

July 10, 1934.

O. J. KUENHOLD

1,966,098

THERMALLY ACTUATED REGULATOR FOR HEATERS

Filed Aug. 12, 1929

FIG. 1.

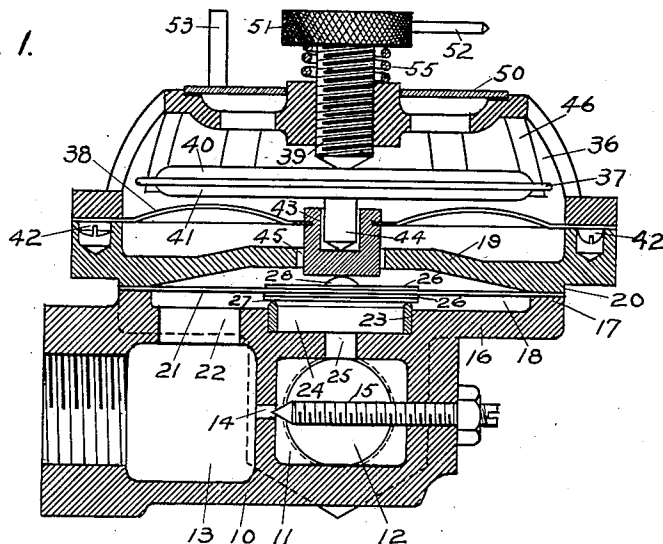
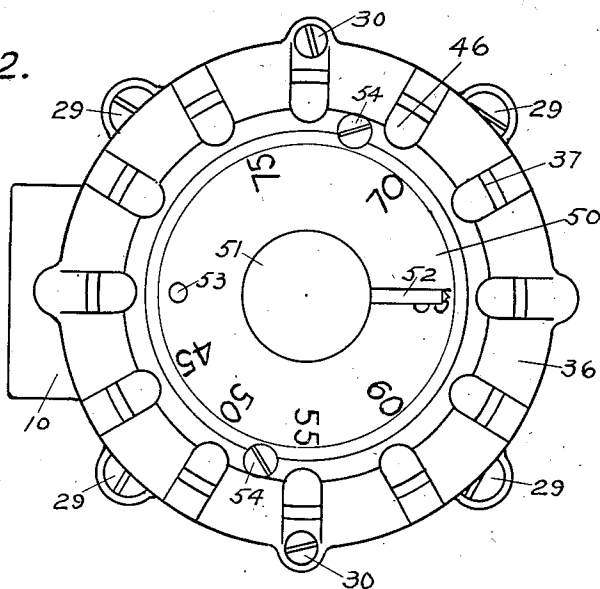


FIG. 2.



Inventor

Otto J. Kuenhold,
By Fassett and Fassett,

Attorney

UNITED STATES PATENT OFFICE

1,966,098

THERMALLY ACTUATED REGULATOR FOR HEATERS

Otto J. Kuenhold, Cleveland, Ohio, assignor to
H. M. Sheer Company, Quincy, Ill., a corporation of Illinois

Application August 12, 1929, Serial No. 385,138

26 Claims. (Cl. 236—99)

This invention relates to means for thermostatically regulating the quantity of fluid-fuel supplied to a room heater.

Thermally controlled valves are not new and the present invention is merely an improvement in various particulars over thermally controlled regulators heretofore produced.

One object of my improvement is to produce a regulator which responds very quickly to slight changes in temperature, and another object is to obtain large variations in the flow of fuel to the heater without the aid of mechanism which produces rubbing friction between its parts. I provide a dial bearing numerals representing various temperatures within the range of the instrument, and associated with this dial is a pointer movable to point to any temperature indicated on the dial. One of my objects is to correlate the spacing of the numerals on the dial and the movements of the pointer to the action of the thermally actuated element, so that the room temperature will be maintained at substantially that to which the pointer is directed, and as one means of effecting this result I provide for moving the dial itself, by way of initial adjustment, so as to bring into registration with the pointer the numeral on the dial which represents the actual temperature of the room at the time. The dial is then fixed in this position to prevent its accidental displacement. Provision is made to prevent injury to the thermal element, or other parts of the instrument, by excessive movement of the pointer. I also provide for reducing variation in the action of the thermally actuated element due to variations in the weight of the atmosphere.

