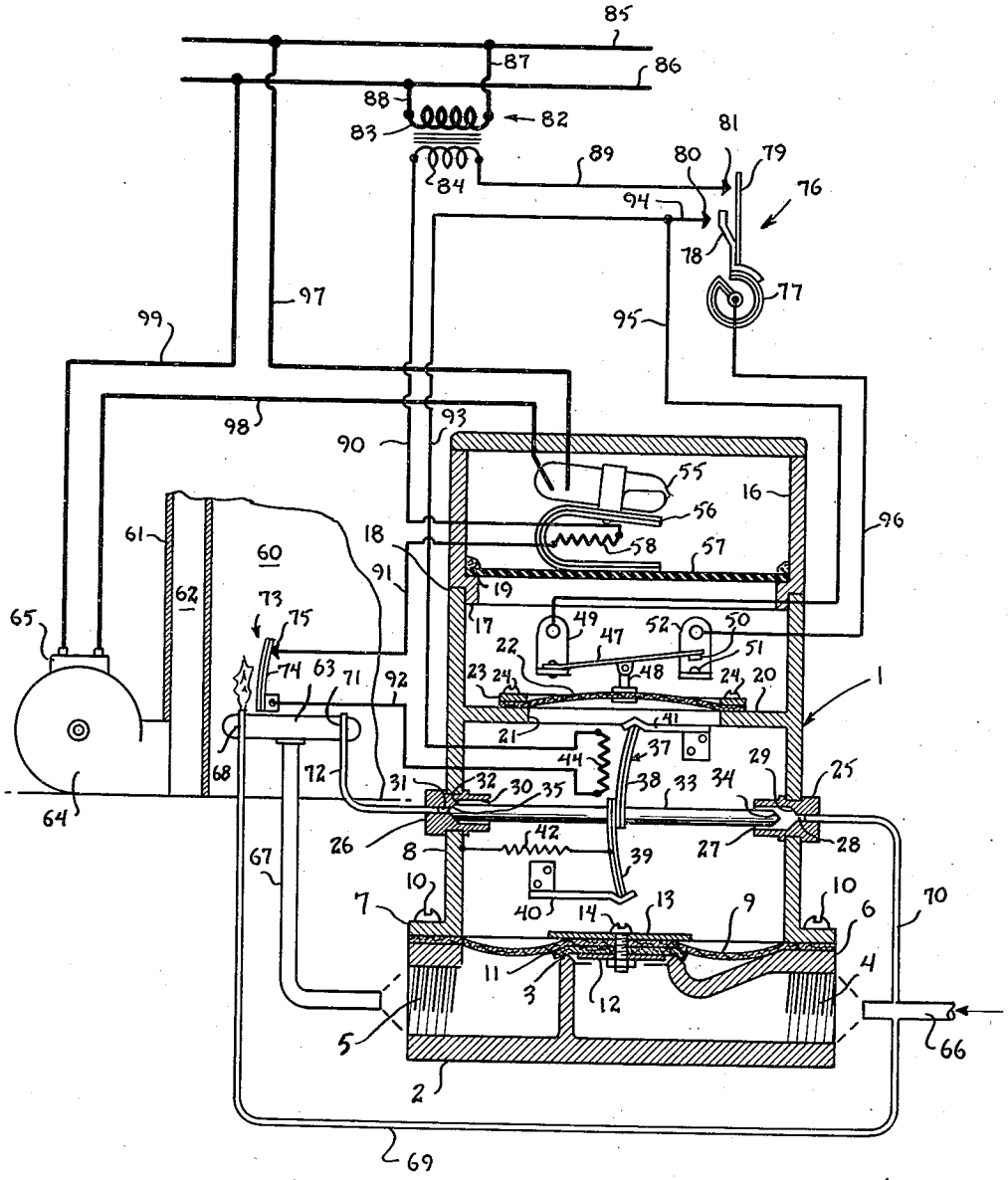
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COMBUSTION CONTROL

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Inventors
Frederick S. Denison,
Daniel G. Taylor
By
George H. Fisher
Attorney

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COMBUSTION CONTROL

Frederick S. Denison and Daniel G. Taylor, Minneapolis Minn., assignors to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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The present invention relates to temperature and combustion control systems and improvements in devices utilized therein.

An object of our invention is to provide improved control means for circulators of a heat transporting medium in systems employing gas fired heat exchange equipment.

Another object is to provide reliable, yet compact and inexpensive apparatus for controlling gas fired heat exchange equipment having forced circulation of heat transporting medium.

