

March 10, 1942.

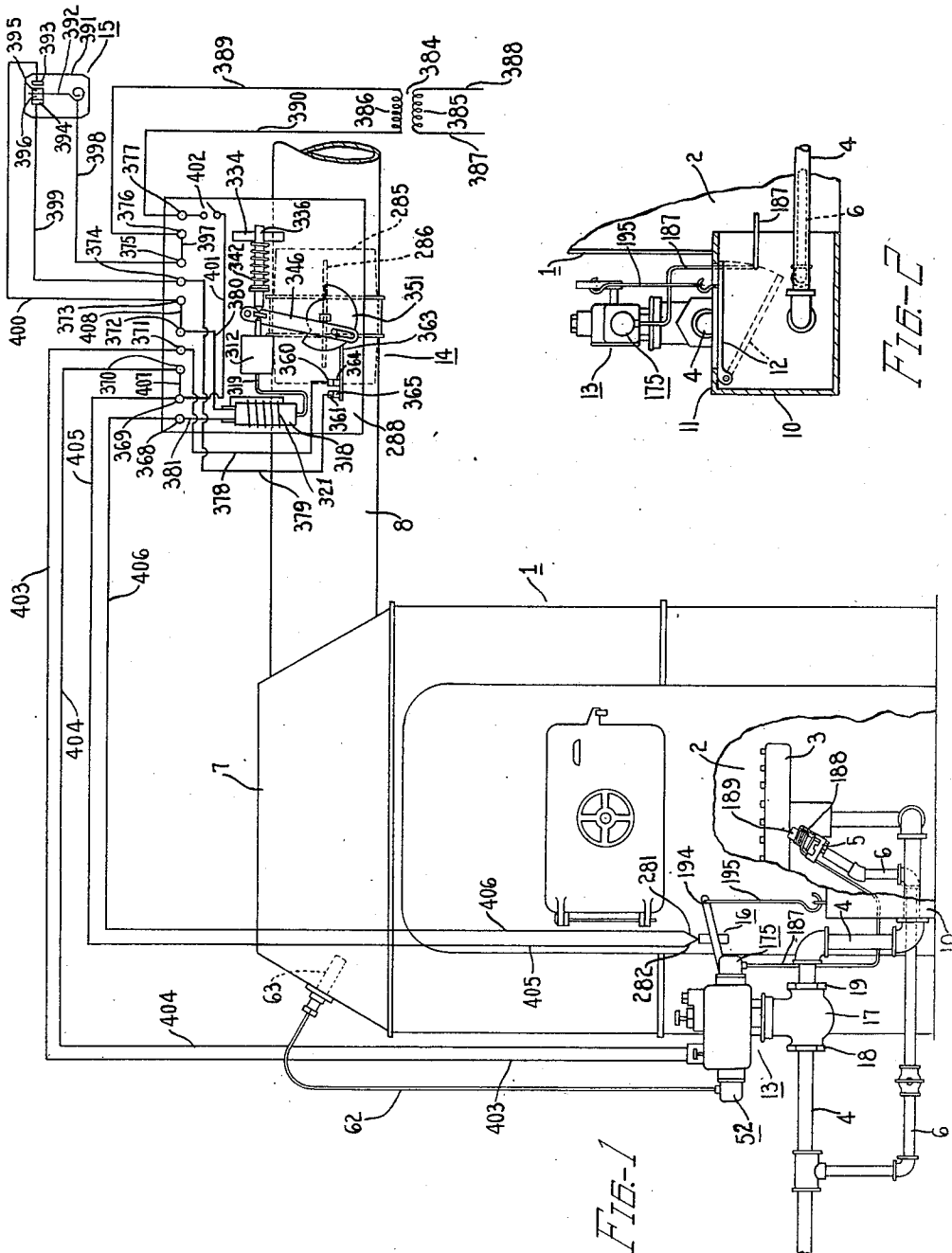
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2,276,227

