76 through a current-limiting resistor 85 inserted in line 83.

Upon momentary depression of switch 81 unidirectional current will flow through the anode-cathode circuit of the rectifier 61, which circuit includes the capacitor 78 connected between the cathode electrode 64 and the supply line 76. The capacitor will be charged with the polarity as indicated and to a potential as determined by the voltage across power lines 75 and 76. Inasmuch as the control electrode 68 of the discharge device 62 is connected to line 77 it will assume a positive potential with respect to the cathode 67 thereof causing tube 62 to pass current through the anode-cathode circuit. The anode circuit of tube 62 extends through a line 86 to the winding of a relay 87, and thence through a line 88 to the supply line 75. A suitable capacitance 89 is connected across the winding of the relay 87 for the purpose of smoothing the pulsations of current flow therethrough. Upon the conduction of the

discharge device 62 in the manner just described, the relay 87 will be picked up moving its normally closed contactor arm 90 to open circuit position and its normally open contactor arm 91 to closed circuit position.

Upon closure of contactor 91 a conducting circuit will be established for the rectifier tube 61 around the momentarily depressed push button 81 so that as this element is released the energization of electric valves 61 and 62 will be maintained. This by-pass circuit extends from anode 65 of the rectifier tube 61 through lines 84 and 83 to a line 92, thence to line 93, normally closed contactor 94 of relay 95, lines 96 and 97, the closed contactor 91, lines 98 and 88 to the power line 75. This means that the conduction of rectifier 61 will be maintained throughout the period of conduction of the electric discharge device 62. One push button 81 is depressed and released the tubes 61 and 62 are rendered conductive and remain in this condition unless deenergized by failure of either tube or by operation of other elements of the master controller in a manner now to be described.

Energization of the circuit of enclosure thermostat 42 is likewise effected by closure of contactor 91. Current from supply line 75 reaches the thermostat through lines 88 and 98, contactor 91, line 97, line 96, normally closed contactor 99 of relay 100 and lines 101 and 102. Should the temperature within the enclosure drop, thermostat 42 will be moved to closed circuit position completing the circuit from the power line 75 to power line 76 through the thermostat to line 103, normally closed contactor 104 of push button 81, line 105, the energizing coil of a relay 95 and normally closed contactors 106 and 107 of the overload devices 108 and 109, respectively. This is the circuit which is completed when the thermostat calls for heat.

Operation of the motor compressor and ignition transformer in response to a call for heat is effected by closure of contactors 57 upon operation of relay 95 which has been energized by closure of the thermostat. Current from the power lines 53, 54 and 55 now feeds the compressor motor 28 and ignition transformer 56 through the closed contactors 57. Simultaneously, with closure of contactors 57 the relay 95 opens the contactor 94. This breaks the holding circuit from the anode 65 to the power line 75 so that the rectifier tube 61 is deenergized. This means that the tube 62 would likewise be rendered non-conductive were it not for the charge stored in the capacitance 78 which maintains the control grid 68 at a positive potential with respect to the cathode and the tube conductive. However, the charge of the capacitor 78 will leak off through the shunting resistor 79' and render the tube 62 non-conductive in a relatively short time unless conductivity of tube 61 is reestablished. The time delay during which the capacitor is discharging may be varied at will in accordance with the setting of the variable resistor 79' but is customarily made of the order of 1 to 4 seconds.

During the period in which discharge of the capacitor takes place energization of the compressor motor and ignition is effected by relay 95 in the manner already described. In the event that these elements function properly and flame is established in the furnace steps are taken to prevent complete discharge of the capacitor 78 and consequent non-conduction of tube 62 which would open contactor 91 and destroy the circuit

through thermostat 42 and relay 95. The controlling means for this purpose is the flame detector 35 which is connected across the power lines 75 and 76 in series with the coil of relay 100. Upon initiation of combustion within the furnace the flame detector will move to closed circuit position energizing the coil of relay 100 and moving normally open contactor 111 to closed position. This forms a shunt circuit past open contactor 94 and causes reconnection of tube 61 since the circuit from the anode 65 is reestablished to power line 75 through lines 84, 83, 92 and 93 to closed contactor 111, thence to line 97, contactor 91 and lines 98 and 88. This means that as soon as flame is initiated tube 61 is again rendered conductive to recharge capacitor 78; therefore, tube 62 remains conductive to maintain contactor 91 in closed position. The furnace now continues to operate as long as the thermostat calls for heat. However, as soon as the predetermined heat in the enclosure is reached, thermostat 42 opens deenergizing relay 95 and opening contactors 57 thereby stopping operation of the furnace. This does not disturb the operation of the tubes 61 and 62 which remain conductive.

