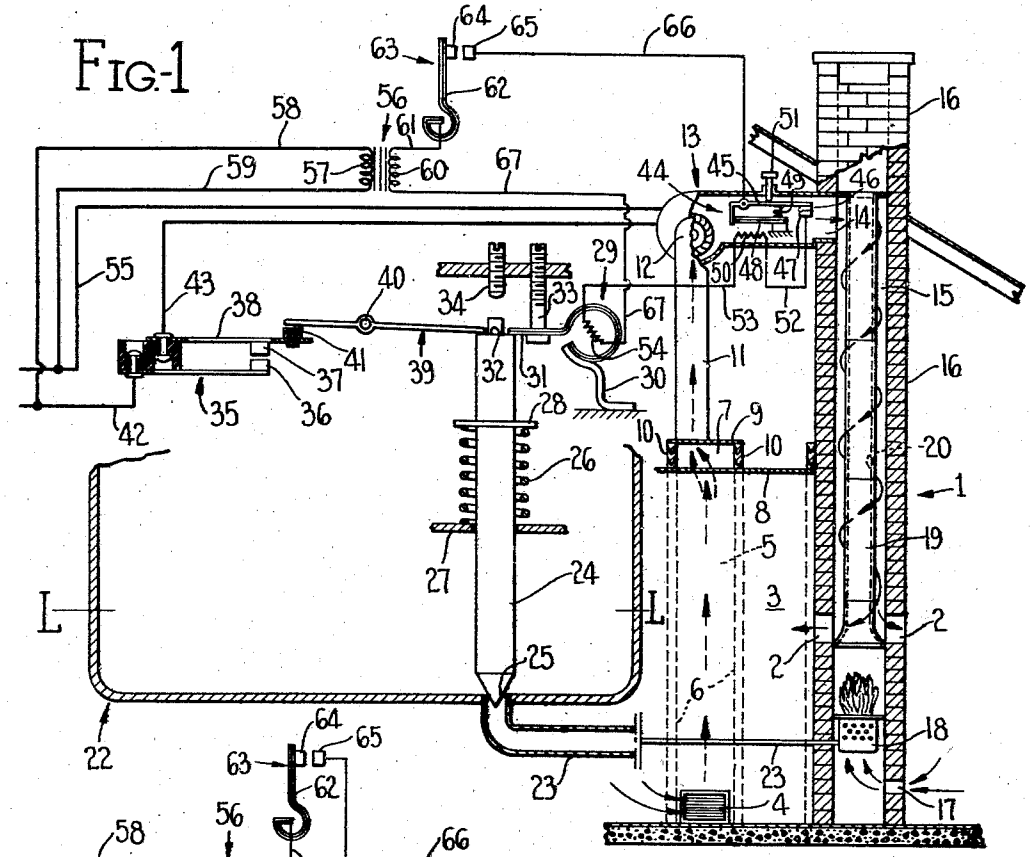
Nov. 28, 1944. P. S. RUSSEL 2,363,696

CONTROL SYSTEM

Filed Feb. 6, 1942

FIG-1



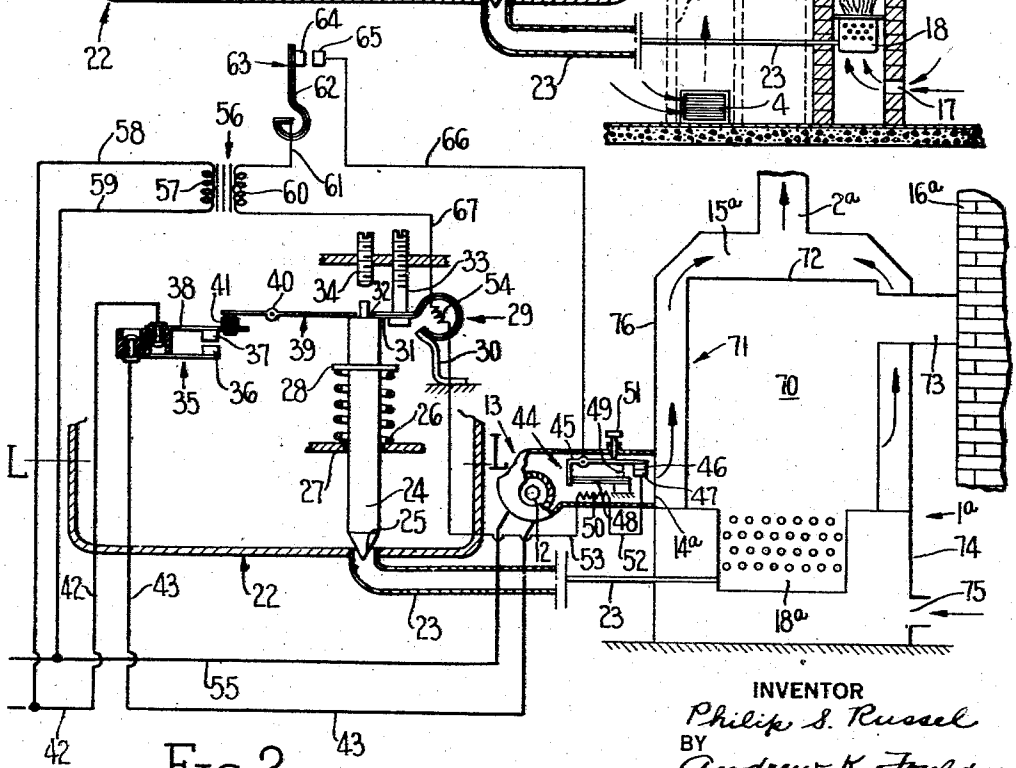


FIG-2

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CONTROL SYSTEM

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Application February 6, 1942, Serial No. 429,725

9 Claims. (Cl. 126—110)

This invention relates generally to control systems and is particularly adapted among other uses for use in a forced draft heating apparatus.

One object of this invention is to provide means for preventing the overheating of a heat generating apparatus.

Another object is to provide such a means which is responsive to the flow of air over the heat generating apparatus.

Another object is to provide means to shut down the heat generating apparatus upon failure of the fan means for supplying the medium to be heated.

Another object is to provide means to reduce to a predetermined minimum the rate of combustion of the fuel in the heat generating apparatus upon failure of the fan means for supplying the medium to be heated.

Other objects will be apparent from a reading of the specification.

The invention consists in the new and novel construction of and combination of parts, to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing to be taken as a part of this specification, there is fully and clearly illustrated a preferred embodiment of the invention in which drawing:

Figure 1 is a schematic view of a heating system embodying the invention.

Fig. 2 is a schematic view of a modified heating system embodying the invention.

Referring to Figure 1 of the drawing by characters of reference the numeral 1 designates generally a chimney type furnace or heat generating apparatus having an outlet 2 for supplying heated air to a room or enclosed space 3. Cool air from the room 3 is drawn through a grill 4 up through a return air duct 5 formed in the wall of the room 3 by adjacent studs 6. From the duct 5 the return air passes into a horizontal