CONTROL DEVICE

Original Filed June 3, 1936

6 Sheets-Sheet 1



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6 Sheets-Sheet 2



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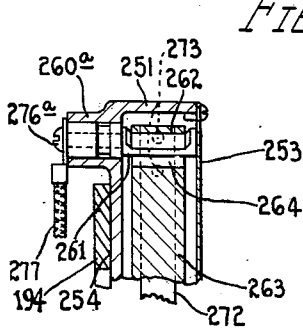
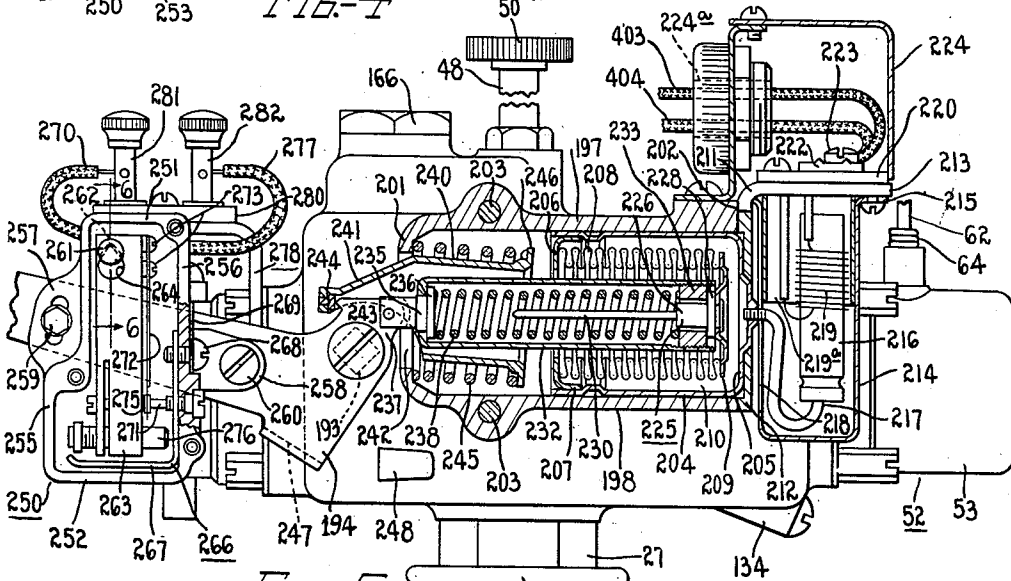
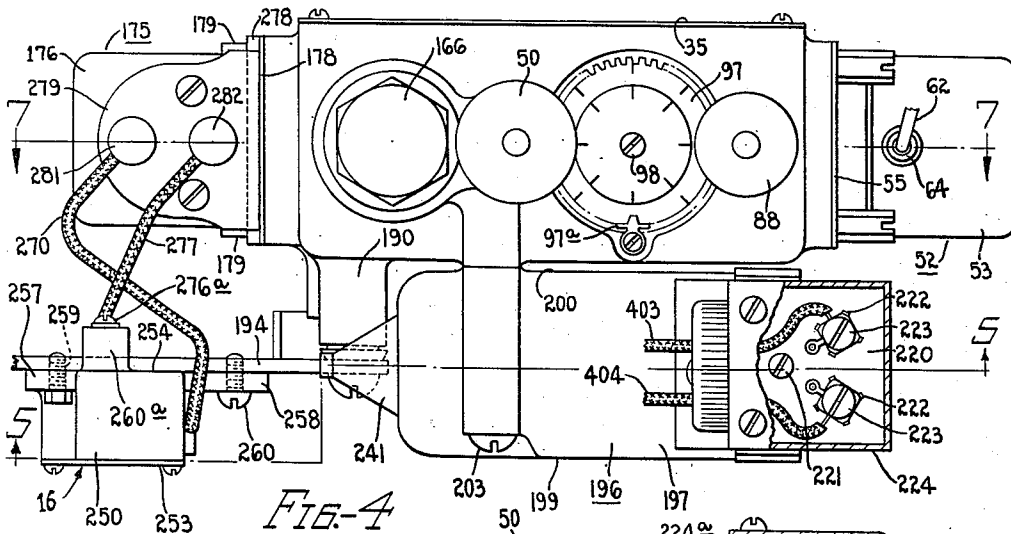
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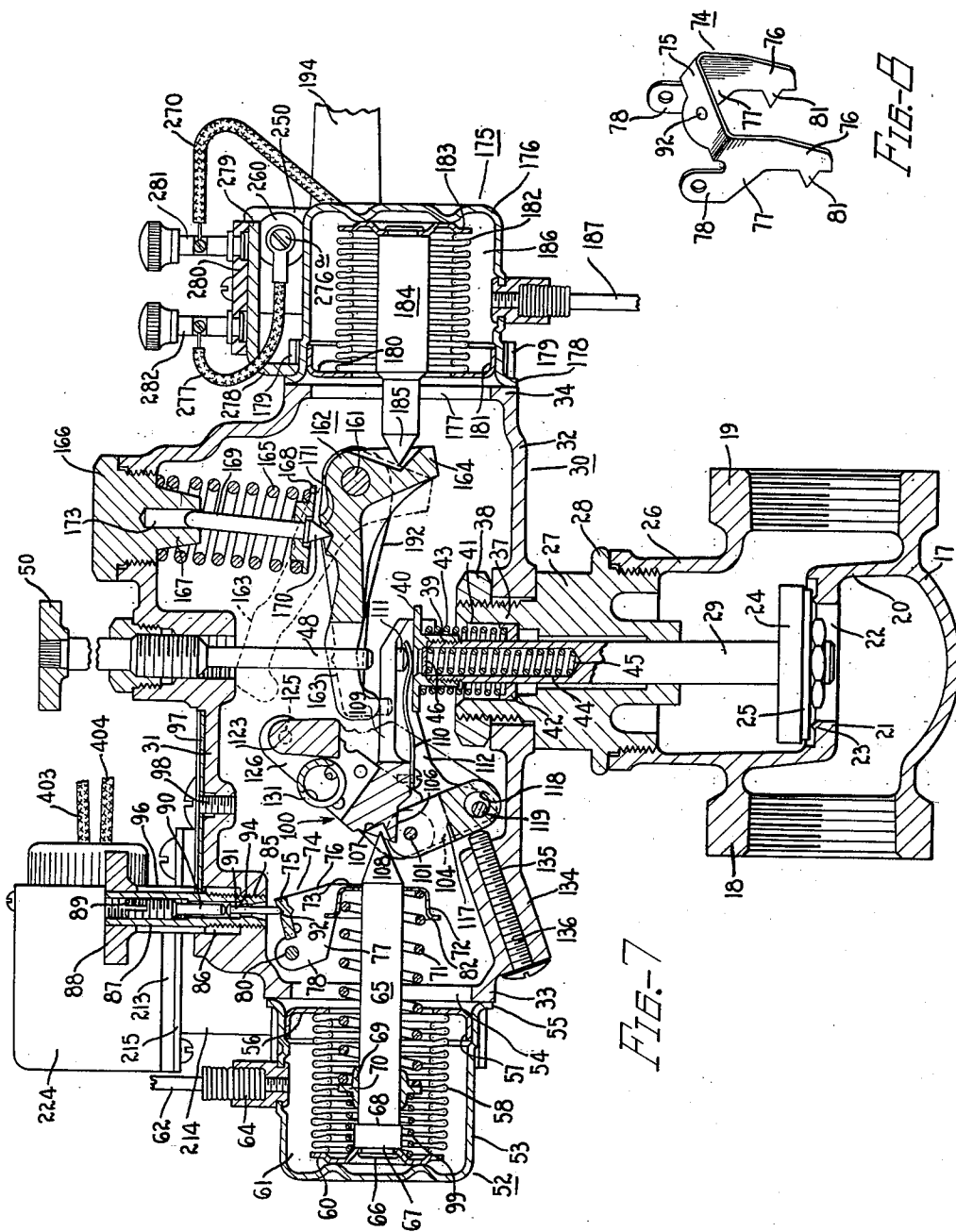
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CONTROL DEVICE