In the event that combustion does not take place following closure of contactors 57, the flame detector 35 will remain in open circuit position so that contactor 111 is not closed by relay 100. This means that the shunt circuit for the rectifier tube 61 will not be closed and, since contactor 94 has already been opened by closure of the thermostat through operation of relay 95, the circuit to anode 65 is interrupted causing non-conduction of tube 61 and consequent discharge of capacitor 78. After the aforementioned predetermined time interval the capacitor is completely discharged rendering tube 62 non-conductive and releasing relay 87 to open contactor 91. This opens the circuit through thermostat 42 and deenergizes relay 95 causing the contactors 57 to open and stop operation of the burner. Failure of combustion is indicated by a signal 112 placed across power lines 75 and 76 by a line 110 connected to contactor 90 which closes upon release of relay 87.

In the event of failure of the flame detector, such as would be the case if this element remained in circuit closing position, it is desirable to have the burner lock out upon subsequent operation of the thermostat. To this end, relay 95 is provided with a normally open contactor 113 shunted across lines 96 and 101, and the flame detector relay 100 is provided with the aforementioned normally closed contactor 99. Closure of the thermostat in response to a call for heat operates relay 95 to close contactor 113 so that current from power line 75 may flow to the thermostat through line 96 and either contactor 99 or 113 to line 102. Upon subsequent initiation of flame and consequent operation of relay 100 contactor 99 is opened so that current for the thermostat circuit can flow only by way of contactor 113. This is the circuit for supplying current to relay 95 during normal operation of the burner. However, if the flame detector sticks in closed position contactor 99 remains open. This means that if, subsequently, the thermostat opens and closes the furnace will be cut off, because opening of the thermostat deenergizes relay 95 opening contactor 113. Current flow to the thermostat is now blocked by the open contactors 99 and 113, and closure of the thermostat is of no effect. In case of failure of the flame detector operation of the burner cannot

be initiated by closure of the resetting switch 81.

Overloading of the compressor motor or ignition transformer is prevented by relays 108 and 109 which operate contactors 106 and 107, respectively, in the circuit including relay 95. Interruption of the circuit deenergizes relay 95 opening contactors 57 which pass current to the compressor motor and ignition transformer.

My control is extremely reliable in operation inasmuch as substantially all contingencies are provided for to insure safe and reliable operation of the furnace. In the event of shutdown of the furnace due to flame failure at any time it is necessary to reset the control manually by pushing button 81. Failure of either of the tubes 61 or 62 will lock out the control and prevent operation of the furnace until the defective part is replaced.

The length of time during which attempted ignition of the burner is permitted before shutdown of the compressor and ignition transformer may be easily and precisely controlled by varying the discharging rate of the capacitor 78 by means of the variable resistor 79'. Reliability of the control is increased by the use of the electric valves 61 and 62 reducing the number of moving parts in the controller. Manual resetting is easily effected by closure of button 81; the latter is keyed to contactor 104 so that the circuit through the thermostat is momentarily opened during the resetting cycle. This means that the circuit through the operating relay 95 is opened and will remain open if the button 81 is held or blocked in closed position. Therefore operation of the burner cannot be initiated by holding the reset button 81 closed.

While my invention has been described as particularly adaptable as a control for automatic heating systems it should be manifest that it may be put to other uses.

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

1. A control for a heating system embodying a furnace provided with power driven means for supplying fuel thereto comprising, in combination, means including a normally conductive electric valve having a control grid for initiating operation of the fuel supplying means, the fuel supplying means being operative upon conduction of said electric valve, and means including said control grid responsive to failure of combustion within the furnace for rendering said valve non-conductive after a predetermined time delay to discontinue operation of said fuel supplying means.

2. A control for a heating system embodying a furnace provided with power driven means for supplying fuel thereto together with means for igniting the fuel, comprising, in combination, means including a normally conductive electric valve having a control grid for initiating operation of the fuel supplying means and ignition means, the fuel supplying means and ignition means being operative upon conduction of said electric valve, and means including said control grid operative upon failure of combustion within the furnace for rendering said valve non-conductive after a predetermined time delay to stop operation of the fuel supplying means and ignition means.

3. A control for a furnace embodying power driven fuel supplying means comprising, in combination, means including a normally conductive electric valve having a control grid for initiating operation of the fuel supplying means, the fuel

supplying means being operative upon conduction of said valve, a conduction device biasing said control grid to render said valve conductive, and means including said conduction device operative upon failure of combustion within the furnace for rendering said valve non-conductive to stop operation of the fuel supplying means.

4. Control means for a furnace embodying power driven fuel supplying means comprising, in combination, means including a normally conductive electric valve having a control grid for initiating operation of the fuel supplying means, the fuel supplying means being operative upon conduction of said valve, a conduction device biasing said control grid to render said valve conductive, a capacitor charged by said conduction device and electrically connected to said grid to render said electric valve conductive for a predetermined period of time after deenergization of said conduction device and means responsive to failure of combustion within the furnace to effect deenergization of said conduction device.