I shall now proceed to describe the construction of my thermally controlled valve, and its operation, with the assistance of the accompanying drawing, in which

Fig. 1 is a sectional elevational view of the complete instrument, and

Fig. 2 is a view of the device looking downward at it.

The body of the instrument, indicated generally by the numeral 10, contains a chamber 11, which, through an opening 12, is connected to a supply pipe. The opening 12 is a tapped hole in a boss formed on the body and the gas supply pipe is screwed into this hole. If desired a similar boss may be provided on the side opposite, that is, the side which, in the drawing, has been removed to exhibit the interior, so the supply pipe can be connected to either side of the body, the unused hole being closed with a threaded plug.

A second chamber, 13, alongside of chamber 11, is to be connected by a suitable pipe to the heater, which is not shown. Chambers 11 and 13 are connected by a by-pass 14 through which a limited quantity of gas passes, according to the position of the regulating screw 15.

The top part of the body 10 comprises a flat member 16 which is surmounted by a low circular wall 17, forming a shallow basin-like chamber 18. This chamber is covered by a circular plate 19, which has a low circular flange 20 of the same diameter as the flange 17. This plate is secured to the member 16 by screws 29, and clamped between the flanges 17 and 20 is a soft leather diaphragm 21. The chambers 13 and 18 are permanently connected by a port 22, making these chambers in effect one chamber, of which the diaphragm 21 is one wall. Further notice will be taken of this point presently.

The chambers 11 and 18 are connected through a valve, of which the diaphragm 21 is one member. The other member of the valve is an annular ring 23, which is set in and extends upward from the top 16 of the body, and forms a seat on which the diaphragm rests to close the valve. The space or chamber 24 encircled by the ring 23 is separated from the chamber 11 by the top 16, but a hole 25 in the top 16 permanently connects the two chambers. This hole is of a rather small size, for a reason which will be mentioned presently. While the diaphragm might be made to seat directly on the ring 23, I prefer to secure a metal disc 26 to each side of the diaphragm, and on the lower disc place a soft leather disc 27, the latter being the member which actually comes in contact with the valve seat 23. These discs are secured to the diaphragm with a rivet having a round head 28. If desired the upper one of the discs 26 may be omitted. The object of providing the disc 27 is that should the ring 23 wear through the leather disc the only harm done would be a small leakage of gas past the valve when the valve is closed. If the diaphragm itself became worn through gas would escape into the room. The valve 21—23 is opened by pressure of the gas in the chamber 24, assisted by the small gas pressure in chamber 18. This will be further referred to presently.

I shall now describe the thermally actuated part of my device. Secured to the plate 19 by screws 30 is a cover or housing 36, within which the thermally actuated element 37 is mounted between a spring 38 and the point of an adjusting screw 39, which is screwed into the top of the housing 36. The element 37 is of the well known

thermo-bellows-diaphragm type, and comprises two circular thin metal discs, 40 and 41, each of which is depressed, so that when they are united face to face with their edges in contact, and soldered together, they form a comparatively thin closed chamber. This chamber is filled, preferably, with a vapor which liquefies at a temperature somewhat below the intended temperature range of the instrument. This vapor expands under the action of heat, pressing the discs 40 and 41 apart more or less, bellows-fashion, thereby varying the thickness of the element in the manner well known and understood in devices of this type.