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CONTROL DEVICE

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6 Sheets-Sheet 5

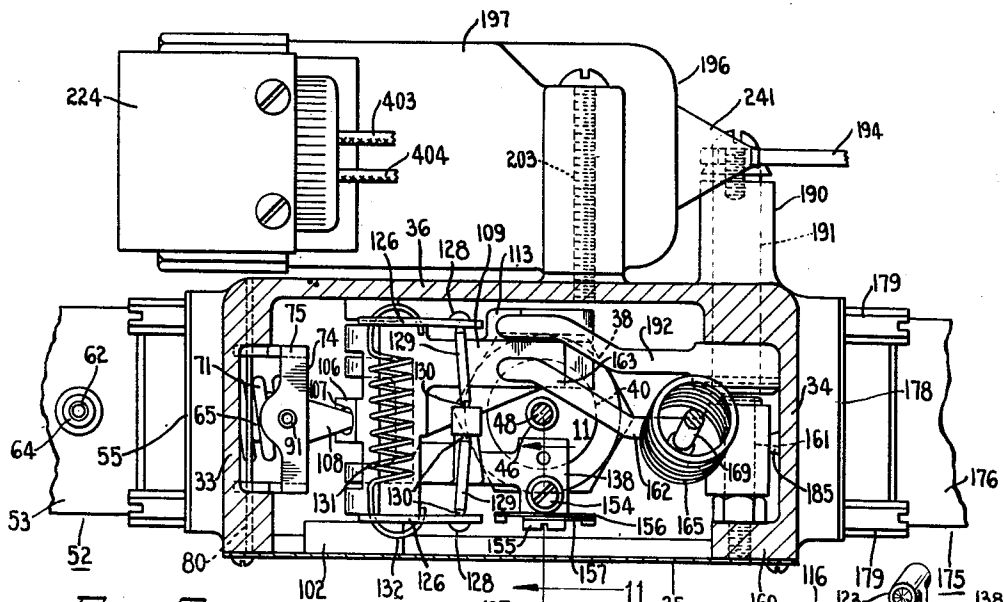


Fig. 9

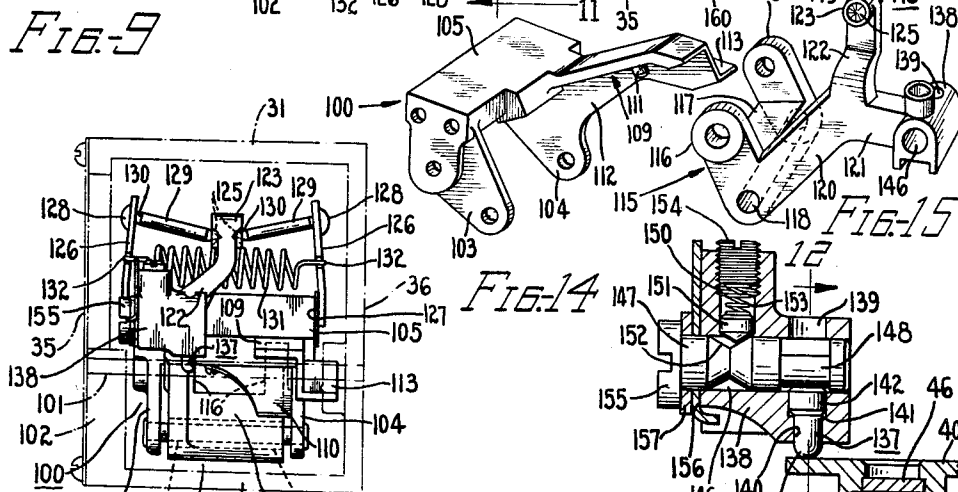


Fig. 10

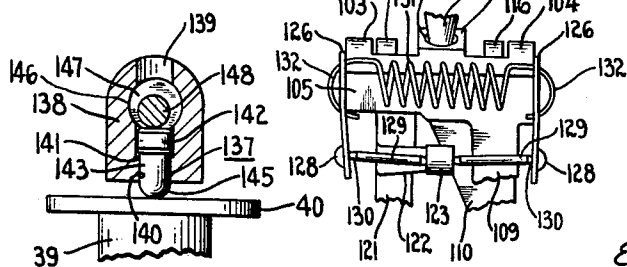


Fig. 11

Fig. 12

Fig. 13

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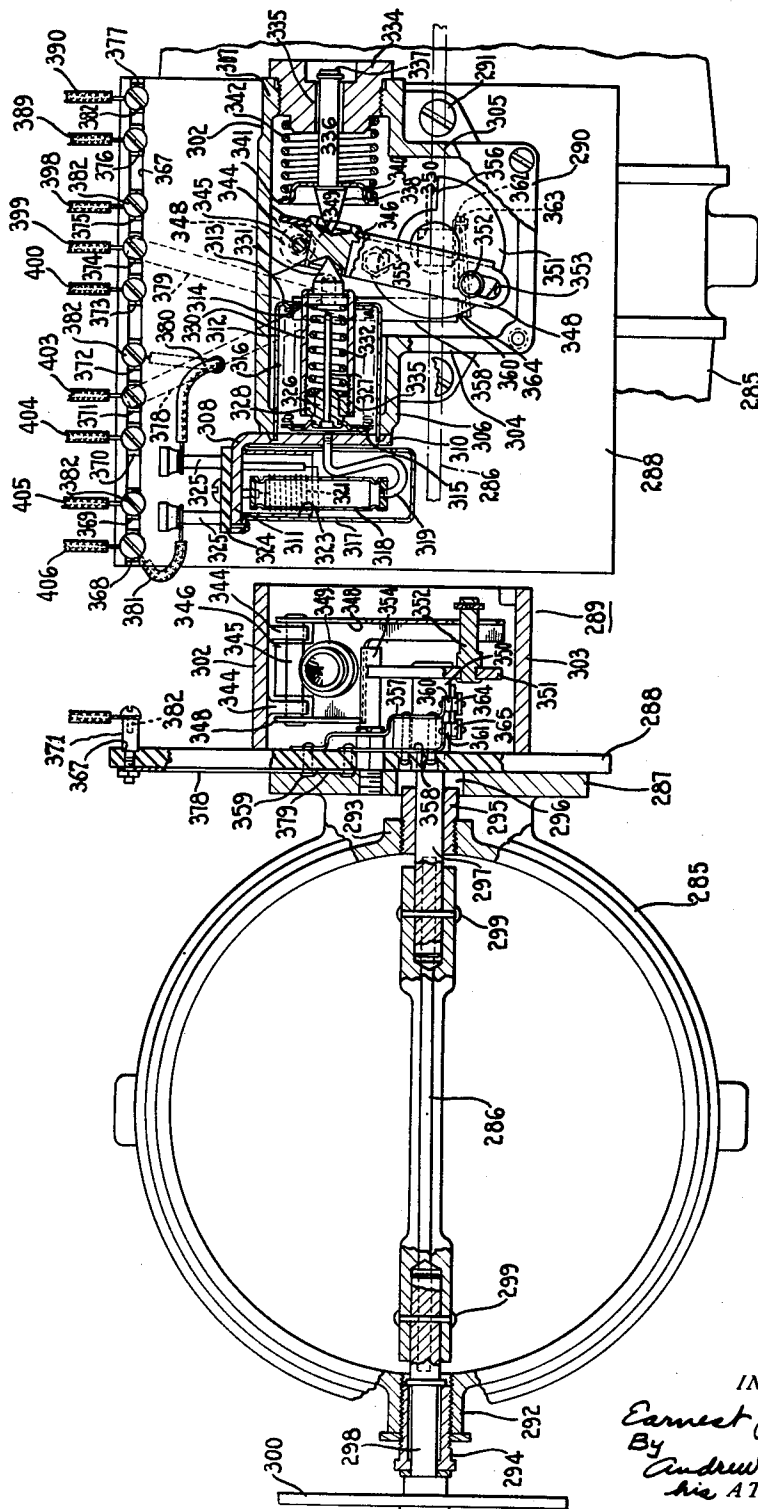
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CONTROL DEVICE

