Jan. 2, 1940. E. J. DILLMAN 2,185,978

HEATING APPARATUS

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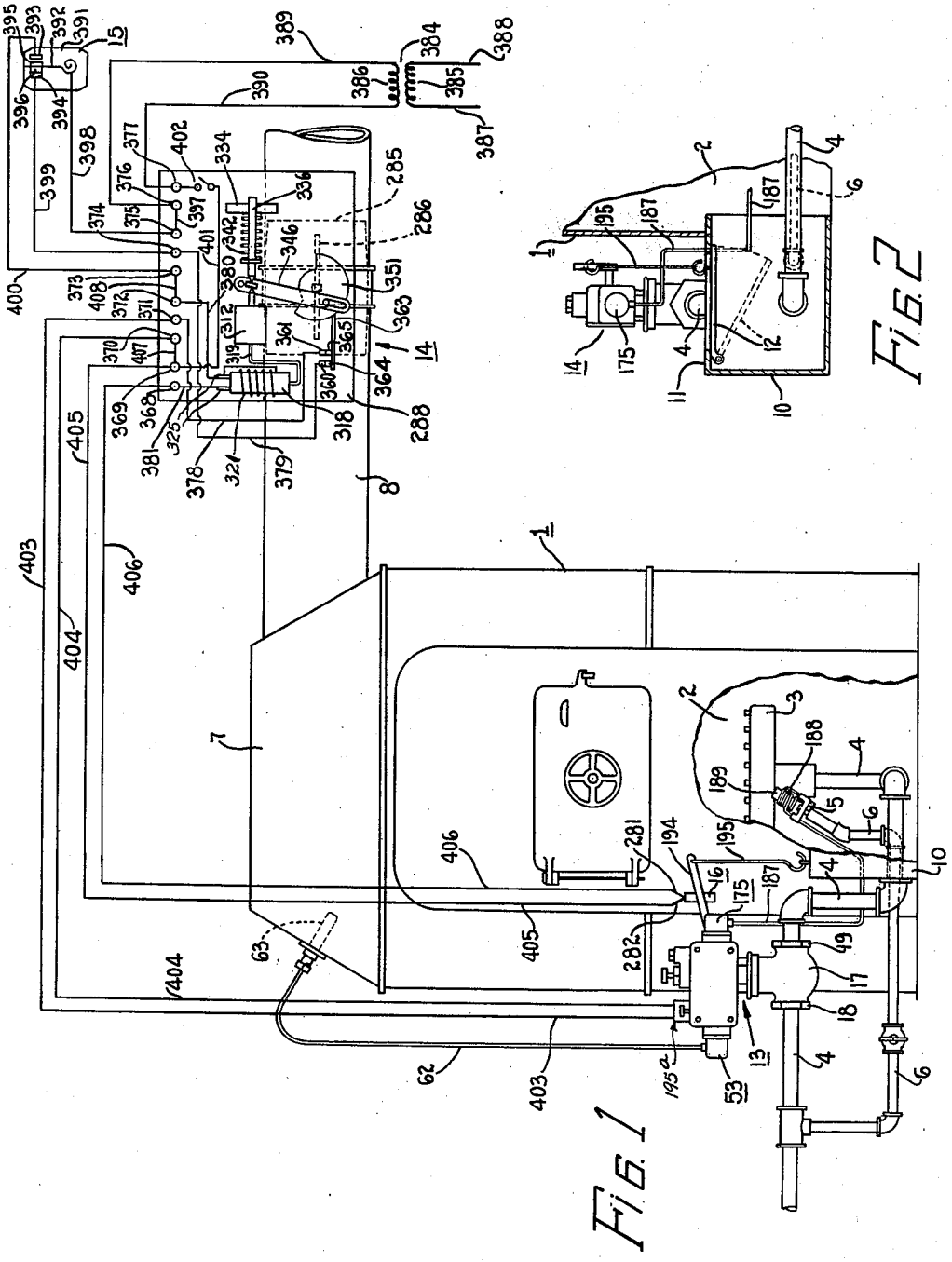


Fig. 1

Fig. 2

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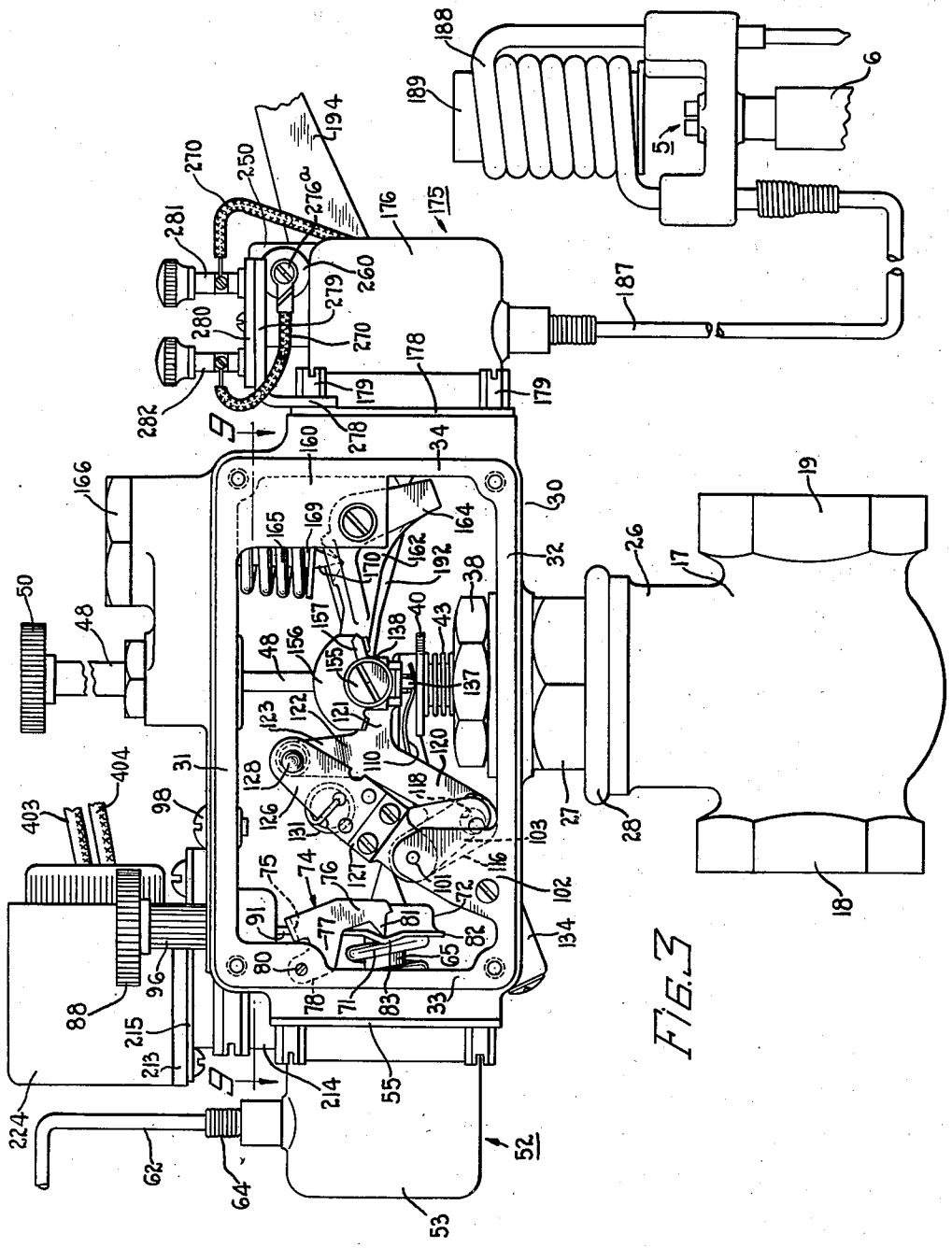


FIG. 3

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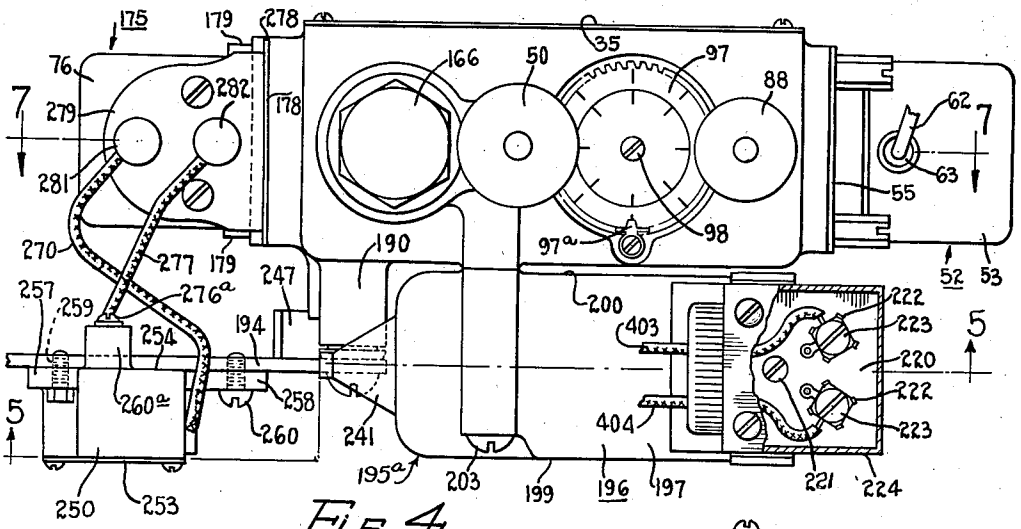


Fig. 4

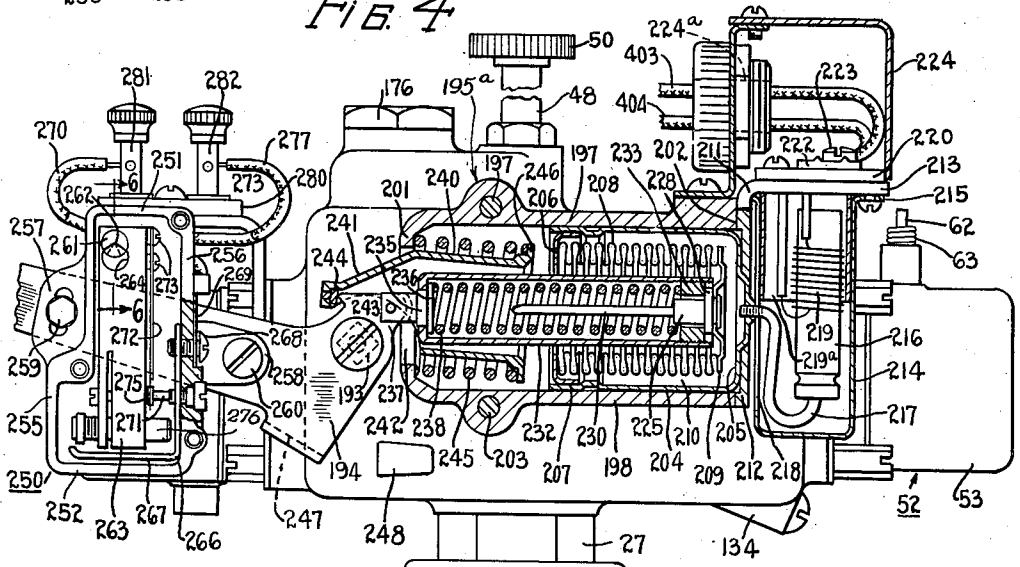


Fig. 5

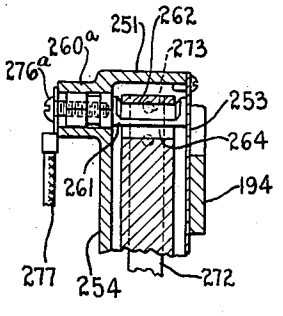
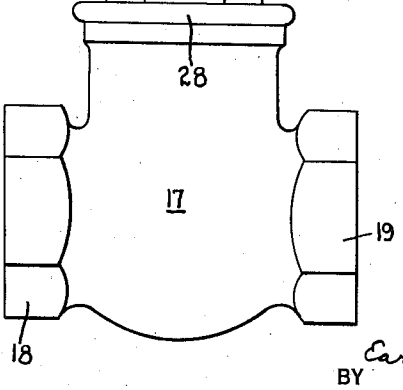