The spring 38 is made of a strip of sheet metal, its ends being secured to the under edge of the housing 36 by screws 42, the heads of which screws extend into holes in the plate 19. At its center the spring carries a boss 43 having a socket which receives a stud 44 extending downward from the disc 41. The tension of the spring is upward, thereby lifting the thermal element and pressing it against the end of the adjusting screw 39. The disc 40 has a conical depression in its center, which the point of the screw enters. Therefore, the thermal element is supported in a sort of floating relationship between the spring 38 and the screw 39 which causes the movements of the thermal element to occur in a line that passes through the centers of the discs 40 and 41 of said element. The boss 43 extends downward from the spring a sufficient distance to pass through a hole 45 in the plate 19 and bear on the rivet head 28. Assuming the screw 39 has been properly adjusted, it is obvious that as the thermal element 37 expands the diaphragm 21 will be pressed toward the seat 23 more or less, according to the temperature of the atmosphere surrounding the thermal element, and even press the leather disc 27 to the seat 23 if the expansion of the thermal element is great enough, thus closing the valve entirely. The flat bottom of the boss 43 resting upon the round head of the rivet 28 provides a connection between the diaphragm 21 and the thermal element in the nature of a universal joint, and insures level seating of the diaphragm on the seat 23. Referring to the drawing it will be noticed that between the boss 43 and each of its ends the spring 38 is curved. This is to enable the boss to pass a central position without a tendency on the part of the spring to snap above or below the center. The housing 36 is provided with numerous openings 46 to permit free circulation of air around the thermal element, thereby effecting great sensibility to temperature changes. The hole 45 is enough larger than the boss 43 to prevent the latter touching the sides of the former, thus avoiding frictional resistance to the movement of the boss.

The top of the housing 36 is rabbeted to receive a circular dial 50. This dial is concentric to the adjusting screw 39, and it carries graduations, preferably numerals, representing various temperatures within the range of the instrument. The screw 39 terminates in a knurled knob 51, from one side of which a pointer 52 projects. A pin 53 is set in the dial in the path of the pointer 52, to prevent the screw being turned more than one revolution. The pitch of the screw and spacing of the dial numerals are coordinated with the coefficient of expansion of the thermal element, so that if with the pointer set at a numeral representing a given temperature the room is maintained at that temperature, the room can be maintained at any other temperature within the

range of the instrument by merely turning the screw to bring the pointer to the numeral representing the desired temperature. A compression spring 55 confined between the knob 51 and the housing holds the screw frictionally and prevents accidental disturbance of the screw after it is adjusted.

In order to adjust my regulator to local conditions, such as rooms of different sizes, heaters of different sizes, different gas pressures, etc., I provide for rotating the dial with reference to the housing 36. Two clamping screws 54 are provided for securing the dial in a desired position. After the heater is installed and connected up, its burner is lighted and the screw is adjusted so the room atmosphere is brought to and maintained at the temperature most commonly used. Then the dial is rotated to bring into registration with the pointer the numeral which represents the temperature of the room at the time, and secured in that position with the screws 54. Thereafter it is only necessary to turn the knob 51 to bring the pointer to the numeral representing a temperature which it is desired to maintain in the room, and the regulator will maintain the desired temperature.

The graduations on the dial 50 are differentially spaced to conform to the varying amount of expansion of the vapor-filled thermal element at various temperatures. It will be noted that in Fig. 2 of the drawing the numerals representing degrees progressively increase their relative angular positions at increasing temperatures. If, for instance, a temperature of 65° is maintained, the pointer must be moved through a greater angle to increase the temperature 10° than to decrease it 10°. Others before me have noted the varying rate of expansion per degree of temperature change at various temperatures in the bellows type expansion elements, but apparently it has not occurred to others that a dial differentially spaced could be rotated for calibration or adjustment purposes to bring the graduation on the dial which represents the temperature actually maintained in the room into registration with the pointer, and that thereafter any desired temperature within the range of the instrument could be accurately maintained simply by turning the pointer to the desired temperature.

One object of the by-pass 14 is to prevent extinction of the heater burner. By means of the by-pass screw 15 the flow of gas to the chamber 13 can be reduced to any desired amount, even to the minimum need of the heater burner. Another function of the by-pass is to maintain gas pressure, small though it be, under the diaphragm 21 when the valve is closed. This is effected through the port 22, which port is for that reason of liberal size, making the chambers 13 and 18 in effect one chamber, and it tends to equalize the amount of pressure necessary to close the valve 21—23 and that required to hold the valve shut after it is closed. If there were no by-pass, and consequently no pressure in the chamber 18 when the valve 21—23 is closed, it would take considerably more force to press the diaphragm down and close the valve than it would require to hold the valve closed. Since the force which closes the valve is derived from expansion of the vapor in the thermal element, it would require a considerably higher temperature to close the valve than it would require to keep the valve closed. Therefore the temperature of the room would have to fall considerably after the valve closed before it got low enough to allow the valve

to re-open. Conversely, the temperature would have to rise considerably above that at which the valve opened in order to give the thermal element sufficient power to close the valve. This difference between the closing and opening temperatures is very materially reduced by the presence of gas under pressure in the chamber 18 when the valve 21—23 is closed.