5. In a heating system embodying heating means and means for starting and stopping said heating means, a control system comprising, in combination, means including an electron discharge device having a control grid for controlling the operation of the heating means in response to operation of the starting and stopping means, means comprising a source of potential, a unilaterally conducting device and a capacitor for biasing said control grid to render said discharge device operative, said capacitor being charged by said unilaterally conducting device and electrically connected to said control grid to render said discharge device operative for a predetermined period of time after deenergization of said unilaterally conducting device, and means responsive to failure of operation of the heating means to effect deenergization of said unilaterally conducting device.

6. A control system for a furnace having power driven fuel supplying means comprising, in combination, an electric valve having an anode, a cathode and a control grid, means for heating said cathode, means comprising a source of potential, a unilaterally conducting device and a capacitor connected to said control grid and normally biasing it in a manner to cause conduction of said electric valve, said capacitor being charged by said unilaterally conducting device and being electrically connected to said control grid to render said electric valve conductive for a predetermined period of time after failure of said unilaterally conducting device, means electrically connected to said anode and responsive to conduction of current through said valve for operating the fuel supplying means, and means responsive to failure of combustion within the furnace to effect deenergization of said unilaterally conducting device.

7. A control system for a furnace having power driven fuel supplying means and a controlling means comprising, in combination, an electric valve having an anode, a cathode, and a control grid, means for heating said cathode, means comprising a source of potential, a unilaterally conducting device and a capacitor connected to said control grid and normally biasing it in a manner to cause conduction of said electric valve, said capacitor being charged by said unilaterally conducting device and being electrically connected to said control grid to render said electric valve conductive for a predetermined period of time after failure of said unilaterally conducting

ing device, means electrically connected to said anode and the controlling means, said means being responsive to conduction of current through said valve for operating the fuel supplying means upon operation of the controlling means, and means responsive to failure of combustion within the furnace to effect deenergization of said unilaterally conducting device.

8. A control means for a heating system embodying a furnace having power driven fuel feeding means together with means for indicating a condition of combustion within the furnace and thermostatic means for starting and stopping the operation of the power fuel feeding means comprising, in combination, means including an electric valve having a control grid for controlling the operation of the fuel feeding means in response to operation of the thermostat, means including a source of potential and a unilaterally conducting device for normally biasing said control grid for operation of said valve, means energized by said unilaterally conducting device electrically connected to and biasing the grid for operation of said valve for a predetermined time after deenergization of said unilaterally conducting device, and means responsive to the combustion indicating means to effect deenergization of said unilaterally conducting device upon failure of combustion within the furnace.

9. A control device for a heating system embodying a furnace having power driven fuel feeding means together with means for indicating a condition of combustion within the furnace and control means for starting and stopping the operation of the fuel feeding means in response to a condition caused by the action of the furnace comprising, in combination, an electric valve having a grid for controlling the operation of the fuel feeding means, means including a source of potential, a unilaterally conducting device and a capacitor for normally biasing said control grid for operation of said valve, said capacitor being charged by said unilaterally conducting device and being electrically connected to said control grid to bias it for operation of said electric valve for a predetermined time interval after deenergization of said unilaterally conducting device, means responsive to operation of the control means for simultaneously deenergizing said unilaterally conducting device and operating the fuel feeding means, said capacitor maintaining operation of said valve for said predetermined time interval, and means responsive to actuation of the combustion indicating means upon existence of combustion for restoring energization of said unilaterally conducting device.

10. A control device for a heating system embodying a furnace having power driven fuel feeding means together with means for indicating a condition of combustion within the furnace and control means for starting and stopping the operation of the fuel feeding means in response to a condition caused by the heating action of the furnace comprising, in combination, an electric valve having a grid for controlling the operation of the fuel feeding means, means including a source of potential, a unilaterally conducting device and a capacitor for normally biasing said control grid for operation of said valve, said capacitor being charged by said conducting device and being electrically connected to said control grid to bias it for operation of said electric valve for a predetermined time interval after deenergization of said unilaterally conducting device, means responsive to operation

of the thermostat upon a call for heat for simultaneously deenergizing said unilaterally conducting device and operating the fuel feeding means, said capacitor maintaining operation of said valve for a predetermined time interval, and means responsive to actuation of the combustion indicating means upon failure of combustion to maintain deenergization of said unilaterally conducting device.

11. A control means for an electric device comprising, in combination, means including an electric valve having a control grid for controlling the

operation of the electric device, the electric device being operative upon conduction of said valve, a conduction device biasing said control grid to render said valve conductive, an energy storing means charged by said conduction device and electrically connected to said grid to render said electric valve conductive for a predetermined period of time subsequent to deenergization of said conduction device, and means responsive to a condition of said electric device to deenergize said conduction device.

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