Fig. 6



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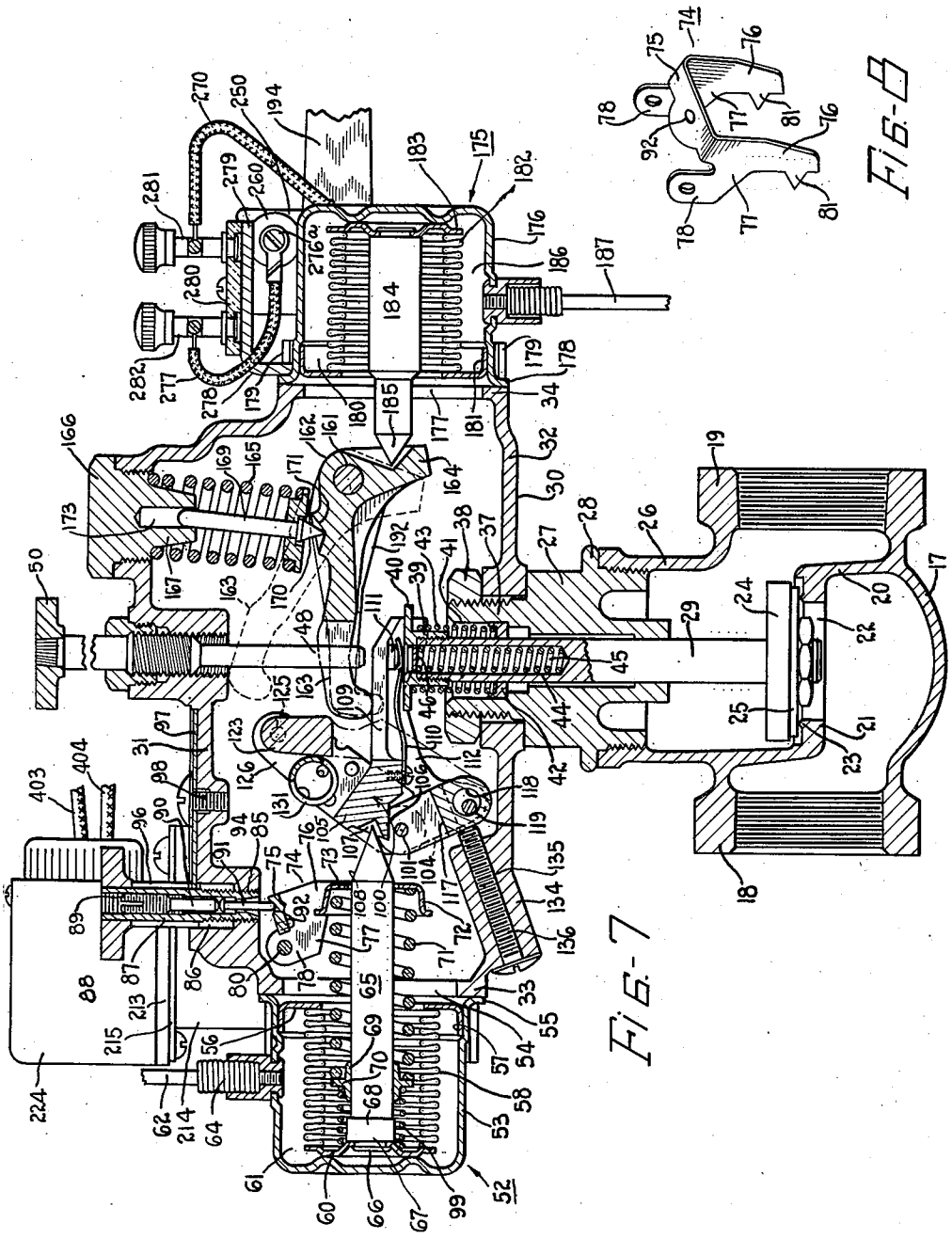


FIG. 7

FIG. 8

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HEATING APPARATUS

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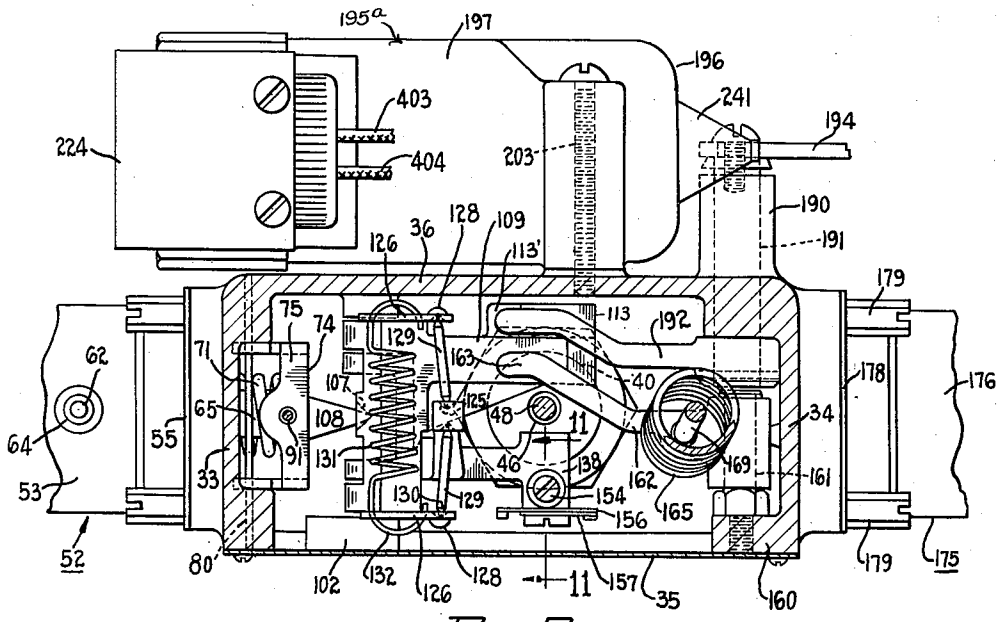


Fig. 9

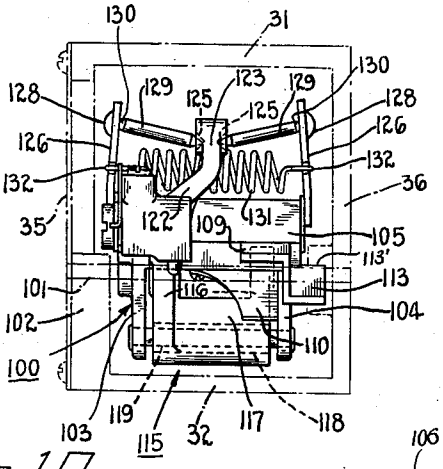


Fig. 10

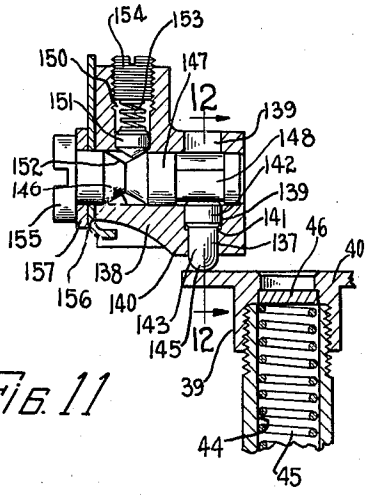


Fig. 11

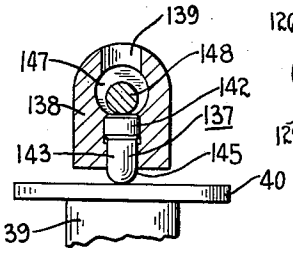


Fig. 12

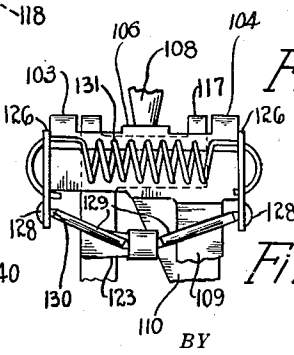


Fig. 13

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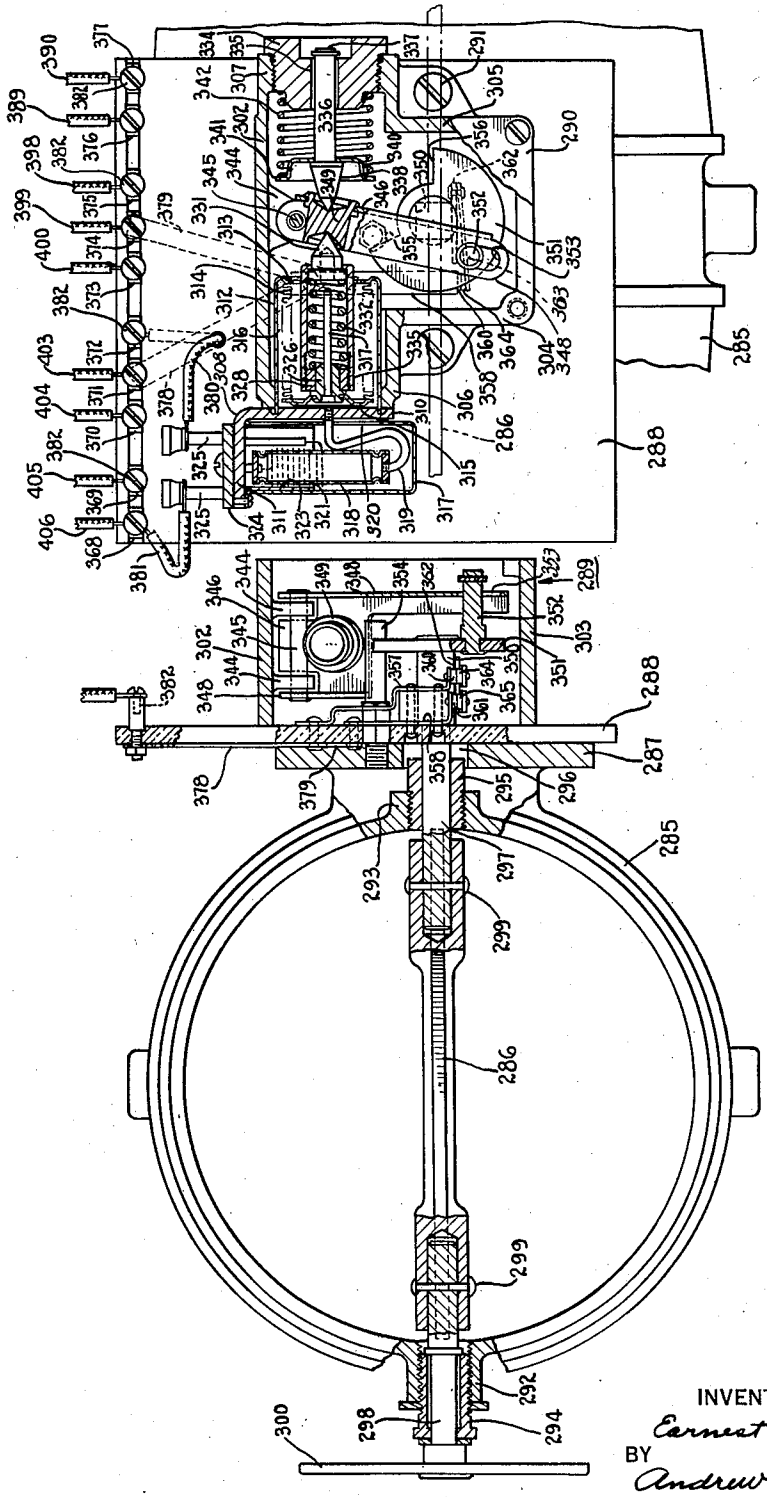


Fig. 14

Fig. 15

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UNITED STATES PATENT OFFICE

2,185,978

HEATING APPARATUS

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Application June 3, 1936, Serial No. 83,232

8 Claims. (Cl. 236—1)

My invention relates generally to heating systems and more particularly to control systems therefor.

One of the objects of my invention is to provide a new and improved control system for heating apparatuses and one which prevents the escape of heat via the furnace stack on the "off" cycle of operation of the heating apparatus in a new and improved manner.

Another object of my invention is to provide a new and improved control device for controlling the supplying of fuel to a heating apparatus.

Another object of my invention is to provide a control device of the above mentioned character having new and improved mechanism for throttling, and for seating a valve to control flow of fuel to the burner of a furnace in accordance with furnace temperature.

Another object of my invention is to provide a control device for controlling the supplying of fuel to the burner of a heating apparatus and also for controlling the operation of a damper.