The difference between the opening and closing temperatures is further reduced by making the diameter of the seat 23 as large in proportion to the diameter of the diaphragm as is practicable, and making the capacity of the port 25 rather limited. The full pressure of the gas is in the chamber 24 when the valve is closed, which, in view of the large diameter of this chamber, exerts a considerable tendency to lift the diaphragm. On the other hand, when the valve is open the gas pressure under the whole diaphragm is considerably less than the pressure in chamber 24 when the valve is closed, because of the comparatively small capacity of the port 25, and the smallness of the flow of gas through the by-pass.

Making the seat 23 large in diameter serves another useful purpose, in that a small movement of the diaphragm from the seat effects a considerable opening of the valve. It is this which enables the valve to be operated directly with the thermal element, without the aid of levers or other mechanism for multiplying the movement of the thermal element. The metal disc 26 under the diaphragm contributes to this desideratum, by producing in the center of the diaphragm a rigid area as large as the diameter of the seat, thereby avoiding lost motion due to flexure of the diaphragm in the area enclosed by the ring 23 as the diaphragm is pressed to the seat by the thermal element. Thus I avoid mechanism having rubbing friction or lost motion. Furthermore, the comparatively small movement of the diaphragm necessary to effect a large opening of the valve favors reduction of the diameter of the diaphragm with reference to the diameter of the seat 23. Since the diaphragm need move but a short distance to effect a large opening of the valve, the difference between the diameter of the seat and the diameter of the diaphragm may be comparatively small without unduly restricting the movement of the diaphragm.

In addition to supporting the thermal element the spring 38 performs the important function of reducing, almost to the point of elimination, the effect on the thermal element due to changes in atmospheric weight (pressure). This results from concentration of the spring tension at the center of the thermal element. The ordinary variation in atmosphere pressure will affect the expansion and contraction of the thermal element at its central axis to an extent equal to a temperature change of from 15° to 20° F., if no opposition to its expansion is present. I have found that giving the spring 38 a tension such that, added to the pressure of the gas under the leather diaphragm, amounts to approximately one-half pound, reduces the effect of ordinary variations in atmospheric weight to the equivalent of about 1½° of temperature.

In operation, and as the effect of the several features above described tending to make the instrument very sensitive to comparatively small changes in temperature, the valve assumes a degree of openness just large enough to maintain the temperature of the room at that for which the instrument is set.

It will be noticed that the entire thermal part

of the instrument can be removed as a unit without disturbing any adjustments. When it is thus removed the action and general conditions of the diaphragm 21 can be ascertained by inspection through the hole 45, and if necessary a new diaphragm may be substituted, it being only necessary to remove the screws 29 and lift off the plate 19. The heads of the screws 42 are made to act as dowels to place the housing 36 in the correct position on the plate 19. To prevent reversing the position of the housing, one of the screwheads is made too large to enter the hole provided for the other head.

While I have described and illustrated what I now regard as the preferred embodiment of my invention, it is not to be supposed that it is limited in all of its details to the present structure, for modifications are possible without departure from the scope of my invention as it is defined by the appended claims. What I claim is as follows:

1. In a thermally actuated fluid-fuel regulator for a heater, a chamber connected to the fuel supply, a chamber connected to the heater burner, a valve connecting said chambers, comprising an annular seat and a flexible diaphragm, the latter lying on the seat to close the valve, said diaphragm forming one wall of the second chamber, a by-pass between said chambers which permits the uninterrupted passage of a relatively small quantity of fuel to the second chamber, and a thermally actuated element whereby said diaphragm is moved to close said valve more or less when the temperature of the surrounding atmosphere rises above a predetermined point, the circumference of said annular seat being large enough so the thermal element will permit a sufficient opening of the valve, the diaphragm being as small in diameter as possible without causing the diaphragm instead of the thermal element to limit the opening of the valve.