duct 7 formed intermediate the ceiling 8 and a duct cover 9 joining a pair of adjacent ceiling joists 10. A fan inlet duct 11 conducts the return or cool air from the duct 7 to the inlet 12 of a pressure type fan unit 13. The fan unit 13 has its outlet 14 opening into and for discharge of air into the upper end portion of a plenum chamber 15 of the chimney furnace 1. The furnace 1 comprises a chimney 16 which may be of brick and which has at its lower end portion an inlet opening for flow of air for supplying the necessary oxygen to a pot type liquid fuel burner 18 positioned within the chimney 16 adjacent the inlet opening 17. Positioned longitudinally of the chimney 16 and extending upward from above the burner 18 toward the upper end of the chimney 16 is a tubular heat exchange member 19 which is preferably circular in cross-section and which may be made of cast iron. The products of combustion from the burner 18 pass upward through the central opening 20 of the member 19 and pass upwardly through the remaining upper end portion of the chimney 16 to be discharged to the atmosphere. The plenum chamber 15 is formed intermediate the heat exchange member 19 and the inner wall of the chimney 16. At its lower end portion, the plenum chamber 15 has the outlets 2 through which the heated air from the plenum chamber 15 is discharged to the room 3. The outlets 2 may be covered with grills if desired but which are not shown for convenience. Liquid fuel for the burner 18 is supplied from a constant level gravity feed control unit 22 through a conduit 23. The control unit 22 is supplied from a source of supply through a conduit (not shown). The rate of inflow to the control unit 22 is controlled by a suitable float controlled valve (not shown) to maintain the level of the liquid within the unit 22 substantially at the line L—L. The outflow of the liquid fuel from the unit 22 is controlled by means of a reciprocally movable valve member 24 which cooperates with an outlet 25 opening into the conduit 23.