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2,276,227

CONTROL DEVICE

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Original application June 3, 1936, Serial No. 83,232, now Patent No. 2,185,978, dated January 2, 1940. Divided and this application August 5, 1937, Serial No. 157,585

19 Claims. (Cl. 137—139)

This application is a division of my copending application, Serial No. 83,232, filed June 3, 1936, for Heating apparatus, now Patent No. 2,185,978, of Jan. 2, 1940.

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

One of the objects of my invention is to provide a new and improved control device for controlling the delivery of fuel to a heating apparatus.

Another object of my invention is to provide a control device of the above mentioned character having a mechanism which will throttle a valve within a predetermined range of operation and which will actuate the valve with a snap action on movement out of said range.

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 connecting means for operatively connecting an actuator and an actuating means.

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 having my new and improved control device;

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 my control device, the cover of the device being removed to show the arrangement of 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 side view taken along the line 5—5 of Fig. 4 showing certain of the mechanism of the control device in section;

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

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

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

Fig. 9 is a partial top plan view shown partly in cross section on the line 9—9 of Fig. 3;

Fig. 10 is a detail assembly view of certain of the mechanism of the control device, looking from the right facing Fig. 9, and with the casing shown in dot-dash lines;

Fig. 11 is an enlarged view shown in cross section of structural details of my device 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 top plan view of part of the mechanism shown in Fig. 10;

Fig. 14 is a view shown in perspective of a lever of the mechanism shown in Fig. 10;

Fig. 15 is a view shown in perspective of another lever of the mechanism shown in Fig. 10;

Fig. 16 is a view of a stack damper and a damper actuating mechanism shown partly in elevation and partly in cross section and comprising part of the apparatus of Fig. 1, and

Fig. 17 is a view looking from left to right of the damper actuating mechanism of Fig. 16 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 control or pilot light burner 5 for lighting and for controlling operation of the main 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, in the present instance, 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, to open the draft inlet. 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, as at 20, separating the inlet and the outlet of the body, the wall 20 having a horizontal portion 21 provided therethrough with an aperture or passage 22 for the passage of fuel. The wall portion 21 preferably has an upwardly directed, extended portion 23 that is preferably concentric with the passage 22 and provides an upwardly facing port and seat for cooperation with a movable valve member 24. The valve member 24 controls flow of gaseous fuel through passage 22 to the main burner 3, and preferably the valve member 24 includes a face or seat disc 25 of resilient material for contact with the seat 23 to prevent leakage through passage 22 when the valve 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 also preferably has 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 being centrally bored to receive and guide the stem 29. 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, 34 and side walls 35, 36. The casing walls 35 and 36 may be termed the front and rear walls respectively, and preferably the front wall 35 is a removable, plate-like cover that may be held in place by screws, or by other suitable means. Preferably the extension member 27 has a reduced upper end portion, as at 37, that preferably extends through an aperture in the bottom wall 32 of casing 30, the reduced portion 37 providing an upwardly facing annular shoulder for abutment with the casing bottom wall 32. The reduced portion 37, of the extension member 27, extends upwardly above the upper or inner surface 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 having a central aperture through which the valve stem 29 extends, the valve stem being slidably received and guided in said aperture. 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 is 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 and may be arranged having one end abutting the inner end wall of the recess and having its other or 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 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 longitudinal 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 finger grip 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 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 56 being disposed substantially parallel with the end wall 33 of casing 30. The plate member 56 is located adjacent the open end of casing 53, or adjacent end wall 33, and is preferably formed having an annular flange 57 that is intumed 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 casing 53, with its axis substantially transverse to the plate member 56, and the free end of the bellows 58 is secured and hermetically sealed to an end wall or plate member 60. The bellows 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 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 furnace 1, see Fig. 1. The bulb 63, expansible chamber 61 and connecting tube 62 provide a closed system which may contain or be charged with a temperature responsive, expansible-contractible fluid, such as methyl chloride. 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 reinforcing the tube against breakage.

Carried by the movable end wall 60 of the bellows 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 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 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 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 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 extending parallel to wall 33 and on which the lever member 74 pivots, the shaft 80 being secured at its ends in spaced bosses projecting inwardly from the end wall 33, 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 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 69. 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 24 through lever mechanism that is disposed within 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 casing 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, or Fig. 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 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 supplements the engagement of lever member 100 with valve member 24 and acts to hold the valve member 24 seated until lever 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 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 reinforcing flange 112 that extends longitudinally of the lever arm and joins the lever arm 104. Adjacent its free end the lever arm 109 is provided with an extended portion or flange 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 lower edge of flange 112 toward the side wall 36 of 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 there-through 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 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 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 100 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 100. 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 to 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 lever member 115 in a clockwise direction, as seen in Fig. 7, but does not limit movement of 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 valve member 24, see Figs. 11 and 12. 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 the 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.