2. In a thermally actuated fluid-fuel regulator for a heater, a chamber connected to the fuel supply, a chamber connected to the heater burner, a valve connecting said chambers, comprising an annular seat and a flexible diaphragm, the latter lying on the seat to close the valve, said diaphragm forming one wall of the second chamber, a by-pass between said chambers which permits the uninterrupted passage of a relatively small quantity of fuel to the second chamber, a thermobellows-diaphragm, one wall of which is stationary with reference to the valve seat, the other wall bearing against the diaphragm and adapted as the bellows expands to press the diaphragm toward or even to the seat, according to the extent of the expansion, and a spring bearing against the movable wall of the bellows to oppose its expansion, whereby to reduce the variation in the operation of the regulator due to variations in the weight of the atmosphere.

3. In a thermally actuated fluid-fuel regulator for a heater, a chamber connected to the fuel supply, a chamber connected to the heater burner, and a valve connecting said chambers, comprising a seat and a flexible diaphragm, the latter lying on the seat to close the valve, said diaphragm being subject to the pressure of the fuel in said second chamber, which pressure tends to prevent the diaphragm from moving toward said seat, said seat comprising a ring of large diameter compared with the diameter of the diaphragm, the ring forming a chamber which is connected to said first mentioned chamber by a port so restricted in size that the fuel pressure under the diaphragm is less, when the

valve is fully open, than the pressure in said first mentioned chamber.

4. In a thermally actuated fluid-fuel regulator for a heater, a chamber connected to the fuel supply, a chamber connected to the heater, a valve connecting said chambers, comprising a seat and a flexible diaphragm, the latter lying on the seat to close the valve, a by-pass between said chambers which permits the uninterrupted passage of a relatively small quantity of fuel, and means whereby the fuel thus passed maintains a relatively small pressure under the diaphragm when the valve is closed; said valve seat comprising a ring of large diameter compared with the diameter of the diaphragm, the ring forming a chamber which is connected to said first mentioned chamber by a port so restricted in size that the fuel pressure under the diaphragm is less, when the valve is fully open, than the pressure in said first mentioned chamber.

5. In a thermally actuated regulator for a heater, a housing the interior of which is open to the atmosphere, a thermal expanding bellows supported therein by being confined between the pointed end of an adjustment screw carried by one wall of said housing, which pointed end impinges on the center of one wall of said bellows, and a flat elongate sheet metal spring, the ends of which are secured to opposite sides of said housing, a pointed projection from the bellows wall impinging on a surface carried by said spring at a place intermediate the ends of the spring, said two impinging points being the sole support of said bellows.

6. In a thermally actuated fuel regulator for a heater, a supporting member, a thermo-bellows, having a depression in the center of one wall and a stud projecting from the center of the opposite wall, an adjusting screw carried by the supporting member, the point of which reposes in said depression, and a guiding member carried by said supporting member, said guiding member carrying a socket in which said stud reposes, said guiding member keeping the bellows in place and permitting the stud to move to and fro as the bellows expands and contracts.

7. In a thermally actuated fuel regulator for a heater, a housing, a thermo-bellows therein, having a depression in the center of one wall and a stud projecting from the center of the opposite wall; an adjusting screw screwed into the top of the housing, the point of which reposes in said depression, and a strip of metal secured at its ends to opposite sides of the housing, carrying at its center a boss having a hole which receives said stud, said strip being flexible, thereby permitting the stud to move to and fro as the bellows expands and contracts, while serving to support the bellows.

8. In a thermostatic controller, a bellows containing thermo-expansive fluid, opposite walls of the bellows being relatively movable in response to expansion or contraction of said fluid, the center of one wall impinging on the point of a fixed abutment, the center of the opposite wall having a pointed stem, a spring carrying a seat on which the point of said stem impinges, the spring and abutment forming the sole support for the bellows and maintaining the bellows in its proper position while allowing said opposite wall to move to and fro with reference to said fixed abutment.