Another object of my invention is to provide new and improved mechanism for actuating a control.

Another object of my invention is to provide new and improved mechanism for actuating a damper and also for controlling a circuit to the valve actuating mechanism to prevent opening of the valve when the damper is closed.

Another object of my invention is to provide new and improved mechanism for actuating the valve in accordance with the temperature of a room or other enclosed space to be heated.

Another object of my invention is to provide a new and improved tilt switch.

The invention consists in the improved construction 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 drawings, to be taken as a part of this specification, I have fully and clearly illustrated my invention, in which drawings—

Figure 1 is a diagrammatic view of a heating apparatus and my new and improved control system therefor;

Fig. 2 is a fragmentary view of the heating apparatus of Fig. 1 to show the preferable construction of the furnace at the draft inlet;

Fig. 3 is a view in side elevation of a control device employed in my system, the cover of the device being removed to show the operating and associated parts of the device;

Fig. 4 is a top plan view of the control device of Fig. 3;

Fig. 5 is a view taken along the line 5—5 of Fig. 4 showing certain of the mechanism of the control device in cross section;

Fig. 6 is a view in cross section taken along the line 6—6 of Fig. 5;

Fig. 7 is a view shown in longitudinal central cross section of the control device and taken along the line 7—7 of Fig. 4;

Fig. 8 is a perspective view of one of the parts of the control device;

Fig. 9 is a top plan view shown partly in cross section and partly in elevation, taken along the line 9—9 of Fig. 3;

Fig. 10 is a view of certain of the mechanism of the control device shown removed from the casing;

Fig. 11 is an enlarged view shown in cross section and taken along the line 11—11 of Fig. 9;

Fig. 12 is a view shown in cross section and taken along the line 12—12 of Fig. 11;

Fig. 13 is a fragmentary top plan view of the mechanism shown in Fig. 10;

Fig. 14 is a view of a stack damper and my damper actuating mechanism shown partly in elevation and partly in cross section, and

Fig. 15 is a view looking from left to right of the damper actuating mechanism of Fig. 14 and having casing portions broken away to show the arrangement of the operating and associated parts.

Referring to the drawings by characters of reference and first to Fig. 1, there is shown a heating apparatus, or furnace 1 having a fire box 2 in which a burner 3 is located, the burner 3 being of the gas burning type, in the present instance. Fuel may be supplied to the burner 3 through a suitable supply line, or pipe 4. Disposed adjacent the burner 3 there is a pilot light burner 5 for lighting the burner 3, fuel being supplied to the pilot light burner through a supply line, or pipe 6, which may be connected in the main supply line, as shown. The furnace 1 includes a bonnet 7 in which is connected the usual stack 8 for the passage of the products of combustion to a chimney (not shown) for discharge to outdoor atmosphere. As is more clearly shown in Fig. 2, the furnace 1 is constructed having an externally disposed, box-like structure 10 communicating with the fire box 2 through an opening in the side wall and at the base of the furnace 1, the box-like structure 10 having a top wall 11 provided with an opening constituting the draft inlet to the furnace. A plate-like damper member 12

controls the draft inlet opening and may be pivoted, or hinged at one of its edges to the box-like structure 10. In the present instance, the damper 12 is disposed within the box-like structure 10 and is adapted to swing inwardly and downwardly to open position, as shown in dotted lines, or to open the draft inlet opening. The damper 12 is automatically operated by mechanism of the control system to be hereinafter described.

Associated with the heating apparatus is my control system therefor, which comprises in general a fuel supply control device 13, a stack damper control device 14, a room thermostat 15, and a tilt switch 16. Referring first to the construction of the fuel supply control device 13, this device includes a valve body 17 having oppositely disposed tubular bosses 18 and 19 defining the inlet and outlet, respectively, of the body, and these bosses may be internally threaded for connection in the main fuel supply line 4. The control device 13 is located in the fuel supply line 4 between the point of connection of the pilot light fuel supply line 6 and the main burner 3. As shown in Fig. 7, the valve body 17 has the usual internal wall 20 between the inlet and outlet of the body, the wall 20 having a horizontal portion 21 in which there is provided a valve port 22 through which the gaseous fuel must flow to reach the main burner 3. The horizontal wall portion 21 preferably has an upwardly extending annular portion 23 around the valve port 22 to provide an upwardly facing seat for a reciprocal valve member 24. The valve member 24 controls flow of gaseous fuel through port 22 to the main burner 3, and preferably includes a seat disc 25 of resilient material for contact with the seat 23 to prevent leakage through port 22 when the valve member is seated.

The valve body 17 is formed having an upwardly extending tubular boss 26 that has an open upper end which is closed by an extension member 27. The extension member 27 preferably has a lower end portion externally threaded for screw threading into the upper end of the tubular boss 26, and an annular external flange 28 for seating on the upper end of the tubular boss. The valve member 24 includes a stem 29 which extends vertically upward through the tubular boss 26 and extension member 27, the extension member being centrally bored to receive the stem 29 and guide the reciprocal valve member 24. Mounted on the upper end of the extension member 27 there is a casing 30 into which an upper end portion of the valve stem 29 extends. The casing 30 is preferably rectangular in shape having a top wall 31, bottom wall 32, end walls 33 and 34, and side walls 35 and 36, which may be termed the front and rear walls respectively of the casing. The front wall 35 of the casing 30 is formed by a removable, plate-like cover that may be secured to the casing by screws, or by other suitable attaching means. Preferably the extension member 27 has an upper end reduced portion, as at 37, that extends through an aperture in the bottom wall 32 of the casing 30, the reduced portion 37 providing an upwardly facing annular shoulder on which the bottom wall 32 of the casing seats. The reduced portion 37 of the extension member 27 extends upwardly above the inner face of the casing bottom wall 32, and is preferably threaded to receive a nut 38 for rigidly securing the casing 30 and extension member 27 together.

An upper end portion of the valve stem 29, within the casing 30, is preferably externally threaded for receiving an internally threaded, tubular-shaped or cap-like member 39 that is preferably formed having an external annular flange 40 at its upper end to provide an enlarged, upwardly facing bearing surface. The extension member 27 has an enlarged bore 41 opening through its upper end, and disposed within bore 41 and seating on an upwardly facing shoulder therein is an abutment member 42 in the form of a washer having a central aperture through which the valve stem 29 extends. A coil spring 43 surrounds the valve stem 29 in bore 41 and has one end, or lower end, abutting the abutment member 42 and its other, or upper end, abutting the underside of the annular flange 40. The coil spring 43 is under compression tending, and operable to move the valve member 24 upwardly away from its seat, or toward open position.

The valve stem 29 has a centrally disposed, longitudinally extending, bored recess 44 that opens through the upper end of the stem and aligns with a relatively small and centrally disposed aperture in the upper end wall of the cap member 39. A coil spring 45 is disposed in the bored recess 44 with its lower end abutting the recessed end wall thereof and with its upper end abutting a disc member 46. The disc member 46 is disposed in the bore 44 and the outer edge or periphery of the disc slidably engages the wall of bore 44. The coil spring 45 urges and is adapted to hold the disc member 46 against the underside of the upper end wall of the cap member 39, in overlying relation with the aperture therethrough. A manually operable means is preferably provided for seating and holding the valve member seated, and may comprise a vertically extending stem 48 adjustably screw threaded in the top wall 31 of the casing 30 in overlying relation to the upper end of the valve stem 29, and in axial alignment therewith. An upper end portion of the stem 48 projects externally of the casing, through the top wall 31 thereof, and may be provided with a knob or thumb screw 50 for rotating the stem. When the stem 48 is rotated to move and seat the valve, the lower end of the stem passes through the aperture in the upper end of the cap member 39 and engages the movable disc member 46 which is moved downward compressing the coil spring 45. Through compression of the coil spring 45 the valve member 24 is moved downward, or toward its seat 23. It will be seen that the coil spring 45, when compressed, will serve to close the valve member 24 and hold it tightly against its seat, and due to its compressibility the spring 45 will also serve to prevent undue force being applied by the manual valve closing means, which might otherwise cause the resilient seat disc 25 to be cut, or otherwise damaged.

It is to be understood that in Fig. 1 my system is illustrated with the various devices thereof in the positions they will assume before the heating apparatus is started. Likewise, the positions of the operating parts of the control device 13, shown in other figures of the drawings, are in the positions they will assume before the heating apparatus is started. The control device 13 includes mechanism for throttling the valve member 24 in accordance with variations in the temperature of the heating apparatus, or furnace 1, and for seating the valve member with a snap-action, and holding the valve member seated in the event of an undue increase in furnace temperature above a selectable temperature. This

mechanism includes a temperature responsive power element, designated in general by the numeral 52, which is preferably mounted on the casing 30, externally thereof, and secured to the end wall 33 of the casing. The power element 52 includes a casing 53 that has an open end disposed toward the end wall 33 and overlying and closing an aperture or opening 54 in the end wall 33. The casing 53 is formed having an outwardly extending annular flange 55 at its open end for seating against the end wall 33, and in which flange apertures may be provided for receiving screws for rigidly securing the power element casing 53 to the main casing 30. A plate member 56 is positioned within and secured to the power element casing 53, the plate member 56 being disposed substantially parallel with the end wall 33 of casing 30. The plate member 56 is located adjacent the open end of the casing 53, or adjacent end wall 33, and is preferably formed having an annular flange 57 that is inturned relative to the casing 53 and engages the inner side wall thereof. The annular flange 57 is to be secured and hermetically sealed to the inner side wall of casing 53 so that the joint therebetween will be fluid tight, and to this end solder, or other suitable means may be employed. The plate member 56 has a centrally disposed opening or aperture therethrough, and secured and hermetically sealed to a border portion of the plate member 56, around the aperture therethrough, is one end of a bellows member 58. The bellows member 58 is disposed in the casing 53, with its axis substantially transverse to the plate member 56, and the free end of the bellows member 58 is secured and hermetically sealed to an end wall or plate member 60. The bellows member 58 and its casing 53 cooperate to provide an expansible chamber 61. A conduit or tube 62 communicates with the expansible chamber 61 and may have one end secured in, and suitably fixed to, the side wall of the casing 53. The other end of the tube 62 is connected to a temperature responsive element or bulb 63 which may be connected to and secured in the wall of the bonnet 7 of the furnace 1, see Fig. 1. The bulb 63, expansible chamber 61, and connecting tube 62 contain a fluid, such as methyl chloride, which is expansible and contractible in response to changes in temperature. Surrounding or wrapped around an end portion of the tube 62, adjacent its point of connection to the casing 53, there is preferably provided a coil of wire 64 for reenforcing the tube against breakage.

Carried by the movable end wall 60 of the bellows member 58 there is a thrust member 65 that extends centrally through the bellows and projects into the main casing 30 through the opening 54 in the end wall 33. The thrust member 65 may be suitably secured to the movable end wall 60 of the bellows 58 by providing the movable end wall with a centrally disposed aperture for receiving a reduced end portion of the thrust member, the end of which reduced portion may be peened over, as at 66, to tightly clamp the movable end wall 60 between the peened over portion 66 and the opposed annular shoulder formed by the reduced portion. Adjacent the movable end wall 60, the thrust member 65 is provided with an enlarged portion 67 providing a shoulder 68 which faces inwardly or toward the fixed end of the bellows 58. A sleeve member, or collar 69 is carried by the thrust member 65 and is slidably movable thereon and longitudinally thereof, movement of the collar being limited in a direction toward the movable wall 60 of the bellows 58 by the shoulder 68 of the thrust member 65. The collar 69 is preferably formed having an external annular flange 70, and surrounding the thrust member 65 there is a coil spring 71 that has one end in abutment with one side or face of the annular flange 70 of the slidable collar 69. The coil spring 71 acts to oppose compression movement of the bellows 58 and resultant inward movement of the thrust member 65. Positioned within the main casing 30 there is a cup-shaped adjustable abutment member 72 into which the other, or inner end of the coil spring 71 extends and abuts an end wall 73 of the abutment member. The adjustable abutment member 72 is provided with a centrally disposed aperture in its end wall 73 for slidably receiving the thrust member 65. The abutment member 72 is held in adjusted position by mechanism to be hereinafter described, and by said mechanism the abutment member may be movable longitudinally of the thrust member 65 to vary the force exerted by the spring 71 opposing compression of the bellows 58. The bellows 58 is shown in its expanded position, which is the position it will assume before the heating apparatus is started, but after the heating apparatus is started the bellows will be compressed and the shoulder 68 of the thrust member 65 will be in engagement with the slidable collar 69, which will be held against the shoulder by the spring 71.