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 provided a manually operable adjustment member 147 operable to move and adjust the bearing member 137 relative to the lever arm 121. The adjustment member 147 may be in the form of a shaft, preferably 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 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 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 shaft 147. In the vertical bore 150 there

is a latch member 151 in the form of a pin or plunger whose lower end 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 plunger 151 and its other end, or upper end, in abutment with the lower end of a screw plug 154, the coil spring being held under compression by the screw plug and urging the plunger 151 downwardly into engagement with the shaft 147. The outer end of 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 preferably 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 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 lever member 100. The lever member 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 ex-

tends downwardly and toward the adjacent end wall 34 of 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 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 there-through 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 thereof 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 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 overlying and adapted to bear on the flange 113 of the lever arm 109 to actuate the valve member 24. One end of the shaft 191 projects externally of the casing 30 through the hollow boss 190 and is provided with a square shank 193 to which is secured one end of a lever member 194 that pivots or moves with the shaft 191. A connecting link or rod 195 is pivotally connected at one end thereof to the free end of lever member 194, 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 swings downward by gravity to open position.

Mounted on the casing 30 there is a heat motor 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 200 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 intumed 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 aper-

ture 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 208 is a movable wall or plate member 209. The bellows member 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 that 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. The bulb 216, expansible chamber 210 and connecting tube 217 provide a closed system that is charged with a temperature responsive, expansible-contractible fluid, such as methyl chloride.

Surrounding or wrapped around the bulb element 216, adjacent the upper end thereof, is a coil of wire 219 having a high resistance to 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 219^a 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 224^a.

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 226 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 clamp the movable end wall 209 tightly 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 210 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 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 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 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 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, as seen in Figure 5, rotates shaft 191 and 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 43 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 secure the casing 250 rigidly to the lever arm 194. 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, see Figs. 4 and 6, and 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, 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 oscilla-

tory 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 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 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 preferably secured thereto, 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 which is disposed toward or faces the end wall 256 of 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 the contact member 271. When the valve 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 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 so doing 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 276^a under 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, 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: Assume that the control burner 5 is lighted and that the power element 175 responsive thereto is holding the lever 162 75

out of holding relation with the valve abutment member 40, or is holding the lever 162 in the position shown in dotted lines, Fig. 7. When the room thermostat 15 is satisfied, the heat motor spring 245, Figs. 5 and 9, holds the valve 24 in closed position, the spring 245 acting through the lever 194, shaft 191, lever 192, and the lever arm 109 which acts directly on the valve abutment 40. When the heat motor spring 245 moves the lever 100, having arm 109, toward the above mentioned position, or toward the position shown in Fig. 7, the lever 115 is also pivoted in the same direction by reason of the connecting spring 131, but pivotal movement of the lever 115 is limited by the stop member 136 prior to completion of movement of lever 100 with the result that the spring 131 is placed under additional tension force. The spring 131 is acting to pivot the now relatively movable lever members 100 and 115 in opposite directions, but since lever member 115 is against its stop 136, the force of spring 131 will be directed to pivot lever member 100 out of engagement with the valve abutment 40 when released by the heat motor spring 245. As previously mentioned, when the room thermostat 15 becomes dissatisfied the thermostat controlled heat motor is energized and overcomes the force exerted by the spring 245 to pivot lever arm 192 away from the bearing flange 40 of the valve member 24. When the force exerted by the spring 245 is overcome and the lever arm 192 is pivoted away or out of engagement with the valve member, the coil spring 131 begins to move the lever member 100 in a counterclockwise direction, as seen in Figs. 3 and 7, to move lever arm 109 out of engagement with the valve member 24. 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 lever member 100. However, after slight pivotal movement of lever member 100 in a counterclockwise direction, the component force of spring 131 acting to pivot the lever is increased, with the result that lever member 100 is pivoted with a snap action. Lever arm 109 is then moved out of engagement with the valve member 24 decreasing the force exerted by the leaf spring 110, with the result that the valve member is opened with a snap or quick action by the coil spring 43. The spring 131 now yieldably holds the lever members 100 and 115 for movement in unison and urges the lever members to pivot in opposite directions, relative movement of the lever members being limited by the pin 119 which acts as a stop. As the furnace temperature increases, the expandable 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 24 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. During the throttling action the lever members 100 and 115 pivot in unison by reason of the holding spring 131, but if the bonnet temperature continues to rise, the lever member 115 will be prevented from further pivotal movement in a valve closing di-

rection 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 115 engages its stop member 136 the valve member 24 will not be seated, but the effective flow capacity of the valve port 22 will depend upon the adjustment of the adjustable bearing member 137 of lever member 115. If the adjustable bearing member 137 is in the position shown in Figs. 11 and 12, in which it is being held in its lowermost position, the valve member 24 will be slowly throttled closed and will be seated when lever member 115 is in engagement with its stop. If the adjustable bearing member 137 is set at the other extreme, or uppermost position, the valve member 24 will not be seated when the lever member 115 engages its stop member 136. This position of the valve member 24 may be termed the minimum throttle position of the valve since the range of throttle or movement of the valve is increased as the position of the adjustment indicator or pointer 157 is moved toward the right, as seen in 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 24 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 24 has been moved toward closed position, such that the lever member 115 is in engagement with its stop 137, 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 the spring 131 rapidly decreases with the result that the lever member 100 is pivoted with a snap action. The lever arm 109 engages with the flange 40 of the valve member 24 and thus the valve member is closed or seated with a snap action. By the provision of a combined modulating and snap-acting movement, it is possible on valve closing movement, first to throttle the flow of fuel to the burner until the fuel flow is just sufficient to maintain burner operation without causing a burner flash-back and then to stop fuel flow at such an accelerated rate as to eliminate the flash-back upon shutting off the burner. As the design of the burner will determine the minimum flow below which flash-back will occur, the adjustment of member 147 may be altered to suit the particular burner with which the fuel supply control device 13 is associated. Some burners are so designed that flash-back will not occur and therefore member 147 is adjustable to provide modulating movement throughout the range of control of the device 13. It is to be understood that the valve member 24 is actuated with a snap action only when the bearing member 137 is set in other than its uppermost 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 24 to be opened by spring 43 with a snap action.