The valve member 24 is urged toward open position by a helical coil spring 26 positioned concentric with and surrounding the member 24. The spring 26 rests at its lower end on a member 27 through which the valve member 24 extends and which is rigid with the unit 22. The upper end of the spring 26 abuts a radially extending circumferential collar 28 which is suitably held to the member 24. A bimetallic power element 29 has one portion held by means of a support 30 to a member rigid with the unit 22 and has a movable lip portion 31 abutting an upwardly facing shoulder 32 of the valve member 24. When the element 29 is at ambient temperature, the lip portion 31 exerts a sufficient downward force on the member 24 to hold it against the upward force of the spring 26 and in a closed position with the outlet 25. Closing movement of the valve member 24 by the element 29 is limited, however, by a low fire stop member 33 which is screw-threadedly secured to a portion of the unit 22 and which has a flanged head portion against which the lip portion 31 abuts. Opening movement of the valve member 24 is limited by

the engagement thereof with a high fire adjusting screw or stop member 34 also screw-threaded to a portion of the unit 22.

A switch 35 is suitably held rigid to the unit 22 and has a first resiliently mounted contact member 36 and a second or movable contact member 37 carried by an arm 38. A lever member 39 is fulcrumed at 40 intermediate its ends and has one end resting on the shoulder 32 of the valve member 24 and has its other end engageable with an insulating button 41 secured to the arm 38. Upon upward or valve opening movement of the valve member 24, the lever member 39 is rocked about its fulcrum 40 in a counter-clockwise direction to move the movable contact member 37 into engagement with the first contact member 36 to complete an electric circuit between lead wires 42 and 43.

Positioned within the outlet 14 of the fan unit 13 and in the path of the air stream is a control unit or switch 44 comprising a pivoted current conducting lever arm 45 having at one end a contact member 46 cooperable upon movement of the arm 45 to engage and disengage a second contact member 47 to control an electric circuit. The other end of the arm 45 has a perpendicularly extending portion which normally engages the free end portion of a bimetallic strip member 48 to prevent counter-clockwise movement of the arm 45 under the influence of a helical coil compression spring 49 held under compression between the arm 45 and the fixed end of the bimetallic member 48. The spring 49 urges the arm 45 in a counter-clockwise direction to move the contact member 46 out of engagement with the member 47. An electrical resistance unit 50 is positioned in heat exchange relation with and for heating the bimetallic member 48. The resistance unit 50 is so chosen relative to the flow output of the fan unit 13 that with the fan unit 13 operating normally, the air flow over the resistance unit 50 and bimetallic member 48 will maintain at all times the temperature of the member 48 below the temperature at which the free end or end of the member 48 which is in engagement with the perpendicular portion of the arm 45 will move beyond the end of the perpendicular portion to allow the spring 49 to rotate the arm 45 counter-clockwise to part the contact members 46 and 47. Should, however, the output of the fan unit 13 be reduced to or below a predetermined minimum flow for any reason such as failure of the driving motor or the blocking of the inlet or outlet of the air circulating system, the resistance unit 50 will supply sufficient heat to raise the temperature of the bimetallic member 48 so that the free end thereof will be flexed or warped sufficiently to pass below the end of the perpendicularly extending portion of the arm 45 to release the arm for counter-clockwise movement by the spring 49 so that the contact member 46 is moved out of engagement with the contact member 47. Upon this counter-clockwise movement of the arm 45, the spring 49 will maintain the contact members 46 and 47 out of engagement until the arm 45 is manually moved in a clockwise direction by a manually operable push button or thrust member 51. When this manual movement is imparted and the bimetallic member 48 has cooled sufficiently, the member 48 will move upward toward the position shown and upon release of the push button 51 the member 49 will again engage the perpendicularly extending portion of the arm 45 to hold the contact members 46 and 47 in engagement. The resistance unit 50 has one end thereof connected by a lead wire 52 to the contact member 47 so that the unit 50 is placed in series circuit with and controlled by the contact members 46 and 47. The other end of the unit 50 is connected by means of a lead wire 53 to one end of a resistance unit 54 which is in heat exchange relation with and acts to heat the bimetallic element 29 so that the lip portion 31 thereof will be moved to position the valve member 24 for increased liquid flow through the outlet 25.