The mechanism for adjusting and holding the spring abutment member 72 in adjusted position includes a lever member 74 that is pivotally supported within the casing 30 adjacent the top wall 31 and end wall 33 thereof. The shape of the lever member 74 is more clearly seen in the perspective view thereof, Fig. 8. The lever member 74 is of general U-shape, having a substantially horizontally disposed connecting side 75 immediately above or overlying the thrust member 65, and from which connecting side depend spaced, substantially parallel sides or lever arms 76. The sides or lever arms 76 straddle the thrust member 65 and also extend substantially parallel to the side walls of the main casing 30. Preferably the lever arms 76 are of general L-shape, as seen from a side view, Figs. 3 and 7, having portions 77 at their upper ends that extend toward the end wall 33 of the casing 30, adjacent which they have substantially parallel ears 78 that extend upward above the connecting side 75. The ears 78 are provided with aligned apertures for receiving a pin or shaft 80 on which the lever member 74 pivots, the shaft 80 being secured in the end wall 33 and extending longitudinally therethrough, as shown in Fig. 9. By pivotally supporting the lever member 74 at two spaced journal points on the shaft 80, it will be seen that rocking of the lever in planes through the longitudinal axis of the shaft is prevented. Adjacent their lower ends, the lever arms 76 are formed having extended edge portions 81 that extend toward the adjustable abutment member 72 and engage therewith. The cup-shaped abutment member 72 is preferably formed having an external annular flange 82 at its open end, and in the flange 82, at spaced opposite points in a plane substantially horizontally through the longitudinal axis of the thrust member 65, are provided indentations 83, see Fig. 3, for receiving the extended portions 81, the portions 81 preferably having pointed ends for seating in the indentations.

A manually operable means is provided for adjusting and holding the abutment member 72 in adjusted position through the lever member 74, and is supported by the top wall 31 of the casing 30 at a point immediately above the connecting side 75 of the lever member 74. In the top wall 31 of the casing 30 there is provided a vertically extending bore 85 that opens into the casing in overlying relation to the connecting side 75, an upper end portion of the bore, as at 86, being of enlarged diameter and opening through the upper outer wall surface of the top wall 31. A tubular member or shaft 87 is adjustably screw threaded in bore 85 and has an upper end portion that extends upwardly above the top wall 31 of the casing 30. A knob 88 may be secured to the upper end of the tubular member 87 for gripping with the hand to rotate the shaft. An upper portion of the tubular member 87 is preferably internally threaded to receive an adjustment member in the form of a screw 89. The adjustment screw 89 has a downwardly extending stem portion 90 of reduced diameter whose lower end abuts the head of a loosely disposed thrust pin 91 disposed within the tubular member 87 and extending longitudinally thereof. A lower end portion of the thrust pin 91 projects into the casing 30, and the lower end of the thrust pin 91 is preferably pointed to seat in an upwardly facing indented portion 92 in the upper face of the substantially horizontally disposed connecting side 75 of the lever member 74. The indented portion 92 is preferably located substantially midway between the depending lever arms 76. The tubular member 87 is preferably provided with a reduced internal bore portion adjacent its lower end, providing an upwardly facing shoulder 94 for engagement with the head of thrust pin 91 to limit downward movement of the thrust pin relative to the tubular member 87. It will be seen that through adjustment of the screw 89, whose lower end acts as an abutment member for the loosely disposed thrust pin 91, the position of the thrust pin relative to the tubular member 87 may be adjusted, or changed. The tubular member 87 is provided, adjacent its upper end, with an integral and external gear 96 whose teeth mesh with gear teeth provided on the outer edge of a rotatable dial or plate member 97 that lies flat against the top wall 31 of the casing 30. The dial plate 97 may be rotatable about a screw 98 threaded into the top wall 31, and preferably the top face of the wall 31 is slightly recessed to receive the dial plate. By rotating the tubular member 87 the lever member 74 will be pivoted, moving the spring abutment member 72 and thereby varying the force exerted by the spring 71 opposing inward movement of the thrust member 65. Thus, it will be seen that through adjustment of the position of the spring abutment member 72, the furnace bonnet temperature at which the power element is to overcome the spring 71 and move thrust member 65 inwardly can be selected. Suitable indicia may be provided on the dial plate 97, and on the top wall 31 there may be provided a fixed pointer 97a for cooperation with the indicia for indicating the furnace bonnet temperature at which the power element 52 will overcome the spring 71. Within the bellows 58, and surrounding the thrust member 65, there is preferably provided a relatively light coil spring 99 having one end abutting the movable end wall 60 of the bellows 58 and the other end abutting the slidable collar 68. The spring 99 maintains the adjustable abutment member 72 in engagement with the contact points of the lever member 74 when the control device is not in operation, as shown.

The power element 52 actuates the reciprocal valve member 24 through lever mechanism that is disposed within the casing 30 between the power element and the valve member, and this lever mechanism includes a lever member 100 which is pivotally supported on a shaft 101. The casing 30 is constructed having an upstanding wall portion or boss 102 adjacent the cover 35, Fig. 3, and in the wall portion 102 and opposite side wall 36 there are provided aligned apertures in which the ends of the shaft 101 are secured. The lever member 100 is formed having a pair of spaced, substantially parallel lever arms 103 and 104 that are integral and are joined by and depend from a connecting portion 105 that extends substantially parallel with the end walls of casing 30. The lever arms 103 and 104 are provided with aligned apertures adjacent their connecting portion 105 for receiving the shaft 101. The connecting portion 105 has a depending extended portion 106 substantially midway between the lever arms 103 and 104, the extended portion 106 having a wall surface disposed toward the end wall 33 and provided with a conical recess 107 to receive the pointed end 108 of the thrust member 65, see Figs. 7, 9 and 13. The lever member 100 includes a lever arm 109 that is integral with the connecting portion 105 and extends therefrom at a point adjacent the lever arm 104, or adjacent the rear wall 36 of the casing 30. The lever arm 109 extends substantially horizontally toward the opposite end wall 34 of casing 30, and has a portion of its free end overlying the upper end of the tubular member or cap 39 that is carried by the valve stem 29. Carried by the lever member 100 there is a leaf spring 110 which acts to hold the valve member 24 seated until the lever member 100 has pivoted through a predetermined angle in a counterclockwise direction, as seen in Figs. 3 and 7. The leaf spring 110 is disposed beneath and extends longitudinally of the lever arm 109 and has one end secured to the underside of the lever arm connecting portion 105. The leaf spring 110 is positioned so that a portion of its free end will bear on the upper face of the annular flange 40 of the valve member 24. Preferably the lever arm 109 is provided adjacent its free end with a downwardly projecting extended portion 111 which is adapted to engage with the upper face of the leaf spring 110 at a point overlying or bearing on the annular flange 40 of the valve member. When the lever member 100 is in the position shown in Figs. 3 and 7, the leaf spring 110 is held under tension and when the lever member 100 pivots slightly in a counterclockwise direction the force of the leaf spring holds the valve seated to prevent leakage of fuel through the valve port. As the lever member 100 moves in a counterclockwise direction the tension force on the leaf spring 110 is reduced and when the said force becomes less than the force exerted by the coil spring 43, the spring 43 will act to move the valve member to open position. The lever arm 109 is preferably formed having a downwardly extending reenforcing flange 112 that extends longitudinally of the lever arm and joins the lever arm 103. Adjacent its free end the lever arm 109 is provided with an extended portion or flange 113 having a horizontal flat or table portion 113', see Figs. 9 and

10, for a purpose to be hereinafter described. The flange portion 113 is integral with the flange 112, extending from the side face of flange 112 toward the side wall 36 of the casing 30.

Pivotally supported on the shaft 101 there is a second lever member 115. The lever member 115 is formed having a pair of spaced, substantially parallel arms 116 which are integrally connected by a horizontally extending connecting portion 117. The arms 116 extend upwardly from the opposite ends of the connecting portion 117 and are positioned between and extend longitudinally of the spaced arms 103 and 104 of the lever member 100. The connecting portion 117 is provided with a bore 118 that extends longitudinally therethrough for loosely receiving a pin 119 that has its opposite ends secured in aligned apertures provided in the lever arms 103 and 104 adjacent their lower ends. The diameter of the bore 118 is larger than the diameter of the pin 119 to provide for slight relative movement, or a lost motion connection between the lever members 100 and 115. The lever member 115 has an integral lever arm 120 that joins the connecting portion 117 and the lever arm 116 that is disposed toward the cover of the casing 30. The lever arm 120 extends upwardly from the connecting portion 117 and toward the valve stem 29, and has a substantially horizontally extending arm portion 121 that extends over the upper end of the valve stem for engagement with the abutment flange 40 thereof. The arm portion 121 extends in spaced, substantially parallel relation with the lever arm 109 and is positioned to engage the flange 40 at one side of the longitudinal axis of stem 29 and adjacent the cover 35. The lever member 115 has another and upwardly extending arm portion 122 that is integral with and joins arm 120 at the junction point of the horizontally extending arm portion 121. The arm portion 122 has an upper end portion 123 offset inwardly, or toward side wall 36, the offset portion being disposed substantially midway between the lever arms 103 and 104 and extending substantially parallel therewith. In the opposite faces of the offset portion 123 adjacent its upper end, are provided substantially conical recesses or sockets 125. The lever member 115 has laterally spaced, substantially parallel arms 126 which are secured one to each of the lever arms 103, 104 and extend upwardly therefrom. The arms 126 are secured to the arms 103, 104 by hinge members 127 in the form of resilient metal plates, preferably of phosphorous bronze, riveted or otherwise secured to the arms 103, 104 and arms 126, such that the arms 126 constitute flexible portions of the lever member 115. The free ends of the flexible arms 126 are provided with inwardly facing, substantially conical recesses or sockets 128, the recesses 128 and 125 being located preferably substantially in the same vertical plane, extending transverse of lever member 100. The levers 100 and 115 are connected by thrust members 129, preferably rods or pins, which terminate at their opposite ends in conical points 130 seating in the pairs of sockets 125 and 128. The pins 129 are held in position in engagement with the sockets 125 and 128, by the resilience of the hinge members 127 and by a tension spring 131 secured at its opposite ends to the flexible lever arms 126, urging the flexible arms toward each other. The spring 131 is preferably of the helical coil type terminating at its ends in hooks 132 engaged in an aperture in the flexible arms 126, the spring being held under tension between the portions 126 so that said portions are under tension but permitting them to move outwardly with respect to the lever arms 103 and 104 of lever member 100.

The bottom wall 32 of the casing 30 is preferably formed having a boss 134 disposed adjacent end wall 33 and substantially midway between side walls 35 and 36, the boss 134 being provided with a threaded bore 135 therethrough opening into the casing through the bottom wall 32. The axis of bore 135 is preferably angularly disposed relative to the bottom wall 32 of the casing 30 and extends upwardly toward the lever member 115. Screw threaded in bore 135 there is an adjustable stop member in the form of a screw 136 that projects into the casing 30 and has its inner end disposed for abutment with the laterally extending connecting portion 117 of the lever member 115. The stop member 136 limits movement of the lever member 115 in a clockwise direction, as seen in Fig. 7, but does not limit movement of the lever member 100 by reason of the lost motion connection between the lever members 100 and 115.