Another object is the provision of a heating system having a fuel valve controlled by bimetal actuating mechanism and a circulator controlled by bimetal actuating mechanism arranged to start the circulator at a predetermined time and after opening of the fuel valve.

Another object is to provide a control arrangement whereby a desired operating sequence is produced and which is inoperative if the arrangement is not in condition to produce the desired sequences.

Another object is the provision of heat actuated bimetal elements having heaters associated therewith connected in series, the elements serving to operate control devices.

Another object is the provision of a unitary control device for use in a combustion system having an air circulating fan, the device having a thermally actuated valve controlling element and a thermally actuated switch controlling the fan, the element and switch responding to series connected electrical heating elements.

Further objects and advantages of our invention will become apparent from the accompanying drawings and detailed specification.

The single figure of the drawing is a cross sectional view of one form of our invention embodied in a gas fired heating system.

The preferred form of our invention takes the form of a combination diaphragm control valve and fan switch forming a unitary device which we have designated generally on the drawing at 1. The device 1 comprises a valve body 2 which may preferably be a casting internally configurated to form a valve seat at 3. The valve body has an inlet 4 and an outlet 5. The upper part of the valve body 2 preferably forms a flat annular surface indicated at 6 and interposed between this annular surface 6 and a flange 7 formed at the lower part of a cylindrical housing or cover portion 8 are the peripheral portions of a diaphragm 9. The flange 7 and the diaphragm may be suitably secured in position with respect to the valve body 2 by screws 10. The diaphragm 9 forms part of a diaphragm valve and secured adjacent the central portion of the diaphragm is a seat disc 11 adapted to seat upon the valve seat 3. The diaphragm 9 and disc 11 may be made of leather or other suitable flexible material. The disc 11 is held in position with respect to the diaphragm 9 by means of metal discs 12 and 13 secured adjacent the disc 11 and diaphragm 9, respectively, and held in position by bolt 14 passing through the discs and the diaphragm.

The upper part of the housing 8 is closed by an inverted cup shaped member 16 having a downwardly extending rim or flange 17 which is of slightly smaller diameter than the cup 16 and forms an annular shoulder at 18 and a second internal annular shoulder at 19. The shoulder 18 engages the upper edges of the housing 8 and the housing 8 may be suitably secured to the flange or rim 17 to retain the cup portion 16 in position. The housing 8 has an integral shelf like member 20 formed horizontally therein, the member 20 having a circular opening 21 in its central portion. The opening 21 is covered by a flexible diaphragm 22 made of leather or other suitable material the edges of which are secured to the portions of the partition member 20 adjacent the opening 21 by means of an annular metal member 23 held in position by screws 24. The portion of the housing 8 between the diaphragms 9 and 22 forms a gas tight chamber the pressure within which is controlled by pilot valves as will now be explained. In opposite side walls of the housing 8 are a plug member 25 and a plug member 26. Each of these members extends through its respective side wall and is secured in gas tight relation thereto. The plug member 25 is bored as at 27 and has a smaller bore 28, the inner end of the bore 27 having a tapering conformation and forming a valve seat 29. The plug 26 is bored as shown at 30 and has a smaller bore 31, the inner end of the bore 30 having a tapering conformation and forming a valve seat 32. Numeral 33 designates a member in the form of a metal rod the ends of which 34 and 35 are machined so as to form valves adapted to cooperate with valve seats 29 and 35, respectively. Numeral 37 designates an actuator for the member 33 comprising two bimetal elements 38 and 39 the end portions of which are secured together and to which the member 33 is suitably secured, the member 33 preferably passing through an opening in the end portions of the elements 38 and 39. Opposite ends of the actuator 37 engage with the ends of resilient supporting brackets 40 and 41, the brackets 40 and 41 being arranged to place the