Referring now to the damper and automatic damper actuating means shown in Figs. 1, 16 and 17, 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 on and seats flat against the vertically extending flange 287 and this terminal board 288 may be constructed of Bakelite, or other suitable electric insulating material. The damper actuating mechanism includes a heat motor that has a supporting member 289, preferably an open ended casing 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 290 in the form of a plate 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 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 that are disposed with their axes in substantially horizontal alignment. Screw threaded into the bosses 292 and 293 there are preferably provided removable tubular bearing members 294, 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. Journalled for rotation in the bearing member 295 there is a stub shaft 297 which projects into and transverse of the flue section 285. Journalled 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 portions of the shafts 297 and 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 285 and beyond the outer end of the tubular boss 292, 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, 305. The casing 289 is formed having two integral and externally extending tubular bosses 306 and 307 that are preferably oppositely disposed and open into the casing through the side walls 304, 305 respectively, adjacent the top wall 302. An L-shaped bracket 308 is secured to the other 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 casing 312 is positioned 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 bracket leg 310 that overlies the outer end of the tubular boss 306. The power element casing 312 may be secured to the vertical bracket leg 310 by solder, or by other suitable sealing means.

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 in and to the lower end of the bulb element 318, and the other end of the tube may be secured in and to the vertical leg 310 of the L-shaped bracket 308. The bulb casing 317 is provided with a slot 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 in and to 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 inner 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 is 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 reinforcing 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. 17, 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, Fig. 17, that projects into casing 289, and secured to the shank

there is a lever member 351 in the form of a disc or plate. 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 lever 346 there is provided a slot 353 for receiving 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 to close the damper 286. Also, the switch arm 363 will be moved in a counterclockwise direction breaking contact of the switch arm carried contact members 364, 365 with their respective cooperating 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. 16 and 17.

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 particularly to Fig. 1, the devices of the 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 the 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. When the force exerted by the expanded fluid exceeds the opposing force exerted by the 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 175. The power element pivots the lever in a clockwise direction, out of engagement with the upper end of the valve member, and holds the lever in the dotted position shown in Fig. 7, unless the pilot light becomes extinguished or the power element fails, whereupon the spring 165 acts 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 of the thermostat controlled valve actuating mechanism will be holding the valve member 24 seated. The damper heat motor will be deenergized and the spring 342 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 is closed, the room thermostat 15 is operable to control the operation of the control device 13. When the thermostat blade 392 is in engagement with contact member 394, as shown, the thermostat 15 is calling for heat. The thermostat 15 may be set to make contact with the contact member 394 at say 70° F., and to make contact with the contact member 393 at say 71° F. When the thermostat blade 392 makes contact with the contact member 394 the following circuit is completed to the heat motor of the valve actuating mechanism: From the secondary 386 of the transformer 384 via lead wire 389, terminal 376, jumper strip 397, terminal 375, lead wire 398, thermostat blade 392, contacts 394, 396, lead wire 399, terminal 374, jumper strip 379, switch contacts 361, 365, blade 363 and contacts 364, 360, jumper strip 378, terminal post 371, lead wire 403 to one of the terminals 222 of the resistance coil 219 of the heat motor, and from the other terminal 222, 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 through lead wire 390 to the other side of the secondary 386 of the transformer 384. The resistance coil 219 of the heat motor generates heat and heats the fluid in the bulb 216 which expands and exerts a force to compress the bellows 208, see Fig. 5. When the force exerted by the expanding fluid exceeds the opposing force exerted by the spring 245, the lever 194 is pivoted in a counter-clockwise direction, Fig. 5, which also pivots the lever 192 in the casing 30 away from and out of engagement with the lever member 109. Pivotal movement of the lever 194 by the power element also permits the draft damper 12 to descend by gravity and open the draft inlet. When the lever member 192 pivots away from the lever member 109, the lever member 100 is pivoted counter-clockwise with a snap action, Figs. 3 and 7, by the spring 131, to move the lever arm 109 out of operative engagement with the valve member. Until the spring 131 functions to hold the levers for movement in unison, the valve member 24 is held seated by reason of the tensioned leaf spring 110 carried by the lever member 100, but upon pivotal movement of the lever member 100 the force exerted by the coil spring 43 overcomes the diminished force exerted by the spring 110 and moves the valve 24 upwardly away from its seat. Gaseous fuel now flows to the main burner 3 and is lighted by the pilot burner 5. The burner then heats the heat conveying medium, which may be steam, water 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 in 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. When the valve actuating means, controlled by the thermostat 15, acts through pivoting lever 194 to open the valve, the tilt switch 16 carried by lever 194 is tilted and contact between its contact members 271 and 275 is broken, thereby breaking the circuit through the heat motor energizing coil 321 of the damper mechanism 14.

When the room thermostat 15 becomes satisfied the thermostat blade 392 will move out of engagement with the contact member 394, thus breaking the circuit to the valve actuating mechanism or to the resistance coil 219, which will then be deenergized and the blade 392 will make contact with the contact member 393. The power element of the actuating means of valve 24 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, and through levers 192 and 109 seats and holds the valve member seated and also closes draft damper 12. When the lever member 194 is pivoted by spring 245, the tilt switch 16 is tilted such that its contact members 271 and 275 are in contact, and when this occurs the following circuit is completed to the heat motor of the damper actuating mechanism: From the secondary 386 of the 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 of and 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 to its other terminal 282, and thence via 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 other side of the transformer secondary 386. The resistance coil 321 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 power element will pivot the lever member 346 in a counterclockwise direction, facing Figs. 1 and 16. 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 as the damper member moves toward closed position, the switch arm 363 will be moved downward to carry its contact members 364, 365 out of engagement with contact members 360, 361 respectively, thereby breaking the circuit to the heat motor coil 219 of the control device 13 so that the furnace cannot be started while the damper is in closed position.

When the thermostat again becomes dissatisfied, the blade contact 395 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, deenergizing 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

ing 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 upon full opening of the damper, the switch contact members 364 and 365 will be moved into engagement or contact with the contact members 360 and 361 respectively. When contact is made by the contact members 364, 365 with their respective contact members 360, 361 the circuit is complete to the heat motor of the valve 24 and the valve is again opened to permit flow of fuel to the main burner 3, provided the pilot burner 5 is lighted and the plunger 65 of power element 52 is retracted by cooling of the bonnet 7.

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

1. In a control device having a movable controlling means, mechanism for actuating the controlling means comprising a movable member operable to move the controlling means, stop means for limiting movement of said movable member in one direction to limit movement thereby of the controlling means in said one direction, a second movable member operable to move said controlling means in said one direction after limiting of movement of said first-named member by said stop means, said movable members having a lost-motion connection therebetween limiting relative movement of said members, and yieldable means connecting said members for movement in unison and acting to move said members in opposite directions relative to each other.