Carried by the lever arm 121, adjacent its free end, there is an adjustable abutment or bearing member in the form of a pin 137 which is arranged to engage or bear against the upper face of the flange 40 of the valve member 24, see Figs. 9 and 11. The lever arm 121 is formed having an enlarged portion 138 adjacent its free end for housing the adjustable bearing pin 137 and associated parts. The enlarged portion 138 is provided with a vertically extending bore 139 that opens through the upper end of the enlarged portion 138 and has a reduced bore portion 140 that opens through the underside of the enlarged portion 138, the reduced portion 140 providing an upwardly facing annular shoulder or seating surface 141. The bearing pin 137 has an enlarged portion or head 142 that positions in, and is slidably engageable with, the wall of bore 139 and has a reduced portion 143 that extends through, and is slidably engageable with, the reduced bore 140. The downwardly facing annular shoulder formed between the head 142 and reduced portion 143 is adapted to seat on the upwardly facing annular shoulder 141 to limit downward movement of the pin 137. A lower end portion of the pin 137 projects below the underside of the enlarged portion 138 and is preferably rounded, as at 145, to reduce friction between the end of the pin and the flange 40 of the valve member. Extending laterally through the enlarged portion 138 of lever arm 121 there is a bore 146 that intersects bore 139, and in the bore 146 there is a rotatable shaft 147. The rotatable shaft 147 is formed adjacent its inner end with an annular relieved portion 148 having a cam contour or face that overlies the upper end or head 142 of the bearing pin 137. The head of the bearing pin 137 engages the cam face 148 which acts as a stop for the pin, and it will be seen that by rotating the shaft 147 the vertical position of the pin 137 relative to the arm 121 can be changed. The enlarged portion 138 of the lever arm 121 is formed having a vertically extending boss having a bore 150 therethrough, that intersects the laterally extending bore 146 at right angles thereto and at a point adjacent the outer end of the shaft 147. In the vertical bore 150 there is a latch member 151 in the form of a pin or plunger whose lower end is preferably carried by and projects into a V-shaped annular groove 152 in the shaft 147 to limit longitudinal movement of the shaft. A coil spring 153 is disposed in bore 150 and has one end in abutment

with the upper end of the plunger 151 and its other end, or upper end, in abutment with the lower end of a set screw 154, the coil spring being held under compression by the set screw and urging the plunger 151 downwardly into engagement with the shaft 147. The outer end of the shaft 147 preferably has a head 155 which is disposed toward the casing cover 35 and may be provided with a slot to receive a screw driver, or other tool for rotating shaft 147 to adjust bearing pin 137. Preferably a fixed dial plate 156 and cooperative movable pointer 157 are provided for indicating the adjustment or setting of the adjustable bearing pin 137. The dial plate 156 may be held against the outer face of the enlarged portion 138 with the face of the dial being disposed toward the casing cover 35. The dial plate 156 has an aperture for receiving the shaft 147 and is held between the outer side face of the enlarged portion 138 and the pointer means 157 by means of the coil spring 153 which urges the shaft 147 inwardly. The pointer means 157 is fixed for rotation with the shaft 147 and is disposed between the head 155 of the shaft and the dial plate 156.

The casing 30 is formed having a wall portion 160 at its open side, or adjacent the cover 35, the wall portion 160 joining the top wall 31 and end wall 34 and being substantially parallel with the side or rear wall 36. In the wall portion 160 is secured one end of a stub shaft 161 that extends within and across the casing 30 adjacent to, and substantially parallel with, the end wall 34. A lever member 162 is pivotally supported on the stub shaft 161, the lever 162 being of the bell crank type, in the present instance, having lever arms 163 and 164. The lever arm 163 extends longitudinally of the casing 30 and has an end portion which overlies and is adapted to engage or bear against the upper face of the lever arm 109 of the lever member 115. The lever 162 is pivoted to the stub shaft 161 at a point substantially midway between the side walls and the top and bottom walls of the casing 30. A coil spring 165 acting through the bell crank lever 162 is adapted to close or seat the valve member in the event that the pilot light burner 5 becomes extinguished. In the top wall 31 of the casing 30, adjacent the end wall 34, there is provided an aperture closed by a closure plug 166, the closure plug 166 preferably having a lower end portion 167 projecting into the casing 30. One end, or upper end of the coil spring 165 surrounds the lower end portion 167 of the closure plug 166, the end portion 167 serving to hold the upper end of the spring against lateral movement. Seated in the other, or lower end of the spring 165 there is an abutment member 168 which has a central aperture for receiving a thrust member 169. The thrust member 169 preferably has a tapered or conically formed end 170 that is adapted to seat in a conical recess 171 provided in the upper face of the lever arm 163 adjacent the pivot point of the bell crank lever 162. The thrust member 169 preferably includes a stem portion which extends centrally and longitudinally through the coil spring 165 and has its free end extending into a centrally bored recess 173 in the closure plug 166. The lever arm 164 of the bell crank lever 162 extends downwardly and toward the adjacent end wall 34 of the casing 30.

Mounted on the casing 30 and secured to the end wall 34, externally of the casing, there is provided a power element, designated in general by the numeral 175, which acts to prevent the spring 165 from closing the valve member 24 as long as the pilot light burner 5 remains lighted. The power element 175 includes a tubular or cup-shaped casing 176 having one end open and disposed toward the end wall 34 of the main casing 30, the end wall 34 having an opening 177 therethrough which is closed by the power element casing 176. Preferably the power element casing 176 has an outturned annular flange 178 at its open end which seats against the outer face of the end wall 34 and is provided with apertures for receiving screws 179 for rigidly securing the power element casing 176 to the main casing 30. Fitting or telescoping within the power element casing 176, and located adjacent its open end, there is a plate member 180 which preferably has an annular flange 181 whose outer face engages the inner wall of the casing 176. The plate member 180 is to be secured and hermetically sealed to the inner wall surface of the casing 176 by solder, or other suitable means, so that there will be a fluid-tight joint between the outer face of the annular flange 181 and the inner wall of the casing 176. The plate member 180 is provided with a centrally disposed aperture, and secured and hermetically sealed to a border portion around the aperture is one end of a metallic bellows member 182. The bellows member 182 is disposed within the casing 176 and has its other, or free end closed by an end wall or plate member 183 which is secured and hermetically sealed to the free end of the bellows member. Secured to, and carried by the movable end wall 183 of the bellows member 182 there is a thrust member 184 which extends centrally through the bellows and projects into the main casing 30. The free or inner end of the thrust member 184 is preferably pointed or conical in form, as at 185, for seating in a conical recess provided in the arm 164 of the bell crank lever 162.

The bellows member 182 and casing 176 cooperate to provide an expansible pressure chamber 186, and communicating with the chamber 186 is one end of a tube or conduit 187 which may be secured in and to the side wall of the casing 176 in any suitable fluid-tight manner. The other end of the tube 187 is connected to a temperature responsive element or bulb 188 which is disposed in heat transfer relation with the flame of the pilot light burner 5, Figs. 1 and 3. In the present instance, the temperature responsive element or bulb 188 is in the form of a tube or conduit which is coiled or wrapped around a shield member 189 that overlies the pilot burner flame. The temperature responsive element 188, pressure chamber 186, and connecting conduit 187 contain a quantity of fluid, such as aniline, that is expansible and contractible in response to changes in temperature. When the pilot light burner 5 is lighted, the expansible-contractible fluid will be expanded and will exert its force against the movable end wall of the bellows member 182. The bellows member 182 will be compressed, transmitting the force of the expanded fluid through the thrust member 184 to pivot the bell crank lever 162 in a clockwise direction, to the position shown in dotted lines in Fig. 7. The force exerted by the power element 175 when the pilot light is lighted, is greater than the force exerted by the spring 165 so that the spring is compressed and the lever arm 163 is held out of engagement with the valve member 24 during normal operation of the system, or when the pilot light is lighted.

Integral with the side wall 36 of the main casing 30, and disposed adjacent the end wall

34, there is an externally and laterally extending boss 190, and through the boss 190 and side wall 36 there is a bore in which a shaft 191 is journaled for rotation, see Fig. 9. The shaft 191 is disposed with its axis of rotation aligned with stub shaft 161 and substantially parallel with the casing end wall 34, and has an inner end portion that projects into the casing 30. A lever member 192 is disposed in the casing 30 and is secured at one end to the shaft 191 for movement therewith. The lever member 192 extends longitudinally of the casing 30 and has a portion of its other, or free end provided with a downward extending toe or boss overlying and adapted to bear on the table portion 113' of flange 113 of the lever arm 109 to actuate the valve member 24. The shaft 191 has an end portion that projects externally of the casing 30 and boss 190 and is provided with a square shank 193, see Fig. 5, which receives and has secured thereon the polygonally apertured end of a lever member 194 that pivots or moves with the shaft 191. Pivotally connected to the free end of the lever member 194 is one end of a connecting link, or rod 195, see Fig. 1, the other end of the connecting link being connected to the inlet draft damper 12 of the furnace 1. When the lever 194 pivots in a counterclockwise direction, as seen in Fig. 1, the damper 12 is closed and conversely, when the lever pivots in a clockwise direction the damper 12 swings downward by gravity to open position.

Mounted on the casing 30 there is a heat motor 195a that actuates the valve member 24 through operation of the lever member 192, the heat motor being controlled by the room thermostat 15. When the room thermostat is dissatisfied the heat motor acts to permit the valve 24 to be moved to open position by the coil spring 43, and when the thermostat becomes satisfied the heat motor acts to seat the valve. The heat motor, see Fig. 5, includes a casing 196 that is preferably a casting having a top wall 197, bottom wall 198, side walls 199, 200, and end walls 201, 202. The side wall 199 is disposed toward and adjacent the side wall 36 of the main casing 30, and the two casings may be secured together by screws 203, or by other suitable means. The heat motor includes a power element which in turn includes a casing 204 that telescopes or fits into the casing 196. The casing 204 has one end, or its outer end, closed by an end wall 205 that is disposed substantially flush with the end wall 202 of casing 196, the end wall 202 being provided with an opening through which the casing 204 is positioned within casing 196. The other, or inner end of the casing 204 is open and terminates substantially midway between the end walls of the casing 196, and disposed within the casing 204 adjacent its open end, there is a plate member 206 that extends substantially transverse to the side wall of casing 204. The plate member 206 is formed having an annular inturned flange 207 that conforms in contour and positions with its outer periphery flat against the inner side wall of the power element casing 204. The flange 207 may be secured to the inner wall surface of casing 204 by solder, or by other suitable means, to provide a fluid-tight joint therebetween. The plate member 206 is provided with a centrally disposed aperture therethrough and secured and hermetically sealed to a border portion of the plate, around its aperture, is one end of a bellows member 208. The bellows member 208 extends longitudinally through the casing 204 having its other, or free end disposed toward the closed end of casing 204, and secured and hermetically sealed to the free end of the bellows is a movable wall or plate member 209. The bellows 208 and casing 204 cooperate to provide an expansible chamber 210.

Secured to the end wall 202 of casing 196 there is an L-shaped bracket 211 that has a vertically extending plate portion or leg 212 overlying and closing the opening in end wall 202. The bracket 211 may be secured to the casing 196 by screws, or by other suitable means. The inner face of the plate portion or leg 212 abuts the end wall 205 of casing 204 and is preferably secured thereto by solder, or by other suitable means, to prevent inward movement of the casing 204. The L-shaped bracket 211 has a horizontally and outwardly extending plate portion or leg 213 at its upper end, and secured to and depending from the underside of the horizontal leg 213 there is a tubular casing 214. The upper end of the tubular casing 214 is open and has an annular flange 215 that seats against the underside of the horizontal bracket, or leg 213. The annular flange 215 may be provided with apertures to receive screws for rigidly securing the tubular casing 214 to the bracket 211. Disposed within the casing 214 and extending longitudinally thereof, is a bulb element 216 which is connected in communication with the expansible chamber 210 by a conduit or tube 217. A slot 218 is provided in the side wall of the bulb element casing 214, extending longitudinally thereof, through which the tube 217 projects, externally of the casing, for connection in the end wall 205 of casing 204. In the bulb 216, expansible chamber 210, and connecting tube 217 there is contained a quantity of fluid that is expansible and contractible in accordance with changes in its heat content, such as methyl chloride.

Surrounding or wrapped around the bulb element 212, adjacent the upper end thereof, is a coil of wire 219 having a high resistance of flow of current therethrough so as to generate heat. Disposed within the casing 214 and surrounding the coil of resistance wire 219 there is preferably provided a polished metallic reflector 219a for reflecting the heat given off by the resistance coil and directing the heat toward the temperature responsive bulb 216. The heat generated by current passing through the resistance coil 219 heats the fluid in bulb 216 and the fluid expands, exerting its force to compress the bellows 208. Mounted on the horizontal leg 213 of the bracket 211 there is a block of electric insulating material 220 which may be formed of Bakelite, or other suitable material, and which may be secured to the leg 213 by screws 221, or by other suitable means. Secured in the insulating block 220 there is a pair of terminal posts 222 to which the ends of the resistance wire 219 are attached and may be secured by solder, or by other suitable attaching means. The terminal posts each have a binding post in the form of a screw 223. Overlying the block 220 and enclosing the terminal posts 222 there is a conduit outlet box 224 having an outlet opening 224a.