actuator 37 under a stress whereby it is bowed into the position shown on the drawing. In this position, it will be seen that the left end of the rod 33, that is, the valve 35, is engaged on the seat 32. A coil spring 42 is connected between the actuator 37 and a side wall of the housing 8 and continuously urges the actuator 37 and member 33 into position shown. As will be apparent from the drawing the stressed actuator 37 may be bowed in the opposite direction past a dead center position so that member 33 is moved to the right to move its right end, that is, the valve 34, into engagement with seat 29. In passing to this latter portion the member 33 will be moved with a characteristic snap movement, the snap being imparted by the actuator 37 moved past its dead center position, the resilient brackets 40 and 41 giving slightly during such operation. For automatically snapping the actuator 37 past its dead center position so as to open the valve 35 and close valve 34 an electric heating resistance 44 is provided. When heater 44 is energized the heat generated thereby causes element 38 to flex in a direction to cause the actuator 37 as a whole to snap past its dead center position moving the member 33 in the manner described. Upon the heater 44 being deenergized and cooling coil spring 42 will quickly move the actuator 37 and member 30 back into the position shown. The purpose of the actuator 37 being formed of two bimetal elements is to provide for compensation for ambient temperatures. The elements 37 and 39 are relatively arranged so that they tend to flex or warp in opposite directions in response to heat. Thus ambient temperatures to which the elements 38 and 39 are equally subjected have no effect tending to snap the actuator 37 from one position to the other. The heater 44 is adjacent the element 38 and whenever the heater is energized the element 38 is primarily affected by the heater to cause operation of the actuator as a whole. By reason of the compensating arrangement of the bimetal elements the operation of the device is stable in the sense that irrespective of ambient temperature conditions substantially the same amount of heating of the resistance 44 is necessary to actuate the device and it always operates in substantially the same increment of time.

From the foregoing it will be understood that the plugs 25 and 26 and the ends of the member 33 form pilot valves for controlling the admission of pressure to and discharge of pressure from within the housing 8. As we will presently describe, the plug 25 forms an opening for admission of pressure to the space within the housing 8 and whenever there is pressure therewithin it acts downwardly upon the diaphragm 9 to keep the diaphragm valve closed. Upon actuation of the actuator 37 whereby it flexes in the opposite direction to seat valve 34 and open valve 35 admission of pressure through the plug 35 is cut off and pressure within the housing 8 is released through the plug 26. Upon pressure being released from above the diaphragm 9 inlet pressure from inlet 4 of the diaphragm valve acting upwardly on the disc 12 and diaphragm 11 will tend to lift the diaphragm assembly sufficiently to break the seal between disc 11 and seat 3. As soon as this takes place the lower side of diaphragm 9 will be exposed to gas pressure and by reason of the pressure acting upwardly upon this increased diaphragm area the diaphragm valve will be moved upwardly to an open position with a snap action which is characteristic of this type of diaphragm valve. Upon the member 33 being again moved to the position shown the diaphragm valve will close with a similar snap action.

Referring again to the small diaphragm 22 it will be seen that the central portion of this diaphragm is connected to the central portion of a resilient switch blade 47 by a stem 48. One end of the blade 47 is secured to and supported by a suitable bracket 49 and the other end of the blade 47 carries an electrical contact 50 which cooperates with an electrical contact 51 carried by a bracket 52 similar to the bracket 49. Whenever there is pressure within the housing 8 underneath the diaphragm 22 the diaphragm 22 is flexed upwardly maintaining the contacts 50 and 51 separated. Whenever pressure is released from underneath the diaphragm 22 it flexes downwardly causing closure of the contacts 50 and 51.

The inverted cup portion 16 forms a housing or enclosure for an electrical switch of the mercury type 55. The switch 55 is secured to one leg of a U-shaped bimetal actuating element 56, the other leg of which is suitably secured to a fibre disc 57 which is supported on the internal annular shoulder 19 of the inverted cup 16. Arranged adjacent the switch carrying leg of the element 56 is an electrical heating resistance 58 similar to the heating resistance 44 and which as will presently become apparent is connected in series relation with the heater 44.

Our device is intended primarily and preferably for use in a combustion control system wherein the combustible medium is a fluid. We have shown our device embodied in such a system wherein numeral 60 designates the combustion chamber of a gas fired furnace, the furnace having a jacket 61 whereby a space 62 is formed between the combustion chamber and jacket and through which air to be heated may be circulated. Within the combustion chamber 60 is a gas burner 63 of conventional type and a motor driven fan 64 is provided for forcing air to be heated into and through the space 62, the fan 64 being driven by an electric motor 65. The inlet of the diaphragm valve may be connected to a gas supply main by means of a conduit 66 and the outlet of the diaphragm valve may be connected to the burner 63 by a conduit 67. Numeral 68 designates a pilot burner which is continuously supplied with fuel through a tube 69 connected with conduit 66 as shown. The bore 28 of plug 25 is connected to the conduit 66 by a tube 70 and the bore 31 of the plug 26 is connected to an auxiliary pilot burner 71 by tube 72. Numeral 73 designates a safety pilot which may be of conventional type and comprises a bimetallic element 74 which is arranged adjacent the pilot burner 68 so that the heat therefrom normally causes the blade 74 to flex into engagement with an electrical contact 75.