9. In a thermostatic controller, a bellows filled with thermo-expansive fluid, opposite walls thereof being flexible and adapted to flex in re-

sponse to expansion and contraction of said fluid in an axial line that passes through the center of each of said walls, the center of one wall abutting a V-shape point on the end of an adjusting screw, which screw carries a pointer, a circular dial associated with said screw, said dial carrying a stud to engage the pointer and prevent excessive rotation of the screw, radial graduations on the dial spaced to correspond to the expansion of the bellows at different temperatures, means for rotating the dial on its axis and securing it in different angular positions, so it will register correctly at a given temperature, and means for holding the center of the opposite wall of the bellows in alignment with the axis of said screw.

10. In a thermostatic controller, a bellows filled with thermo-expansive fluid, opposite walls thereof being flexible and adapted to flex in response to expansion and contraction of said fluid in an axial line that passes through the center of each of said walls, the center of one wall abutting a V-shaped point on the end of an adjusting screw, which screw carries a pointer, a circular dial associated with said screw, said dial carrying a stud to engage the pointer and prevent excessive rotation of the screw, radial graduations on the dial spaced to correspond to the expansion of the bellows at different temperatures, means for rotating the dial on its axis and securing it in different angular positions, so it will register correctly at a given temperature, and means for holding the center of the opposite wall of the bellows in alignment with the axis of said screw, said means permitting movement of said wall to and fro without producing rubbing friction.

11. In a thermostatic controller, a bellows filled with thermo-expansive fluid, opposite walls thereof being flexible and adapted to flex in response to expansion and contraction of said fluid in an axial line that passes through the center of each of said walls, the center of one wall abutting the V-shape point of an adjusting screw, which screw carries a pointer, a circular dial associated with said screw, said dial carrying a stud to engage the pointer and prevent excessive rotation of the screw, radial graduations on the dial spaced to correspond to the expansion of the bellows at different temperatures, means for rotating the dial on its axis and securing it in different angular positions, so it will register correctly at a given temperature, means for holding the center of the opposite wall by means of a V-shape point in alignment with the axis of said screw, and means for imposing a force on the center of said opposite wall tending to prevent expansion of the bellows, whereby to reduce variations in the action of the bellows due to variation in the weight of the atmosphere to which the bellows is subjected.

12. In a graduated action thermostatic fuel valve, a thermostatic element having two terminals relatively movable in response to changes in temperature, a valve comprising a flexible diaphragm and a circular valve seat therefor, said valve seat being large in diameter with reference to the diameter of the diaphragm, whereby to effect a large opening of the valve with a small movement of the diaphragm, means connecting one of said terminals to an abutment which is fixed relative to said seat and the other terminal to the diaphragm, whereby to effect relative movement between the seat and diaphragm equal to the relative movement of the terminals, and means for effecting said movement without rub-

bing friction, the connection to the diaphragm being in the center of the valve seat and in the nature of a universal joint, thereby insuring level seating of the diaphragm on the seat.

13. In a graduated action thermostatic fuel valve, an inlet chamber, an outlet chamber and a passage having a valve seat therebetween, a flexible diaphragm adapted to move to and from said valve seat and having a valve member to fit said seat, said diaphragm forming one wall of said outlet chamber, fuel pressure in said chamber tending to move said diaphragm away from the valve seat; a flexible expansion member exposed to atmospheric temperature and adapted upon expansion to push the diaphragm toward the valve seat, the periphery of the valve seat being comparatively large to give required opening area with small lift, the radial distance from said valve member to the perimeter of the diaphragm being only great enough to permit the required valve-member lift, whereby the area of the diaphragm externally of the valve seat is reduced to the minimum, and a by-pass for fuel from said inlet chamber to the outlet chamber, which fuel is designed to maintain as nearly uniform lifting pressure under the diaphragm as possible.

14. In a fuel regulator, a thermal element having two terminals relatively movable in response to temperature changes, a valve comprising a flexible diaphragm and a seat therefor, means connecting one of said terminals to an abutment which is fixed relative to said seat and the other terminal to the diaphragm, each connection being in the nature of a universal joint, whereby to effect relative movement between said seat and diaphragm equal to the relative movement of the terminals, and means independent of the diaphragm for guiding the terminal connected to the diaphragm.