The movable end wall 209 of the bellows 208 is provided with a centrally disposed aperture for receiving an end portion of a tubular shaped, or longitudinally bored collar 225 that is secured thereto. The collar 225 has a shank portion that projects into the bellows 208 and has an external annular flange 228 that seats against the inner face of the movable wall 209. The collar 225 may be rigidly secured to the end wall 209 in a leak-

proof manner by peening over the end portion of the collar to tightly clamp the movable end wall 209 between the flange 228 and the peened over portion. Secured and sealed in the bore of the collar 225 is one end of a filler tube 230 through which the expansible-contractible fluid is introduced into the pressure chamber 210. After the fluid has been introduced into the pressure chamber the tube 230 is severed and the severed end sealed by solder, or by other suitable sealing means.

Disposed within the casing 196 and extending longitudinally thereof is a thrust member which includes a rigid tube 232 having an end portion extending centrally through the bellows 208 and surrounding the filler tube 230 and collar 225. An inner end portion of the rigid tube 232 is internally threaded to receive an externally threaded tubular abutment member 233 that abuts the flange 228 of the collar 225. The diameter of the bore through the tubular abutment member 233 is larger than the diameter of the shank 226 of the collar 225 to permit lateral movement, or canting of the rigid tubular member, for a purpose to be hereinafter described. The other, or outer end of the tubular member 232 is disposed adjacent the end wall 201 of casing 196, and carried by the tubular member at its outer end there is a connecting member or link 235. The tubular member 232 is formed at its outer end having an end wall provided with a centrally disposed aperture through which the connecting member 235 extends, the connecting member having an external annular flange or head 236 positioned in the tubular member 232 and adapted to abut the end wall thereof. The connecting member 235 projects externally of the tubular member 232 and its outer end is bifurcated to receive an upstanding arm portion 237 of the lever member 194. The lever member 194 and the bifurcated end portion of the connecting member 235 are provided with aligned apertures to receive a pivot pin for pivotally connecting the lever member 194 and the connecting member 235. Disposed within the tubular member 232 and extending longitudinally thereof there is a coil spring 238 that has one end in abutment with the head 236 of the connecting member 235, and its other end in abutment with the abutment member 233 of the tubular member 232. The coil spring 238 is under compression and acts to maintain the head 236 of the connecting member 235 in engagement with the end wall of the tubular member 232. The connecting member 235 is movable relative to the rigid tube 232 so that in the event the lever 194 is manually operated when the bellows 208 is under pressure, the bellows will not be injured.

Disposed within the casing 196 adjacent the end wall 201 thereof, there is a holding means that opposes the heat motor and acts to seat and hold the valve member seated, and this holding means includes a tubular member 240. The tubular member 240 has an outer end portion 241 which is preferably conical in shape and projects externally of the casing 196 through an opening 242 in the end wall 201 of the casing. The conical shaped end portion 241 of the tubular member 240 has an opening in its underside through which the upwardly extending arm portion 237 of lever 194 projects into the tubular member. The arm portion 237 has an extended portion 243 that extends outwardly and toward the apex of the conical shaped end portion 241, the end of the extended portion 243 bearing against a seat member 244 that is secured in the conical portion substantially at the apex thereof. Surrounding the tubular member 240 within the casing 196 there is a coil spring 245 that has one end abutting wall 201 and its other end abutting an external annular flange 246 formed on the inner end of the tubular member 240. The coil spring 245 is under compression and acts to move the tubular member 240 inwardly to pivot the lever arm 194 in a clockwise direction, as seen in Fig. 5. Pivotal movement of the lever 194 in a clockwise direction rotates shaft 191 and the lever 192 until the valve member 24 is seated, and the spring 245 holds the valve member seated until overcome by the heat motor.

When the heating coil 219 of the heat motor is energized the fluid in bulb 216 will be heated and will expand, with accompanying increase in pressure acting to compress the bellows 208. When the force exerted by the expanded fluid acting on the bellows 208 overcomes the opposing force exerted by the spring 245, the bellows will compress and move the thrust member to rotate the lever 194 in a counterclockwise direction, which will move lever 192 away from the valve member 24 permitting spring 45 to move the valve to open position. The lever member 194 is formed having a lateral flange 247 at its lower edge for abutment with an external boss 248 formed on the side wall 36 of the main casing 30 to limit pivotal movement of lever 194 when the lever is actuated by the heat motor.

Carried by the lever arm 194 is the tilt or pendulum switch 16. The tilt switch 16 is housed in a casing 250 that is preferably a casting of rectangular shape having a top wall 251, bottom wall 252, side walls 253, 254, and end walls 255, 256. The side wall 253 is formed by a removable closure member or cover in the form of a plate that may be secured to the casing 250 by screws, or by other suitable means. The casing 250 is formed having integral and oppositely extending external ears or flanges 257 and 258 that extend from opposite end walls of the casing and are flush with the side wall 254. The flanges 257 and 258 lie flat against the side of lever 194 and are provided with apertures for receiving screws 259, 260 which thread into the lever arm 194 to rigidly secure the casing 250 to the lever. The aperture in the flange 257 is preferably in the form of a slot, as shown, so that the position of the casing 250 relative to the lever arm 194 can be adjusted. Integral with the side wall 254, adjacent the top wall 251, there is an external tubular boss 260^a. Fixedly secured in the boss 260^a and projecting into the casing 250, there is a supporting member 261 in the form of a rod, or pin. The supporting pin 261 extends across the casing 250 to the side wall 253, and intermediate its ends and within the casing 250, the pin 261 is provided with an upwardly directed edge 262.

Disposed within the casing 250 and extending longitudinally thereof there is an oscillatory member or pendulum 263 that is supported for swinging movement from one position to another to make and break circuit in accordance with movement of lever arm 194. The oscillatory member 263 is pivotally supported at its upper end on the pin 261, and depends therefrom. The oscillatory member 263 is provided with an aperture or bore 264 therethrough for receiving the pin 261, the bore being larger than the pin. The wall of bore 264 is formed having an upwardly converging portion that converges to an apex

providing a V-shaped recess that extends along the face of the bore, from end to end, and seats on the upwardly directed bearing edge 262 of the pin 261.

Disposed within the casing 250 there is a jumper strip 266 in the form of an L-shaped plate member that has a vertically extending portion or leg which is positioned flat against the inner surface of end wall 256. The L-shaped jumper strip 266 has a horizontal leg portion 267 that extends from end wall 256 toward end wall 255 beneath the lower end of the oscillatory member 263. The jumper strip 266 may be secured to the wall 256 by a screw 268, and clamped or secured under the head of the screw 268, externally of the casing 250, there is another jumper strip 269 to which one end of a jumper wire 270 is connected and may be secured, such as by solder. Adjustably screw threaded in the side wall 256 and through a threaded aperture in the vertical leg of the jumper strip 266 there is a contact member 271 that has an inner end portion projecting into the casing 250. Carried by the oscillatory member 263 there is a metallic contact strip 272 that extends longitudinally of the member 263 and is disposed toward, or faces, the end wall 256 of the casing 250. The contact strip 272 may be secured at its upper end to the member 263 by screws 273, or by other suitable means. Carried by the strip 272 adjacent its lower end, there is a contact member 275 which is positioned to engage with the inner end of contact member 271. When the valve member 24 is being held in closed position by the spring 245, as shown in the drawings, the contact member 275 carried by the oscillatory member 263 is in engagement with the contact 271. To insure positive engagement of the tilt switch contacts there is preferably provided a permanent magnet 276 that may be carried by the oscillatory pendulum member 263. The magnet 276 may be adjustably screw threaded into a threaded bore, in and adjacent the lower end of the pendulum member 263, and may have one end disposed toward and adjacent the vertical leg of the L-shaped jumper strip 266. When the power element acts to open the valve member, and in doing so pivots lever 194, the oscillatory member 263 remains in its vertical position while the casing 250 tilts and contact member 271, carried by the casing, moves away from contact 275 to break circuit. Threaded into the outer end of the supporting member or pin 261 there is a binding post in the form of a screw 276a on the head of which is secured one end of a jumper wire 277. Secured to the end wall 34 of the main casing 30 there is an L-shaped bracket 278 that has a horizontally disposed portion or leg 279 on which is mounted a block or pad of electric insulating material 280, such as Bakelite. A pair of vertically extending, spaced terminal posts 281, 282 are mounted on the bracket 278 and have their lower ends secured in and to the electric insulating material 280. The other ends of the jumper wires 270 and 277 are respectively connected to the terminal posts 281, 282.

The operation of the power element 52 and associated mechanism that actuates the valve member 24 in response to furnace bonnet temperature is as follows: As previously mentioned, when the room thermostat 15 becomes dissatisfied the heat motor is energized and when the force exerted by the heat motor plus the force of valve spring 43 and the lever-moving component of force of spring 131 slightly exceeds the opposing force of the spring 245, then the lever arm 192 will be lifted or turned counter-clockwise, facing Fig. 7, so that the spring 43, if not opposed by arm 163 and rod 65, can move the valve toward open position. When the force exerted by the spring 245 is overcome, the initial movement of lever 192 will permit the coil spring 131 to move the outer ends of pins 129 toward each other thereby forcing the lever member 100 in a counterclockwise direction, as seen in Figs. 3 and 7, so that the lever arm 109 will move upward with the arm 192 and will soon move out of direct engagement with the valve member. For a slight movement of the lever member 100, the tension leaf spring 110 exerts a greater force than the valve opening coil spring 43, with the result that the valve member is held seated during the initial movement of the lever member 100. However, initial pivotal movement of the lever member 100 and its arm 109 in a counterclockwise direction resulting from the force exerted by spring 131, causes an increase in the component of force of the spring 131 acting through pins 129 to pivot the lever. As the active component of the spring 131 increases with each increment of movement of lever 100, it will be apparent that the initial force required to overcome spring 245 is suddenly increased so that lever member 100 is pivoted and arm 109 is lifted with a snap action. Lever arm 109 being thus moved quickly away from holding engagement with the valve member and thereby releasing the inherent force exerted by the resilience of the leaf spring 110, the valve member is opened with a snap action by the quickly unleashed potential force of the compressed coil spring 43. The spring 131 yieldably holds the lever members 100 and 115 for movement in unison, and urges the lever members to pivot in opposite directions, the movement of member 115 however being limited to stop screw 136 and relative movement of the lever members being limited by the pin 119 which acts as a stop by engagement with the wall of aperture 118. When the movement of lever member 100 is limited by pin 119, then spring 131 will be ineffective to continue the valve opening movement, which will however be continued by the valve spring 43 as the force of the expanding fluid in the heat motor unaided by the force of spring 131 becomes equal to and overcomes spring 245. As the furnace temperature increases by reason of the operation of the burner supplied by valve 17, the expansible fluid of the power element 52 exerts an increasing force acting through the thrust member 65 and the lever members 100 and 115 to move the valve member toward closed position. The temperature responsive element, through the lever members 100 and 115, throttles the valve member in accordance with changes in furnace bonnet temperature, and it is to be understood that during the throttling of the valve member only the lever member 115 is in engagement with the valve member, the bearing point of lever member 100 being slightly spaced from and above the bearing flange 40 due to the prior described relative movement of members 100 and 115. During the throttling action the levers 100 and 115 pivot in unison by reason of the holding spring 131, but if the bonnet temperature continues to rise above a predetermined desired degree, the lever member 115 will be prevented from further pivotal movement in a valve closing direction by the stop member 136. The furnace bonnet temperature at which the lever member 115 will engage its stop is determined by the adjustment of the spring abutment member 72. When the lever member 115 engages its stop member 136 the valve member 24 may or may not be seated, and the

effective flow capacity of the valve port 22 will depend upon the adjustment of the adjustable thrust pin or bearing member 137 of lever 115. If the adjustable bearing member 137 is in the position shown in Figs. 11 and 12, with pointer 157 as in Fig. 3 wherein member 137 is being held in its lowermost or extended position, the valve member will be slowly throttled closed by the power element 52 and will be seated when the lever member 115 is in engagement with its stop. If the adjustable bearing member 137 is set at the other extreme, or uppermost position with pointer 157 directed toward wall 33, the valve member will not be seated when the lever member engages its stop member 136. This last mentioned position of the valve member 24 may be termed the minimum throttle position of the valve since the range of throttle is increased as the position of the pointer 157 is moved clockwise and toward the right, facing Fig. 3. That is to say, by moving the bearing member adjustment means so that the pointer 157 moves to the right, Fig. 3, the valve member will be closer to its seat when the lever member 115 engages its stop. If for some reason the bonnet temperature continues to increase after the valve has been moved toward closed position, such that the lever member 115 is in engagement with its stop 136, the power element will act to overcome the opposing force created by the holding spring 131. When the force of the power element slightly exceeds the component force of the spring 131 the lever member 100 will begin to pivot in a clockwise direction, as seen in Figs. 3 and 7, and as the outer ends of the thrust pins 129 move toward alignment with their inner ends, the component force of spring 131 rapidly decreases with the result that the lever member 100 is pivoted with a snap action. The lever arm 109 moving with the lever 100 engages with the flange 40 of the valve member and thus the valve is closed, or seated with a snap action. It is to be understood that the valve is actuated with a snap action only when the bearing member 137 is set in other than its lowermost or fully extended position. When the furnace bonnet temperature decreases to a predetermined temperature the spring 131 will pivot lever member 115 in a counterclockwise direction, as seen in Figs. 3 and 7, and will permit the valve to be opened by the spring 43 with a snap action.