The system is primarily controlled by a space thermostat 76 comprising a bimetal element 77 and two resilient switch blades 78 and 79 cooperating with fixed electrical contacts 80 and 81, respectively. The thermostat 76 is of a known type wherein blade 79 engages contact 81 at a predetermined temperature and at a predetermined lower temperature which may be one or two degrees lower blade 78 engages the contact 80. Power for the control devices of the system is supplied by a voltage step down transformer 82 of a conventional type comprising a primary winding 83 and a secondary winding 84.

the primary winding having a greater number of turns than the secondary winding. Primary winding 83 is connected to line conductors 85 and 86 which may lead to a suitable source of external power by wires 87 and 88, respectively.

Referring now to the operation of the apparatus with the parts in the position shown, the thermostat 76 is satisfied and the diaphragm valve is in closed position. Assume now that the temperature to which the thermostat 76 is responsive falls to a predetermined value at which the blade 79 engages contact 81 and which may be 70° for example and that the temperature continues to fall until blade 78 engages contact 80 which may be 68° for example. Upon these contacts being made a circuit energizing the heaters 58 and 44 is completed as follows: from fixed contact 81 through wire 89, secondary winding 84, wire 90, heater 58, wire 91, safety pilot 73, wire 92, heater 44, wire 93, wire 94, fixed contact 80, and through the blades of thermostat 76 back to fixed contact 81. From the foregoing circuit it is obvious that the heaters 58 and 44 are connected in series. The heaters 44 and 58 and the bimetal actuators 37 and 56 are so arranged that the switch 55 will not be actuated from its open position as shown to a closed position until a predetermined time has elapsed after actuator 37 has moved member 33 to the right. We may accomplish this result by providing heaters 58 and 44 of relatively different heating capacities but we may also use an element 56 which is relatively slow to be actuated in response to heat. Within a few seconds after completion of the circuit described above the actuator 37 snaps the member 33 to the right seating the valve 34 and opening the valve 35. Immediately upon this occurring the diaphragm valve comprising the diaphragm 9 opens in the manner above described, it being understood that the admission of pressure through plug 25 and tube 70 is cut off and the gas which was within housing 8 is released through plug 26 and tube 72 to the auxiliary pilot burner 71. As soon as the diaphragm valve opens gas is admitted to the burner 63 where it is ignited by the pilot burner 68. As soon as gas is released from within the housing 8 the diaphragm 22 flexes downwardly closing contacts 50 and 51 completing a maintaining circuit for the heating elements 58 and 44, this circuit being as follows: from fixed contact 81 of the thermostat through wire 89, secondary winding 84, wire 90, heater 58, wire 91, safety pilot 73, wire 92, heater 44, wire 93, wire 95, bracket 49, blade 47, contact 50, contact 51, bracket 52, wire 96, and through the thermostat 76 back to the fixed contact 81. It is seen that this maintaining circuit just described is independent of the thermostatic blade 78 and contact 80 so that after the diaphragm valve has been opened in response to both the thermostatic blades having engaged their associated contacts the electrical heaters will remain energized not only until blade 78 disengages from its associate contact but until blade 79 disengages from contact 81 when the temperature rises above the predetermined value of 70°. Obviously therefore the thermostat 76 in cooperation with the contacts 50 and 51 provides a positive definite operating differential. At a predetermined time after the diaphragm valve opens in response to energization of heater 44, the bimetal element 56 will be actuated to a position causing switch 55 to close. Upon this occurring the motor 65 driving the fan 64 is energized through the following circuit: from line conductor 85 through wire 97, switch 55, wire 98, motor 65 and wire 99 back to the line conductor 86. As soon as motor 65 is thus energized operation of fan 64 begins and air is circulated through the space 62 and to the spaces being heated, it being understood that the fan 64 draws air from the spaces being heated and recirculates it through the space 62. Our novel arrangement for initiating fan operation at a predetermined time after combustion has been started insures that circulation of air to the spaces being heated will begin when the temperature within the space 62 has risen to a value suitably high for beginning. Our device provides a unitary and compact arrangement for controlling both combustion and the air circulation and eliminates the need for separate thermostatic controls responsive to the temperature within the space 62 for controlling the fan 64 as were conventionally used in the past. By starting the air circulating fan at a predetermined time after combustion has been initiated we eliminate difficulties which formerly arose from maladjustment of temperature controls which were used to control air circulation.