The lead wire 43 is connected to one terminal of the motor (not shown) for driving the fan unit 13. The other terminal is connected by a lead wire 55 which along with the lead wires 42 provides the source of electrical energy supply. A transformer 56 has a primary coil 57 connected by means of lead wires 58 and 59 to the lead wires 42 and 55 for energization thereof. One end of a secondary coil 60 of the transformer 56 is connected by a lead wire 61 to a bimetallic blade 62 of a room thermostat diagrammatically shown at 63. The blade 62 carries a contact member 64 which is moved by and at a predetermined minimum temperature of the blade 62 to engage a fixed contact member 65. A lead wire connects the contact member 65 to the movable arm 45 of the flow sensitive control unit or switch 44. As stated hereinbefore the electrical circuit through the unit 44 is through the arm 45, contact members 46 and 47, lead wire 52 and unit 50 to the lead wire 53. The lead wire 53 is connected to one end of the resistance unit 54 and the other end of the unit 54 is connected by a lead wire 67 to the other side of the secondary coil 60 from that connected to the lead wire 61.

The operation of the invention as shown in Fig. 1 is as follows: Electrical energy is supplied to the primary coil 57 of the transformer 56 through the lead wires 42, 58 and 55, 59. In the position of the elements as shown in the drawing, the temperature of the room 3 is above the predetermined desired temperature and the contact members 64 and 65 are in a separated position. It should be noted that the room thermostat 63 is positioned in the room 3 or in any other space in which the temperature is to be controlled. The contact members 64 and 65 being separated, the resistance units 50 and 54 are de-energized and the element 29 is at ambient temperature and therefore the lip portion 31 is in engagement with the low fire stop member 33 and holding the valve member 24 in a position to permit only pilot flow of fuel to the burner 18. Since the valve member 24 is being held in pilot fire position, the switch 35 will be in open circuit with the contact members 36 and 37 in a separated position so that the fan unit 13 is not circulating air from the room 3 through the plenum chamber 15. As the temperature surrounding the thermostat 63 decreases to the predetermined minimum temperature, the blade 62 will warp toward the right moving the contact member 64 into engagement with the contact member 65 to complete the secondary circuit of the transformer 56. Electric current will then flow from the secondary coil 60 through lead wire 61, blade 62, contact members 64 and 65, lead wire 66, arm 45, contact members 46 and 47, lead wire 52, resistance unit 50, lead wire 53, resistance unit 54 and lead wire 67 back to the secondary coil 60. The units 50 and 54 now being energized begin to heat the bimetallic member 48 and bimetallic power element 29 respectively. The relative heating ef-

fects of the units 50 and 54 are so interrelated to each other and to the member 48 and element 29 that the lip portion 31 will have been moved to allow the valve member 24 to be moved sufficiently toward open position to cause the lever member 39 to close switch 35 to start the fan unit 13 prior to the member 48 reaching the predetermined temperature at which the free end portion of the member 48 is moved beyond the downward end portion of the perpendicularly extending portion of the arm 45. The closure of the switch 35 starts the operation of the fan unit 13 and air is drawn from the room 3 through the grill 4, up through the duct 5, through the ducts 7 and 11, and through the fan unit 13 for discharge into the plenum chamber 15 where it is heated by the heat exchange member 19. The air then flows from the plenum chamber 15 back to the room 3 through the outlet 2. The air flowing from the unit 13 to the plenum chamber 15 cools the unit 50 and bimetallic member 48 and prevents the temperature of the member 48 from reaching the predetermined temperature at which the arm 45 is released to part the contact members 46 and 47 to deenergize the units 50 and 54. The unit 54 will continue to heat the element 2 so that the portion 31 will move upward at least a sufficient amount to enable the spring 26 to move the valve member 24 into engagement with the high fire stop member 34. Subsequent movement of the lever member 39 after the contact member 37 has engaged the contact member 36 is allowed due to the resilient mounting of the member 36 and will cause a sliding and wiping action between the two contact members 36 and 37 to insure a good electrical contact therebetween. The units 50 and 54 remain energized and the element 29 remains heated while the member 48 normally remains below its predetermined critical temperature until the ambient temperature about the thermostat 63 reaches the desired temperature. Subsequent to the thermostat 63 reaching this desired temperature, the contact member 64 will be moved out of engagement with the contact member 65 thereby deenergizing the secondary circuit of the transformer 56. The unit 50 and member 48 then cool to ambient temperature without any useful result, but cooling of the unit 54 and element 29 moves the valve member 24 to pilot fire position and opens the switch 35 to stop operation of the fan unit 13. The system then remains in the condition shown until the temperature about the thermostat 63 falls starting a subsequent operation of the system.