Referring now to my damper and automatic damped actuating means shown in Figs. 1, 14 and 15, this apparatus includes a pipe or flue section 285 in which a rotatable damper 286 is disposed for controlling flow therethrough, the flue section being interposed in the furnace stack 8. The flue section 285 is preferably a casting having an external and vertically extending flange 287 in the form of a plate providing a mounting on which the damper actuating mechanism and associated parts are mounted as a unitary structure. A supporting member or terminal board 288 is mounted to, and flat against the vertically extending flange 287 and this terminal board may be constructed of Bakelite, or other suitable electric insulating material. The damper actuating mechanism includes a heat motor that has a supporting member, preferably an open-ended casing 289 that has one end abutting and closed by the terminal board 288. The other, or opposite end of the casing 289 may be closed by a removable closure member or cover in the form of a plate 290 that may be secured to the casing by screws, or by other suitable attaching means. The casing 289 may be provided with ears or flanges 291 having apertures for receiving screws that may extend through apertures in the terminal board 288 and thread into the flange 287 to tightly clamp and rigidly secure the flue, board, and casing together.

The flue section 285 is preferably formed having oppositely and outwardly extending tubular bosses 292 and 293 that are integral with the side wall of the flue section and are disposed with their axes in substantially horizontal alignment. Screw threaded into the bosses 292, 293 there are preferably provided removable tubular bearing members 294 and 295 respectively. The bearing member 295 is in alignment with, and in the present instance has an outer end portion that projects into an aperture 296 through the flange 287 of the flue section 285. Journaled for rotation in the bearing member 295 there is a stub shaft 297 which projects into and transverse of the flue section 285. Journaled for rotation in the other bearing member 294 there is a stub shaft 298 that has an inner end portion projecting partway into the flue section 285 in axial alignment with the shaft 297. Secured to the inner end portion of the shafts 297, 298 is the damper 286 which may be secured thereto by rivets 299, or by other suitable means. The stub shaft 298 projects externally of the flue section, and beyond the outer end of the tubular boss 290, and to its outer end there is preferably secured a handle 300 for manually actuating the damper 286.

The heat motor casing 289 is preferably a casting having a top wall 302, bottom wall 303, and side walls 304 and 305. The casing 289 is formed having two integral and externally extending tubular bosses 306 and 307 that are oppositely disposed and open into the casing through the side walls 304 and 305, respectively, and adjacent the top wall 302. An L-shaped bracket 308 is secured to the outer end of the tubular boss 306, the L-shaped bracket having a vertically extending plate portion or leg 310 that overlies and closes the outer end of the boss 306, and having an outwardly extending horizontal plate portion or leg 311. Carried by the L-shaped bracket, as a unitary structure, is the heat motor which includes a power element that in turn includes a tubular casing 312. The tubular casing 312 positions in the tubular boss 306 and has its inner end projecting into the casing 289, the inner end wall, as at 313, having a centrally disposed aperture therethrough. The other, or outer end of the power element casing 312 is open, and a portion of its side wall at said open end, projects and is secured in a continuous recess provided in the inner face of the vertical leg 310 that overlies the outer end of the tubular boss 306. The power element casing 312 may be secured to the vertical leg 310 by solder, or by other suitable means for sealing in a fluid-tight manner.

Disposed within the power element casing 312 there is a metallic bellows member 314 that has one end secured and hermetically sealed to a border portion of the end wall 313, around the aperture therethrough. The other end of the bellows 314 is secured and hermetically sealed to a movable end wall, or plate member 315. The bellows member 314, its casing 312, and the vertical leg 310 of the L-shaped bracket 308 cooperate to provide an expansible pressure chamber 316. Secured to the underside of the horizontally extending leg 311 of bracket 308 there is a tubular casing 317 that depends therefrom. The upper

end of the casing 317 is open and has an outturned annular flange that may be provided with apertures for receiving screws for rigidly securing the casing to the bracket 308. Disposed within the casing 317 there is a temperature responsive element or bulb 318 that extends longitudinally of the casing, in the present instance. A tube or conduit 319 provides communication between the interior of the bulb 318 and the expansible chamber 316. One end of the tube 319 may be secured to and in the lower end of the bulb element 318, and the other end of the tube may be secured to and in the vertical leg 310 of the L-shaped bracket 308. The bulb casing 317 is provided with a slot 320 extending longitudinally thereof, through which the tube 319 projects externally of the casing. The expansible chamber 316, tube 319, and bulb 318 contain a temperature responsive, expansible contractible fluid which may be methyl chloride.

Surrounding or wrapped around an upper end portion of the bulb 318 there is a coil of wire 321 that has a high resistance to passage of current therethrough so as to generate heat to heat the fluid in the bulb. Disposed within the bulb casing 317 and surrounding the resistance coil 321 there is preferably provided a shield or reflector member 323 for reflecting the heat given off by the resistance coil 321, and directing the heat toward the bulb 318. Mounted on, and secured to the top face of the horizontal leg 311 of the bracket 308, there is a block or pad of electric insulating material 324 which may be Bakelite. A pair of terminal posts 325 have their ends secured to and in the insulating material and attached, one to each terminal post, are the ends of the coil of resistance wire 321.

Secured in and projecting centrally through the movable wall 315 of the bellows 314 there is a collar 326. The collar 326 is provided with a central bore longitudinally thereof, in which is inserted and secured one end of a filler tube 327 through which the expansible-contractible fluid is introduced into the power element. The collar 326 is formed having a shank portion that projects into the bellows 314, and sleeve-fitted over the shank portion there is a loosely disposed abutment member 328 that is externally threaded for screw threading into one end of a rigid tube 330. The tube 330 extends centrally through the bellows 314 and projects through the inner end wall 313 of the bellows casing 312 and into the casing 289. Carried by the tube 330, at its inner end, there is a thrust member 331 that has a head within, and adapted to abut the innner end wall of the tube, and has a shank portion that projects externally of the tube and into the casing 289. The thrust member 331 is slidable longitudinally of the tube 330 and is yieldably held against the end wall of the tube by a coil spring 332. The coil spring 332 is disposed within the tube 330, having one end abutting the abutment member 328 and the other end abutting the inner end of the head of thrust member 331. The coil spring 332 is under compression and is adapted to transmit movement of the bellows 314 to the thrust member 331, but in the event the damper 286 is manually operated against the force of the power element, the spring yields to prevent rupture of the bellows.

The tubular boss 307 of the casing 289 is preferably internally threaded for receiving an externally threaded closure plug 334. The closure plug 334 is provided with an axially extending bore 335 that extends therethrough, and slidably supported in the bore 335 there is a thrust member 336. The outer end of the thrust member 336 is preferably provided with an external annular flange or head 337, for abutment with the end wall of the closure plug 334 to limit inward movement of the thrust member 336. The thrust member 336 projects into the casing 289, preferably in axial alignment with the thrust member 331, and the inner end of the thrust member 336 is preferably pointed, as at 338. Adjacent its inner end the thrust member 336 is provided with an external and outwardly facing shoulder against which an abutment member 340 is adapted to seat, the abutment member 340 having a centrally disposed aperture for receiving the thrust member 336 and being slidably movable longitudinally thereof. The abutment member 340 is cup-shaped, in the present instance, and has an external annular flange 341. Surrounding the thrust member 336 there is a coil spring 342 that has one end in abutment with the external annular flange 341 of the abutment member 340, and has its other, or outer end in abutment with the inner end of the closure plug 334. The spring 342 is under compression acting to urge the thrust member 336 inwardly. Integral with and depending from the underside of the top wall 302 of casing 289 there are a pair of spaced arms or bosses 344 that are positioned above and between the inner ends of the thrust members 331 and 336. The arms 344 are provided with aligned apertures for receiving a pivot pin or shaft 345 that extends substantially transverse to the longitudinal axes of the thrust members. A lever member 346 is pivotally supported at one end on the shaft 345 and depends therefrom, between the opposed pointed ends of the thrust members 331 and 336. The lever member 346 is preferably in the form of a plate, and preferably has side reenforcing flanges 348 longitudinally thereof that are provided adjacent their upper ends with apertures for receiving the shaft 345 to pivotally support the lever 346. As shown in Fig. 14, the lever member and one of its side flanges have cut-out portions to provide clearance for parts to be hereinafter described. Rigidly secured in and to the lever member 346, adjacent and beneath the shaft 345, there is an abutment member 349 that is preferably provided with conical recesses in opposite faces for receiving the pointed ends of the thrust members 331 and 336.

The inner end of the damper shaft 297 preferably has a square shank 350 that projects into the casing 289, and secured to the shank there is a lever member in the form of a disc or plate 351. Carried by and secured to the disc 351 there is a connecting pin 352 that projects laterally from the disc and toward the cover 290 of casing 289. In the lower end of one of the side flanges 348 of the lever 346, there is provided a slot 353 for receiving the pin 352. A stop member in the form of a pin 354 has one end screw threaded into the flange 287 of the flue section 285, and projects into the casing 289 for abutment with the disc 351 to limit rotation of the disc in either a clockwise or counterclockwise direction. The outer edge of the rotatable disc 351 has a cut-out portion, in the present instance, providing two abutment edges 355 and 356 for abutting the stop member 354, the abutment edge 355 being adapted to abut the stop member to limit rotation in a clockwise direction, and the edge 356 being adapted to abut

the stop member 354 to limit rotation in a counterclockwise direction.

Disposed within the casing 289 there is a switch means that is actuated by the heat motor when the heat motor actuates the damper, and this switch means includes a pair of contact strips 357 and 358 that may be secured at their upper ends to the terminal board 288 by rivets 359, or by other suitable means. A pair of downwardly facing contact members 360 and 361 are secured to the lower ends of the contact strips 357 and 358, respectively. Secured to the square shank 350 of the shaft 297 there is a plate member 362 to which is secured one end of a contact strip, or switch arm 363 that carries two upwardly facing contact members 364 and 365 that are adapted to make contact with the contact members 360 and 361 respectively.

The operation of the damper actuating mechanism is as follows: When the resistance coil 321 is energized, the fluid in the bulb 318 will be heated and will expand, exerting an increasing force tending to compress the bellows 314. When the force exerted by the expanded fluid exceeds the opposing force exerted by the coil spring 342, the lever 346 will be pivoted in a counterclockwise direction rotating shaft 297 and opening the damper 286. Also, the switch arm 363 will be moved in a counterclockwise direction breaking contact between the movable contact members 364, 365 and their respective fixed contact members 360 and 361. When the resistance coil 321 is deenergized the fluid in the pressure chamber 316 will contract, with accompanying decrease in force exerted against the bellows 314, and when the force exerted by the spring 342 exceeds the force exerted by the fluid, the lever 346 will be pivoted in a clockwise direction with the result that the damper 286 will be opened and the switch closed, which is the position of the parts shown in Figs. 13 and 14.

Provided in the face of the terminal board 288, adjacent its top edge, there is a horizontally extending groove or slot 367 in which is secured end portions of a plurality of spaced terminal posts 368, 369, 370, 371, 372, 373, 374, 375, 376 and 377. Connecting the terminal post 371 and the fixed contact strip 357 there is a metallic jumper strip 378, and connecting the terminal post 374 and the contact strip 358 there is a metallic jumper strip 379. Connecting one of the terminal posts 325 of the heat motor, and the terminal post 372 there is a jumper wire 380, and connecting the other terminal post 325 of the heat motor and the terminal post 368 there is a jumper wire 381. Each of the terminal posts 368 to 377 inclusive, may be provided with a binding post in the form of a screw 382.