15. In a fuel regulator, a thermal element having two terminals relatively movable in response to temperature changes, a valve comprising a flexible diaphragm and a seat therefor, means connecting one of said terminals to an abutment which is fixed relative to said seat and the other terminal to the diaphragm, each connection being in the nature of a universal joint free from rubbing friction, whereby to effect relative movement of the terminals, and means independent of the diaphragm for guiding the terminal connected to the diaphragm.

16. In a fuel regulator, a thermal element having two terminals relatively movable in response to temperature changes, a valve comprising a flexible diaphragm and a ring acting as a seat therefor, the portion of the diaphragm which coacts with said seat being rigid, means connecting one of said terminals to said seat, a spring carrying a member having two flat surfaces parallel to each other and perpendicular to a line passing through said terminals, said spring pressing one of the flat surfaces of said member against the remaining terminal, thereby insuring that said member will move to and fro in unison with the terminal when the latter moves in response to temperature changes, the opposite surface bearing against the diaphragm and pressing the diaphragm to its seat when the thermal element expands sufficiently, the spring serving as the sole guide for said member, thereby avoiding rubbing friction.

17. In a gas regulator, a thermal element having two terminals relatively movable toward and from each other in response, respectively, to re-

ductions and increases in the temperature of the atmosphere surrounding said element, a valve comprising a flexible diaphragm and a ring acting as a seat therefor, the interior of the ring being subject to gas pressure capable of pressing the diaphragm away from the ring in the absence of a superior counter pressure, the area of the diaphragm which coacts with the seat being rigid, means connecting one of said terminals with said ring, the remaining terminal consisting of a pointed stud, a flat spring supported at its ends, and at its center carrying a boss provided with a hole having a flat bottom, which bottom is perpendicular to the line wherein said stud moves in response to temperature changes and is pressed against the point of the stud by the tension of the spring, the bottom of the boss, which is parallel to the bottom of said hole, being so positioned with reference to the diaphragm that it bears against a button in the center of said rigid area of the diaphragm and presses the diaphragm to the seat when the temperature of the atmosphere reaches the point at which it is desired to cut off the gas.

18. In a gas regulator, a thermal element having two terminals relatively movable toward and from each other in response, respectively, to reductions and increases in the temperature of the atmosphere surrounding said element, a valve comprising a flexible diaphragm and a ring acting as a seat therefor, the interior of the ring being subject to gas pressure capable of lifting the diaphragm in the absence of a superior counter pressure, means connecting one of said terminals to said ring, said means comprising an adjusting screw against which said terminal bears, the remaining terminal consisting of a pointed stud, a flat spring supported at its ends at its center having a socket to receive the point on said stud, the tension of the spring being toward said adjusting screw, thereby supporting the thermal element between two points, the opposite side of the spring having a part adapted to press the diaphragm to the seat when the temperature of the atmosphere reaches a given point; a circular graduated dial through which said adjusting screw passes and a pointer carried by said screw to point to said graduations, the graduations being differentially spaced to accord with variations in the distance the terminals move at different temperatures in response to equal temperature changes.

19. In a thermally actuated regulator for a heater, a body containing a chamber connected to the fuel supply and a chamber connected to the heater burner, a valve connecting said chambers comprising a flexible diaphragm, a cover for said diaphragm, said cover being secured to said body; a housing carrying a thermal mechanism, said housing being removably secured to said cover, the thermal mechanism comprising a member which passes through a hole in said cover when the housing is connected to the cover and establishes an operative connection between the diaphragm and the thermal mechanism, said housing being removable and replaceable without disturbing the adjustment of the thermal mechanism.

20. In a thermally actuated regulator for a heater, a body containing a chamber connected to the fuel supply and a chamber connected to the heater burner, a valve connecting said chambers comprising a flexible diaphragm, a housing carrying a thermal mechanism, said housing having a smooth surface which rests upon and is se-

cured to a smooth surface carried by the body by screws, the housing being removable from and attachable to said surface without disturbing the diaphragm or changing the adjustment of the thermal mechanism, and means whereby putting the housing in place automatically establishes an operative connection between the diaphragm and said thermal mechanism.