2. In a control device, a controlling means, a movable member operable to move said controlling means in one direction from one position to a second position, stop means for limiting movement of said movable member on movement of said controlling means by said movable member to said second position, a second movable member operable to move said controlling means in said one direction from said second-named position to a third position, resilient means yieldably connecting said members for movement in unison prior to limiting of movement of said first-named member by said stop means and yieldable so that said second-named member can move relative to said first-named member to move said controlling means to said third-named position, said resilient means opposing movement of said second-named member relative to said first-named member and operable to move said second-named member in the opposite direction relative to said first-named member, and means operable to move said members in one direction.

3. A control device comprising a movable controlling means, a lever having a fulcrum support and operable to actuate said controlling means, power means operable to pivot said lever to actuate said controlling means, a second lever having a fulcrum support and having operative connection with said controlling means, yieldable means connecting said levers for limited pivotal movement in unison, said yieldable means urging said levers in opposite directions about their fulcrum supports and normally holding said first-named lever in an inactive position relative to said controlling means, stop means limiting relative movement of said levers in opposite directions about their fulcrum supports by said yieldable means, and stop means limiting pivotal movement of said second-named lever in one direction and correspondingly limiting movement of said controlling means by said second-named lever, said yieldable means opposing movement of

said first-named lever relative to said second-named lever by said power means when said second-named lever engages said second-named stop means and being yieldable so that said first-named lever can pivot to actuate said controlling means.

4. A control device comprising a casing, a valve member for controlling flow through said casing, a lever having a fulcrum support and operable to move said valve member to closed position, power means operable in response to a fluid characteristic for actuating said lever, said lever having an arm portion movable substantially transverse to the direction of movement of said lever about its fulcrum support, a second lever having a fulcrum support and operable to actuate said valve member, means operatively connecting said arm portion and said second-named lever, a tension spring connected to said arm portion and acting through said connecting means to exert a component of the spring force holding said levers for limited pivotal movement in unison to throttle said valve member in accordance with changes in the fluid characteristic, said component spring force urging said levers in opposite directions about their fulcrum supports and normally holding said first-named lever in an inactive position relative to said valve member, stop means for limiting relative movement of said levers in opposite directions about their fulcrum supports by said spring, and stop means for limiting movement of said second-named lever in a valve closing direction to limit throttling of said valve member, said spring opposing movement of said first-named lever relative to said second-named lever by said power means when said second-named lever engages said second-named stop means, said spring being yieldable with a rapid change in the direction of its force and a correspondingly rapid diminishing of its component force whereby the power means pivots said first-named lever to move said valve member to closed position with a snap action.

5. A control device comprising a casing, a valve member for controlling flow through said casing, a lever having a fulcrum support and operable to move said valve member to closed position, power means operable in response to changes in a fluid characteristic for actuating said lever, said lever having an arm portion movable substantially transverse to the direction of movement of said lever about its fulcrum support, a second lever having a fulcrum support and operable to actuate said valve member, means operatively connecting said arm portion and said second-named lever, a tension spring connected to said arm portion and acting through said connecting means to exert a component of the spring force holding said levers for limited pivotal movement in unison to throttle said valve member in accordance with changes in the fluid characteristic, said component spring force urging said levers in opposite directions about their fulcrum supports and normally holding said first-named lever in an inactive position relative to said valve member, stop means for limiting relative movement of said levers in opposite directions about their fulcrum supports by said spring, stop means for limiting movement of said second-named lever in a valve closing direction to limit throttling of said valve member, said spring opposing movement of said first-named lever relative to said second-named lever by said power means when said second-named lever engages said second-named stop means, said spring being yieldable

with a rapid change in the direction of its force and a correspondingly rapid diminishing of its component force whereby the power means pivots said first-named lever to move said valve member to closed position with a snap action, an adjustable bearing member carried by said second-named lever for engaging said valve member, and means for adjusting said bearing member to vary the throttle range of said valve member.

6. A control device comprising a casing, a valve member for controlling flow through said casing, a lever operable to move said valve member to closed position and having a fulcrum support, a pair of opposed arms carried by said lever and being movable substantially transverse to the plane of movement of the lever about its fulcrum support, a power means operable in response to variations in a fluid characteristic for actuating said lever, a spring connected to said arms and normally urging said arms toward each other, a second lever for actuating said valve member and having a portion positioned between said arms, a thrust member positioned between each of said arms and said lever portion, said thrust members being positioned overcenter when said valve member is closed and being moved further overcenter when said valve member is in an open position, said spring holding said levers for limited pivotal movement in unison to throttle said valve member in accordance with variations in the fluid characteristic, said levers having a lost motion connection therebetween, stop means limiting relative movement of said levers, said spring exerting a component force urging said levers in opposite directions about their fulcrum supports and normally holding said thrust members in said further overcenter positions, and stop means for limiting pivotal movement of said second-named lever in a valve closing direction to limit throttling of said valve member, the component force of said spring opposing movement of said first-named lever relative to said second-named lever after said second-named lever engages its stop, said spring being yieldable with rapid diminishing of its component force as the thrust members move toward center whereby when the component force is overcome by the power means the power means will pivot said first-named lever with a snap action to close said valve member.

7. In a control device, a movable controlling means, a lever member having a fulcrum support and movable in one direction to move said controlling means to one position and being movable in the opposite direction, means for actuating said lever member, a leaf spring carried by said lever member and operable to hold said controlling means in said one position until said lever member is pivoted in said opposite direction through a predetermined angle, and means co-operable with and operable to overcome the force of said spring thereby to move said controlling means to another position when said lever member has moved through said predetermined angle.

8. In a control device, a movable controlling means, means engageable with and operable to hold said controlling means in one position and being operable to move out of holding relation with said controlling means, means acting in opposition to said second-named means and operable to move said controlling means, and supplemental means carried by said second-named means and operable to hold said controlling means against movement by said moving means upon disengagement of and for predetermined initial movement of said second-named means.

9. In a control device, a movable controlling means, means engageable with and operable to hold said controlling means in one position and being operable to move out of holding relation with said controlling means, means acting in opposition to said second-named means and operable to move said controlling means, and spring means carried by said second-named means and operable to hold said controlling means against movement by said moving means upon disengagement of and for predetermined initial movement of said second-named means.