Referring now, and more particularly to Fig. 1, the devices of my control system are electrically connected as follows: The numeral 384 designates a transformer having the usual primary 385 and secondary 386. Connected to the terminals of the primary 385 are the main lead wires 387 and 388. One end of a lead wire 389 is connected to one terminal of the secondary 386, and the other end of lead wire 389 is connected to the terminal post 376 on the terminal board 288. A lead wire 390 has one end connected to the other of the transformer secondary terminals, and has its other end connected to the terminal post 377 on the terminal board 288. The thermostat 15 comprises, in general, a support 391 on which is mounted a temperature responsive, bi-metal blade 392, the free end of which positions between two spaced contact members 393 and 394 mounted on the support 391. Carried by the blade 392 adjacent its free end there is a pair of oppositely disposed contact members 395 and 396 that are adapted to make contact with the contact members 393 and 394, respectively.

A jumper strip 397 connects the terminal posts 375 and 376 of the terminal board 288, and connected to the terminal post 375 is one end of a lead wire 398 that has its other end connected to the bi-metal blade 392. A lead wire 399 connects the thermostat contact member 394 and the terminal 374 of the terminal board 288, and a lead wire 400 connects the other thermostat contact 393 and the terminal 373 of the terminal board 288. Connecting the terminals 377 and 369 of the terminal board there is a jumper wire 401 in which there is preferably provided a manually operable switch 402. Connected to one of the terminal posts 222 of the heat motor of the fuel supply control device 13, is one end of a lead wire 403 that connects at its other end to the terminal post 371 of the terminal board 288. The other terminal post 222 of the heat motor is connected to the terminal post 370 of the terminal board by a lead wire 404. A lead wire 405 has one end connected to the tilt switch terminal 282, and its other end connected to the terminal 369 of the terminal board 288, the terminal posts 369 and 370 being connected by a jumper strip 407. The other terminal 281 of the tilt switch 16 is connected to the terminal 368 of the terminal board 288 by a lead wire 406. A jumper strip 408 connects the terminals 372 and 373 of the terminal board 288.

The operation of my control system for controlling the operation of a heating apparatus is as follows: The manual switch 402 on the terminal board 288 is first closed and the pilot light burner 5 lighted. The pilot light burner heats the expansible fluid in the bulb 188, the fluid expanding and acting to compress the bellows 182 of power element 175. When the force exerted by the expanded fluid exceeds the opposing force exerted by the power element spring 165, the bellows 182 will be compressed and will move the thrust member 184 inwardly to pivot the lever member 162 in a clockwise direction. The force exerted by the spring 165 acting to hold the valve member 24 closed is thus overcome by the power element which holds the lever member in the dotted position shown in Fig. 7, unless the pilot light becomes extinguished or the power element fails, in either event of which the spring 165 acts through the lever member 162 to close the valve. However, removal of the holding force of the spring 165 will not cause the valve member to be opened, for the spring 245, Fig. 5, of the thermostat controlled valve actuating mechanism in casing 196 will be holding the valve member 24 seated through the medium of lever 194 and arm 192. The damper heat motor 312 of course will be deenergized when the main manual switch 402 is open so that the spring 342, Figs. 1 and 14, will be holding the stack damper 286 in open position, and the switch contacts 364, 365 in engagement with the contacts 360, 361, respectively. When the manual switch 402 was closed to render the apparatus effective, the room thermostat 15 became operable to control the operation of the fuel and air control device 13. When the room thermostat blade 392 is in engagement with the contact member 396, as

shown, the room or space is below the desired temperature and the thermostat 15 is calling for heat. The thermostat 15 may be set for blade 392 to make contact with the contact member 396 at say 70° F., and to make contact with the satisfied or "no-heat-demand" contact member 393 at say 71° F. When the thermostat blade 392 is in contact with the contact member 396 as on a demand for heat, and assuming the valve 17 to be closed and the damper 286 to be open, then with the manual switch 402 closed and the circuit through the primary 385 of transformer 384 completed through lead wires 387, 388, the following secondary circuit will be established: from the secondary 386 through lead wire 389, terminal 376 on the panel board, jumper strip 397, terminal 375, lead wire 398, thermostat blade 392, contacts 396, 394, lead wire 399, terminal 374, jumper strip 379, switch contacts 360, 364, switch strip 363, contacts 365, 361, jumper strip 378, terminal post 371, lead wire 403, to one of the terminals 222, see Figs. 4 and 5, of the resistance coil 219 of the heat motor for valve arm 192 and damper arm 194, and from the other terminal 222, through lead wire 404, the terminal post 370 of the terminal board 288, jumper strip 407, terminal 369, jumper wire 401 through closed manual switch 402, terminal 377, and lead wire 390 to the secondary 386 of the transformer 384. The resistance coil 219 of the heat motor 195a being thus energized, generates heat and heats the fluid in the bulb 216 which expands and exerts its force to compress the bellows 208, see Fig. 5, to overcome the spring 245 and move air damper lever 194 and valve lever 192 in a clockwise direction, facing Fig. 3, so that the air inlet draft damper 12, Fig. 2, and the valve member 24 of gas valve 17 are opened, and circuit is broken at tilt switch 16. Gaseous fuel now flows through the open valve 17 to the main burner 3 and is lighted by the pilot burner 5. The burner then heats the heat conveying medium, such as air or any other suitable medium, for conveying the heat to a room or other enclosed space to be heated. As the temperature in the furnace bonnet 7 increases, the expansible fluid in the bulb 63 is expanded exerting its force to compress the bellows 58. When the bellows 58 is compressed the thrust member 65 is urged into engagement with the lever member 100 and pivots the lever members 100 and 115 in unison to throttle the valve member in accordance with furnace bonnet temperature. As previously mentioned, only the lever member 115 engages the valve member during the throttling action, but when the bonnet temperature rises to a predetermined temperature the lever member 100 acts to close the valve with a snap action, or to seat on the closed valve member with a hammer blow if the thrust member 137 is in its downmost adjusted position to provide throttling to full-closed valve position. The regulation or movement of valve member 24 toward open and closed position will of course continue under the control of power element 53 and in accordance with bonnet temperature as long as the room thermostat 15 is calling for heat.

When the room thermostat 15 becomes satisfied the thermostat blade 392 will move out of engagement with the contact member 394 and move into engagement with contact member 393, thus breaking at contact members 394, 396, the circuit to the valve actuating mechanism, or to the resistance coil 219 which will then be deenergized. The power element of the actuating means of valve member 24 being deenergized is now decreasing in power and when the force exerted by the coil spring 245 exceeds the force exerted by the power element, the spring pivots lever 194 in a clockwise direction, as seen in Fig. 5, to close the draft damper 12 and also acts through levers 192 to 109 to seat and to hold the valve member 24 closed. When the lever member 194 is pivoted upwardly by the spring 245, the tilt switch 16 is tilted such that its contact members 271 and 275 move into contact, and when this occurs the following circuit is completed to the heat motor of the damper actuating mechanism: From the secondary 386 of transformer 384 to the lead wire 389, terminal post 376, jumper strip 397, lead wire 398, thermostat blade 392, contact members 395, 393, lead wire 400, jumper strip 408, jumper wire 380, to one of the terminals 325, through the resistance coil 321, to the other resistance coil terminal 325, to lead wire 381, to terminal 368, lead wire 406 to the tilt switch terminal 281, through the closed tilt switch and terminal 282, lead wire 405, terminal 369 of the terminal board 288, jumper wire 401 through the closed manual switch 402 to the terminal 377 and from terminal 377 through lead wire 390 to the transformer secondary 386. The resistance coil 321 of the damper heat motor is now energized and heat is generated which heats the expansible fluid in the bulb 318, the expanding fluid exerting its force to compress the bellows 314. When the force exerted by the expanding fluid exceeds the force exerted by the coil spring 342 the damper motor power element will pivot the lever member 346 in a counterclockwise direction, as seen in Figs. 1 and 14. The damper member 286 will then be closed to prevent the escape of heat through the chimney during the off-cycle of operation of the heating apparatus and when the damper is closed, contact will be broken between the pairs of contact members 361, 365 and 360, 364. Separation of the contact members 361, 365 and 360, 364 respectively opens the circuit to the fuel and air supply control device 13 so that the furnace cannot be started while the damper 286 is in closed position.

When the room thermostat again becomes dissatisfied it breaks contact with contact member 393 and makes contact with contact member 394. Disengagement of the contacts 395 and 393 opens the circuit to the damper heat motor to deenergize the resistance coil 321. The fluid in the damper power element then begins to contract with corresponding and gradual diminishing of the force it exerted in overcoming the spring 342, and when the force exerted by the spring exceeds the force exerted by the power element, the damper will be rotated to open position and the switch contact members 364 and 365 will, as the damper 286 comes to full open position, be moved into engagement or contact with the contact members 360 and 361 respectively. When contact is made by the contact members 361, 365 and 360, 364, the circuit is complete to the heat motor 195a of the valve 17 to permit flow of fuel to the main burner 3, to open the air damper 12, and to actuate the tilt switch 16 to break circuit to the damper heat motor coil 321.

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

1. In a heating apparatus, automatically operable means for controlling a fuel supply, temperature responsive means operatively connected to

and controlling said means, an automatically actuated flow controlling damper, means operable to actuate said damper, means operable upon movement of said damper to open position to render said responsive means effective to control said supply means, means operatively connecting said responsive means to said damper actuating means, and means operable upon actuation of said supply means to render said responsive means effective to control said damper actuating means.

2. In a heating apparatus, fuel supply means, means operable to actuate said supply means, a flow controlling damper, means operable to actuate said damper, temperature responsive means having a first position for rendering said supply actuating means effective and having a second position for rendering said damper actuating means effective to close said damper, safety means operable upon actuation of said supply means and having a position to render control by said responsive means ineffective in said second position, and a second safety means operable with said damper and having a position to render control by said responsive means ineffective in said first position.

3. In a heating apparatus, a fuel supply controlling valve, temperature responsive means operable to regulate the supply of fuel by said valve, means holding said valve closed, temperature controlling means, actuating means operable by said controlling means to overcome said holding means so that said regulating means can actuate said valve, a flow controlling damper, damper closing means, means operable by said actuating means to render said damper closing means effective, and means operable upon movement of said damper toward open position to render said controlling means effective to control said actuating means.

4. In a heating apparatus, a fuel supply valve, a flow controlling damper, an electric switch having two circuit controlling positions, electrical means operable to actuate said valve and having a circuit energized in one position of said switch, electrical means operable to actuate said damper and having a circuit energized in another position of said switch, safety switch means in said valve circuit and closed upon opening movement of said damper, and safety switch means in said damper circuit closed upon closing movement of said valve.

5. In a heating apparatus, a burner having an air inlet, a valve controlling the fuel supply to said burner, a damper controlling the outlet flue from said burner, a damper for said air inlet, an electrically heated expansion motor operable to actuate said valve, an electrically heated expansion motor operable to actuate said flue damper, a room thermostat having one circuit controlling said valve motor and having another circuit controlling said flue damper motor, a safety switch in said flue damper motor circuit and opened on opening movement of said inlet damper, and a safety switch in said valve motor circuit and closed on opening movement of said flue damper.

6. In a heating apparatus, heating means having an outlet flue, automatically operable means to supply fuel to said heating means, means to energize said automatic means, automatically actuated means controlling flow through said flue, operating means to actuate said flow controlling means to discontinue flow through said flue, means operable upon establishment of flow through said flue to render said fuel supply controlling means effective, and means operable upon operation of said supply means to supply fuel to render said operating means ineffective.

7. In a heating apparatus, heating means having an outlet flue, means to supply fuel to said means, means controlling said supply means, means to discontinue flow through said flue, means controlling said flow discontinuing means, operating means having a first position for rendering said supply controlling means effective and having a second position for rendering said flow controlling means effective to operate said discontinuing means, safety means operable upon operation of said supply controlling means to supply fuel to render said operating means ineffective in said second position, and a second safety means operable upon operation of said flow controlling means to discontinue flow to render said operating means ineffective in said first position.

8. In a heating apparatus, heating means having a combustion chamber, means to supply fuel to said heating means, means controlling flow through said chamber, operating means having two controlling positions, means operable to actuate said supply means upon movement of said operating means to one of said positions, means operable to actuate sail flow controlling means upon movement of said operating means to the other of said positions, safety means to render said actuating means for said supply means ineffective upon operation of said flow controlling means to discontinue flow, and safety means to render said actuating means for said flow controlling means ineffective upon operation of said supply means to supply fuel.

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