Should, however, the air flow of the fan unit 13 be reduced below a predetermined minimum for any reasons during a period of operation, the heater unit 50 will act to heat the member 48 at least to the predetermined critical temperature so that the free end portion thereof will move downward beyond the end of the perpendicularly extending portion of the arm 45 thereby allowing the arm 45 to be moved by the spring 49 to part the contact members 46 and 47. Parting of the members 46 and 47 deenergizes the secondary circuit of the transformer 56 causing the unit 54 to be deenergized and the element 29 to cool and move the valve member 24 to pilot fire position. The predetermined minimum flow at which the heat unit 50 actuates the switch 44 is preferably chosen so that air flows at or above this minimum flow are sufficient to prevent overheating of the furnace or generating apparatus 1. It follows therefore that at all air flows below the predetermined minimum flow the switch 44 acts to prevent an undesired operation wherein the apparatus would be injured due to overheating by shutting down the apparatus.

In Figure 2 of the drawing a modified system is shown in which like parts are designated by like numerals. In this system a conventional type furnace or heating apparatus 1a is used and has a combustion chamber 70 formed by a tubular heat exchange member 71. The lower end of the member 71 is closed by a pot type burner 18a and the upper end is closed by an end wall 72. The products of combustion are exhausted to the chimney 16a through a flue pipe 73 opening into the chamber 70 adjacent the wall 72. The burner 18a is enclosed by a shell 74 having an inlet 75 for admitting air for combustion to the burner 18a. A shell 76 encases the combustion member 71 and is spaced therefrom to provide a plenum chamber 15a wherein air is heated by the member 71. The plenum chamber 15a has an inlet opening 14a adjacent its lower end portion for flow of air thereto and an outlet opening 2a adjacent its top end portion for flow of air to a space or room 2a.

The operation of the system is identical to that of Figure 1 and the difference being that the air is forced upward through the plenum chamber 15a in the conventional manner rather than downward as in Fig. 1 and the furnace 1a is a conventional type.

It may now be seen that there is provided by this invention a new and novel control system for forced convection heating systems in which the burner is controlled by the convection air flow through the furnace or heating apparatus and in the event the flow of air over the furnace falls below a predetermined minimum the burner is rendered ineffective to provide more than a predetermined minimum heat output.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. In a heating system, a heat generating means having a plenum chamber in heat exchange relationship with said heat generating means, means for supplying air to be heated to said chamber, an electric switch, bimetallic means positioned in the path of the air supplied by said air supplying means and operatively connected to and for holding said switch in closed position, said bimetallic means being operable at a temperature above a predetermined temperature to cause said switch to move to an open position, means positioned in heat exchange relation with said bimetallic means and operable to supply heat at a substantially predetermined rate, said rate being so related to the flow of said supplied air that said bimetallic means is maintained below said predetermined temperature for normal flows of said supplied air and so related to the flow of said supplied air that said bimetallic means is heated to said predetermined temperature at subnormal flows of said supplied air, electrical means connected to said switch and operable to increase the rate of heat being supplied by said heat generating means to said chamber, said switch when in said open position acting to render ineffective said electrical means.

2. In an oil burning system, a pot type oil burner, valve means for controlling the flow of oil to said burner, means for limiting movement of said valve means toward minimum flow position to provide for a pilot flame in said burner, electrically actuated means for moving said

valve means toward a maximum flow position to increase the flow of oil to said burner, a heat exchange surface heated by said burner, a casing surrounding at least a portion of said surface and cooperable therewith to form a flow passageway for fluid flow, fan means for propelling air and having an outlet, an electric motor for driving said fan means, means connecting said fan means outlet to said passageway, switch means operated upon movement of said valve means by said moving means for energizing said electric motor, a bimetallic member positioned in the flow path of at least a portion of the fluid flow caused by said propelling means, electric heating means positioned in heat exchange relation with and operable to heat said bimetallic member, switch means operatively connected to said bimetallic member and operable to be moved to open circuit position thereby, and an electrical circuit connecting said electrically actuated moving means and said last-named switch means, said heating means being so interrelated to said flow of air that at all rates of flow of air below a predetermined minimum rate said bimetallic member will be heated sufficiently to move said last-named switch means to open circuit position.