Whenever the temperature to which thermostat 76 is responsive rises to a value which causes the blade 79 to separate from contact 81 the above described maintaining circuit is interrupted and both the heaters 58 and 44 will be deenergized. Coil spring 42 will now snap the actuator 37 into the position shown causing the diaphragm valve to close in the manner above described. As soon as heater 58 cools sufficiently switch 55 will be opened and operation of the fan 64 will be terminated.

From the foregoing the novel features and advantages of our invention should be apparent to those skilled in the art. By providing an arrangement whereby we can control both combustion and fan operation in response to electrical heaters the power necessary for operation is reduced to a minimum and the initial cost and cost of repair of the equipment is made very small. By connecting the heaters which we use in series we have provided an important safety feature in that should failure of either heater occur neither one can be energized and therefore neither combustion nor fan operation can take place. Thus the danger of the furnace becoming overheated which might take place in the event of fan failure is eliminated and without the use of the usual temperature controls. Furthermore the series arrangement assures that fan operation cannot take place unless the diaphragm valve actuating mechanism has functioned properly and thus there is no danger of cold air being circulated to the spaces being heated.

The form of the invention which we have disclosed is representative and exemplary of other forms which it may take and of various changes and modifications which may be made by those skilled in the art. It is to be understood that the disclosure is an illustrative one and that only the appended claims and not the disclosure are to be interposed as limiting upon the invention.

We claim as our invention:

1. In a warm air heating system, in combination, a warm air furnace, means comprising a valve for controlling the supply of fuel to said furnace, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said valve, an electric

heater for said valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, said switch actuating means and said valve actuating means being so constructed and arranged that said switch causes said fan to start at a predetermined time after said valve is actuated to cause fuel to be supplied to said furnace.

2. In a warm air heating system, in combination, a warm air furnace, means comprising a gas valve for supplying fuel to said furnace, a pilot valve in control of said gas valve, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said pilot valve, an electric heater for said pilot valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, means comprising a pressure actuable switch responsive to pressure controlled by said pilot valve, said pilot valve causing opening of said gas valve and closure of said pressure actuable switch in response to energization of said circuit, closure of said pressure actuable switch completing an additional circuit for said heaters, and said actuating means for said first mentioned switch causing said switch to start said fan at a predetermined time after opening of said gas valve.

3. In a warm air heating system, in combination, a warm air furnace, means comprising a gas valve for supplying fuel to said furnace, a pilot valve in control of said gas valve, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said pilot valve, an electric heater for said pilot valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, means comprising a pressure actuable switch responsive to pressure controlled by said pilot valve, said pilot valve causing opening of said gas valve and closure of said pressure actuable switch in response to energization of said circuit, closure of said pressure actuable switch completing an additional circuit for said heaters, said additional circuit also being controlled by said control means and also connecting said heaters in series, and said actuating means for said first mentioned switch causing said switch to start said fan at a predetermined time after opening of said gas valve.

4. In a warm air heating system, in combination, a warm air furnace, means comprising a valve for controlling the supply of fuel to said furnace, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said valve, an electric heater for said valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, said switch actuating means and said valve actuating means being so constructed and arranged that said valve is actuated substantially immediately in response to said control means and said switch causes said fan to start after a predetermined time.

5. In a warm air heating system, in combination, a warm air furnace, means comprising a valve for controlling the supply of fuel to said furnace, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said valve, an electric heater for said valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, means comprising a pressure actuable switch responsive to pressure controlled by said valve means, said valve means operating and causing closure of said pressure actuable switch in response to energization of said circuit, closure of said pressure actuable switch completing an additional circuit for said heaters, and said actuating means for said first mentioned switch causing said switch to start said fan at a predetermined time after completion of said first circuit.

6. In a warm air heating system, in combination, a warm air furnace, means comprising a valve for controlling the supply of fuel to said furnace, a fan for circulating warm air to spaces being heated, a switch controlling said fan, heat responsive actuating means for said switch, an electric heater for said last means, heat responsive means for actuating said valve, an electric heater for said valve actuating means, means forming an electric circuit connecting said heaters in series, control means for energizing said circuit, said heat responsive switch actuating means comprising a bimetal element having characteristics whereby after energization of said circuit actuation of said switch is delayed for a predetermined time and said valve actuating means having characteristics whereby said valve is actuated relatively quickly after energization of said circuit.

FREDERICK S. DENISON.
DANIEL G. TAYLOR.