10. In a control device, a movable controlling means, means engageable with and operable to hold said controlling means in one position and being operable to move out of holding relation with said controlling means, means exerting a force on and acting to move said controlling means, means carried by said second-named means and operable to hold said controlling means against movement by said moving means upon disengagement of and for predetermined initial movement of said second-named means, means for moving said second-named means with acceleration out of holding relation with said controlling means, and means cooperable with and operable to overcome the force of said carried means thereby to move said controlling means to another position when said lever member has moved through said predetermined movement.

11. In a control valve, a reciprocal valve member, a power element, an operating member co-operable with said valve member, operating means for transmitting movement from said power element to said operating member to move said valve member in one direction, means to limit the movement of said operating member, said operating means being movable into engagement with and being operable to move said valve member in said one direction, and automatically operable means cooperable with said operating means and operable therethrough to move said valve member upon limitation of movement of said operating member.

12. A control device comprising a valve casing having a passageway therethrough, a mechanism casing mounted on said valve casing, a valve member controlling flow through said passageway and having a stem extending from said valve casing into said mechanism casing, lever means in said mechanism casing and cooperable with said stem to move said valve member, power means carried by said mechanism casing and operable to actuate said lever means, a control casing carried by said mechanism casing, a power element in said control casing, an operating shaft journaled through the wall of said mechanism casing adjacent said control casing, a lever member fixed on said shaft within said mechanism casing and operable through said lever means to actuate said valve member, an operating lever secured to said shaft external of said mechanism casing, and means operatively connecting said power element to said operating lever.

13. A control device comprising a movable controlling means, an operating means for moving said controlling means a predetermined distance, an operating means for continuing the movement of said controlling means beyond said distance, drive means to move said second-named operating means, means to transmit movement of said second-named operating means by said drive means to said first-named operating means to move said controlling means said predeter-

mined distance, said motion transmitting means exerting a predetermined resistance to movement of said second-named operating means relative to said first-named operating means, and means establishing said predetermined distance of movement of said controlling means so that said drive means can overcome the resistance of said motion transmitting means and move said second-named operating means relative to said first-named operating means to continue the movement of said controlling means.

14. A control device comprising a movable controlling means, an operating means for moving said controlling means a predetermined distance, an operating means for continuing the movement of said controlling means beyond said distance, drive means to move said second-named operating means, means to transmit movement of said second-named operating means by said drive means to said first-named operating means to move said controlling means said predetermined distance, said motion transmitting means exerting a predetermined resistance to movement of said second-named operating means relative to said first-named operating means, means establishing said predetermined distance of movement of said controlling means, and means operable on said second-named operating means to overcome the resistance of said motion transmitting means to move said second-named operating means relative to said first-named operating means to continue the movement of said controlling means.

15. In a control device, a casing, a valve member for controlling flow of fluid and having a stem portion with an abutment within said casing, a pair of lever members concentrically fulcrumed within said casing, one of said lever members having a portion operable to engage said abutment and operable to move said valve member in one direction, a power element operable to move the other of said pair of lever members, means interconnecting said lever members and operable to transmit the movement of said other lever member to said one lever member for unison movement of said lever members by said power element, said interconnecting means acting upon relative movement of said lever members in one direction to decrease the force exerted thereby against the relative movement of said lever members in a second direction, said power element acting during said unison movement to move said valve member to modulate the flow of fluid, and means limiting said unison movement of said lever members and determining the limit of modulation of said flow of fluid, said lever members acting upon relative movement in said one direction subsequent to said limitation of said unison movement to move said valve member with a rapid movement to stop the flow of fluid.

16. A control device comprising a controlling means, a first movable member engageable with and operable to move said means, a second movable member engageable with and operable to move said means, yieldable means for transmitting movement from said second movable member to said first movable member to operate said controlling means, stop means to limit movement of said first movable member, and means acting through said second movable member and operable to overcome said yieldable means upon engagement of said first movable member with said stop means thereby to move said second

movable member relative to said first movable member to operate said controlling means.

17. A control device comprising a controlling means, a first movable member engageable with and operable to move said means, a second movable member engageable with and operable to move said means, yieldable means exerting a force for opposing relative movement of said movable members in one direction and operable for transmitting movement from said second movable member to said first movable member to operate said controlling means, stop means to limit movement of said first movable member, and means acting directly on said second movable member and operable to overcome said yieldable means upon engagement of said first movable member with said stop means thereby to move relatively said movable members in said one direction to operate said controlling means, said yieldable means acting upon relative movement of said movable members in said one direction to exert a decreasing force opposing relative movement in said one direction.

18. In a device for controlling the supply of gaseous fuel to a burner, a movable valve means for controlling flow of the fuel to the burner, a first movable member, adjustable abutment means carried by said member engageable with and operable to move said valve means, a second movable member engageable with and operable to move said means, yieldable means for transmitting movement from said second movable member to said first movable member to cause unison movement of said movable members thereby to move said valve means toward closed position, stop means to limit movement of said first movable member, power means acting through said second movable member and operable to move said movable members in unison and said first movable member into engagement with said stop means with a gradual movement, said power means being operable to overcome said yieldable means upon engagement of said first movable member with said stop means thereby to move said second movable member relative to said first movable member with a quick action to snap said valve means further toward closed position, said adjustable means acting upon engagement of said first movable member with said stop means to determine the limit of modulation of flow of fuel by said valve means.

19. A control device comprising a movable controlling means, a pair of relatively movable members, one of said members having a portion engageable with and operable to move said controlling means, a resilient means interconnected between said movable members and acting to oppose relative movement therebetween in one direction and to urge relative movement of said movable members in a second direction, stop means limiting relative movement of said movable members in said second direction, power means engageable with the other of said movable members and operable positively to move said other movable member to cause movement of said controlling means and acting to urge relative movement of said movable members in said second direction, said other member acting upon movement to exert a force through said resilient means to move said controlling means, a stop member limiting movement of said one member by said other member, said resilient means being operable to exert a greater force against relative movement of said movable members in said one direction

than the force exerted by said power means in said second direction to provide unison movement of said movable members prior to engagement of said one member with said stop member, said power means being operable to exert a greater force in said second direction than said resilient means exerts in said one direction subsequent to limitation of movement of said one movable mem-

5 ber thereby to cause relative movement of said movable members, said resilient means acting subsequent to limitation of movement of said one movable member and due to said relative movement to cause said power means to move said controlling means with a quick movement.

EARNEST J. DILLMAN.