21. In a thermally actuated regulator for a heater, a body containing a chamber connected to the fuel supply and a chamber connected to the heater burner, a valve connecting said chambers comprising a flexible diaphragm, a housing carrying a thermal mechanism, said housing having a smooth surface which rests upon and is secured to a smooth surface carried by the body by screws, the housing being removable from and attachable to said surface without disturbing the diaphragm or changing the adjustment of the thermal mechanism, means whereby putting the housing in place automatically establishes an operative connection between the diaphragm and said thermal mechanism, and means for preventing replacement of the housing in other than the same position relative to the body that it previously occupied.

22. In a thermally actuated regulator for a heater, a body containing a chamber connected to the fuel supply and a chamber connected to the heater burner, a valve connecting said chambers comprising a flexible diaphragm, a cover for said diaphragm, said cover being secured to said body, a housing secured to said member and containing a thermal mechanism comprising a spring that extends like a bridge across the housing and being secured thereto by two screws one at each end of the spring, said heads being of different diameters, holes in said member into which said screw heads enter to serve as dowels, the holes being also of different diameters so the housing can be placed on the cover in only one way, and means whereby putting the housing in place on said member automatically connects the thermal mechanism to the diaphragm, all to the end that the thermal mechanism can be removed and replaced without changing or disturbing its adjustment.

23. In combination, a valve for regulating the flow of fuel to a heater, a thermally actuated element, means whereby said element moves the valve to various degrees of closure according to changes in the temperature of the atmosphere surrounding the element, said valve being opened by the pressure of the fuel, means for adjusting the relationship between the valve and said element, whereby to maintain said surrounding atmosphere at substantially a predetermined temperature, said means comprising a circular dial carrying a graduated scale indicating temperatures and a pointer mounted in the center thereof and revoluble with reference thereto to point to any graduation thereon, the graduations on said dial being differentially spaced, said dial being itself revoluble by way of initial adjustment to bring into registration with the pointer the graduation which represents the temperature at the moment surrounding the thermally actuated element.

24. In combination, a valve for regulating the flow of fuel to a heater, a thermally actuated element, means whereby said element moves the valve to various degrees of closure according to changes in the temperature of the atmosphere surrounding the element, said valve being opened by the pressure of the fuel and means for adjusting the relationship between the valve and said element, whereby to maintain said surrounding atmosphere at substantially a predetermined temperature, said means comprising a circular dial carrying a graduated scale indicating temperatures and a pointer mounted in the center thereof and revoluble with reference thereto to point to any graduation thereon, the graduations on said dial being differentially spaced, said dial being itself revoluble by way of initial adjustment to bring into registration with the pointer the graduation which represents the temperature at that moment surrounding the thermally actuated element, and a stud carried by the dial in the path of the pointer to limit the movement of the latter to a single revolution around the dial.

25. In a thermostatic controller, a bellows filled with expansive fluid, opposite walls thereof being adapted to move toward and from each other in response to expansion and contraction of said fluid, one wall abutting a point on an adjusting screw which carries a pointer, a dial associated with said screw, radial graduations on the dial representing temperatures at which it may be desirable to maintain the atmosphere surrounding the bellows, said graduations being differentially spaced, the opposite wall of the bellows abutting the member to be controlled by the bellows, said dial being revoluble about the adjusting screw by way of initial adjustment of the controller.

26. In a thermally actuated fluid-fuel regulator for a heater, a chamber connected to the fuel supply, a chamber connected to the heater burner, a third chamber, a valve connecting said first and third chambers through a port no larger than necessary to pass enough gas to supply the burner, a port connecting the second and third chambers, which port is very much larger than the previously mentioned port and thereby making the second and third chambers practically one, said valve comprising an annular seat and a flexible diaphragm which lies on the seat to close the valve, said diaphragm forming one wall of the third chamber, a by-pass connecting the first and second chambers, which permits of a relatively small quantity of fuel flowing to the second chamber, and a thermally actuated element whereby said diaphragm is moved to close said valve more or less when the temperature of the surrounding atmosphere rises above a predetermined point, the circumference of said annular seat being large enough so the thermal element will permit a sufficient opening of the valve, the diaphragm being as small in diameter as possible without causing the diaphragm instead of the thermal element to limit the opening of the valve.

OTTO J. KUENHOLD.