3. In a heating apparatus, heat transfer means, means for controlling a supply of fuel to the apparatus for heating said transfer means, means for supplying combustion supporting air to the apparatus, electrically operated means for actuating said controlling means, means for supplying to said transfer means a fluid medium to be heated and actuated by said electrically operated means, a heat actuated switch means controlling the circuit of said electrically operated means and positioned in the inlet path of the fluid medium to said transfer means, heater means positioned in heat exchange relation with said switch means, said heater means being operable to raise the temperature of said switch means above a predetermined temperature when the rate of flow of the fluid medium is below a predetermined minimum flow rate, the heat output of said heater means being so related to the output of said fluid supplying means that at all rates of fluid flow above said predetermined minimum rate the fluid will cool said switch means below said predetermined temperature, and means for simultaneously energizing said electrically operated means and said heater means, said heater means having a rate of increase in temperature upon energization thereof so related to the rate of actuation of said electrically operated means that said fluid supplying means will be actuated by said electrically operated means to cool said switch means prior to said switch means reaching said predetermined temperature.

4. In a heating system, a heat exchanger, a fan for supplying to said exchanger air to be heated, electrically operable means for controlling the heating of said exchanger, a thermostatic switch controlling the circuit of said electrically operable means, and an electric heater for heating said switch to open said circuit, said switch being positioned to be cooled by air flow created by operation of said fan so that said switch will not be actuated by said heater.

5. In a heating system, a furnace having a plenum chamber and a combustion chamber separated by a heat transfer wall, means controlling combustion in said furnace combustion chamber, a fan for supplying air to be heated to said plenum chamber, electrically operable means controlling said combustion controlling means, a switch controlling said fan and closed by said electrically operable means, a thermostatic switch controlling the circuit of said electrically operable means, and an electric heater for heating said thermostatic switch to open said circuit, said thermostatic switch being positioned to be cooled by the flow of air to be heated and resulting from operation of said fan so that said electric heater will be ineffective to open said thermostatic switch.

6. In a heating system, a furnace having an oil burner and a plenum chamber heated thereby, an electrically operable valve controlling the supply of fuel to said burner and movable toward open position upon energization, a fan for supplying air to said chamber, a switch controlling said fan and closed upon energization of said valve, a thermostatic switch controlling the circuit of said valve and positioned to be cooled by air flow created by said fan, and an electric heater for heating said thermostatic switch to open said circuit upon failure of said fan, said heater being in circuit with said thermostatic switch.

7. A heating apparatus comprising an air heating chamber and a combustion chamber separated by a heat transfer wall, a fuel burner in said combustion chamber for heating said wall, means controlling the rate of combustion of fuel in said burner, electrically operable means controlling said controlling means and operable when energized to increase the rate of combustion, an electrically driven fan for supplying air to be heated to said heating chamber, a thermostatic switch controlling the circuit of said electrically operable means and positioned to be cooled by air flow to said heating chamber resulting from operation of said fan, and an electric heater in circuit with said electrically operable means and operable to heat said thermostatic switch, said heater actuating said thermostatic switch upon failure of said fan to cool the same thereby to prevent increase in the rate of combustion.

8. A heating apparatus comprising an air heating means having a heat exchange wall separating a combustion chamber from an air heating space, a fuel burner in said chamber for heating said wall, means controlling the rate of combustion of fuel in said combustion chamber, electrically operable means controlling said controlling means and operable when energized to increase the rate of combustion, an electrically driven fan for supplying air to be heated to said heating space, an electric switch controlling the circuit of said fan and closed upon energization of said electrically operable means, a thermostatic switch controlling the circuit of said electrically operable means and positioned to be cooled by air flow caused by operation of said fan, and an electric heater in circuit with said electrically operable means and operable to heat said thermostatic switch, said heater actuating said thermostatic switch upon failure of said fan to cool the same thereby to prevent increase in the rate of combustion.

9. A heating apparatus comprising an air heating means having a heat exchange wall separating a combustion chamber from an air heating space, a fuel burner in said chamber for heating said wall, means controlling the rate of combustion of fuel in said combustion chamber, an electrically driven fan for supplying air to be heated to said heating space, a thermostatic switch posi-

tioned in the fan outlet to be cooled by air flow to said space, electrically operable means controlled by said switch and operable when energized to actuate said controlling means to increase the rate of combustion, an electric switch controlling said fan and closed by operation of said electrically operable means, an electric heater in circuit with said thermostatic switch and said electrically operable means and operable to heat said thermostatic switch to break the circuit of said electrically operable means, and a switch controlling the circuit of said heater and said electrically operable means, said heater actuating said thermostatic switch to prevent increase in the rate of combustion upon failure of said fan to cool said thermostatic switch.

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