Sept. 19, 1944. W. L. HAWK ET AL 2,358,637

THERMOSTATICALLY OPERATED VALVE MECHANISM

Filed Nov. 17, 1941 2 Sheets-Sheet 1

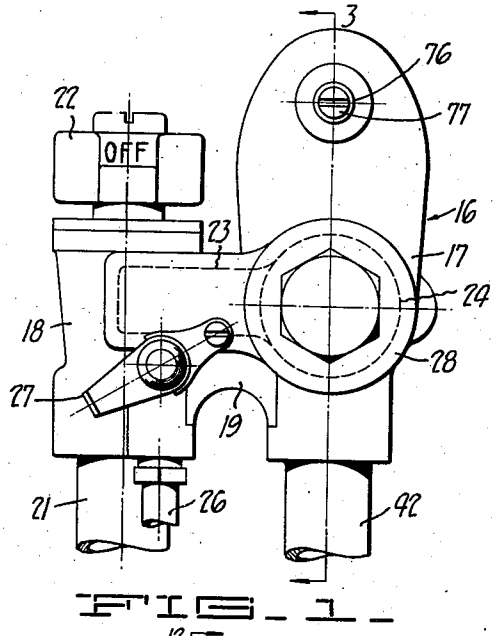

FIG. 1

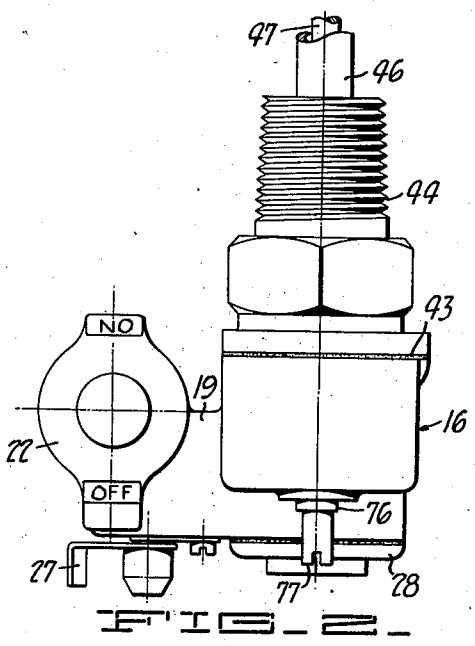

FIG. 2

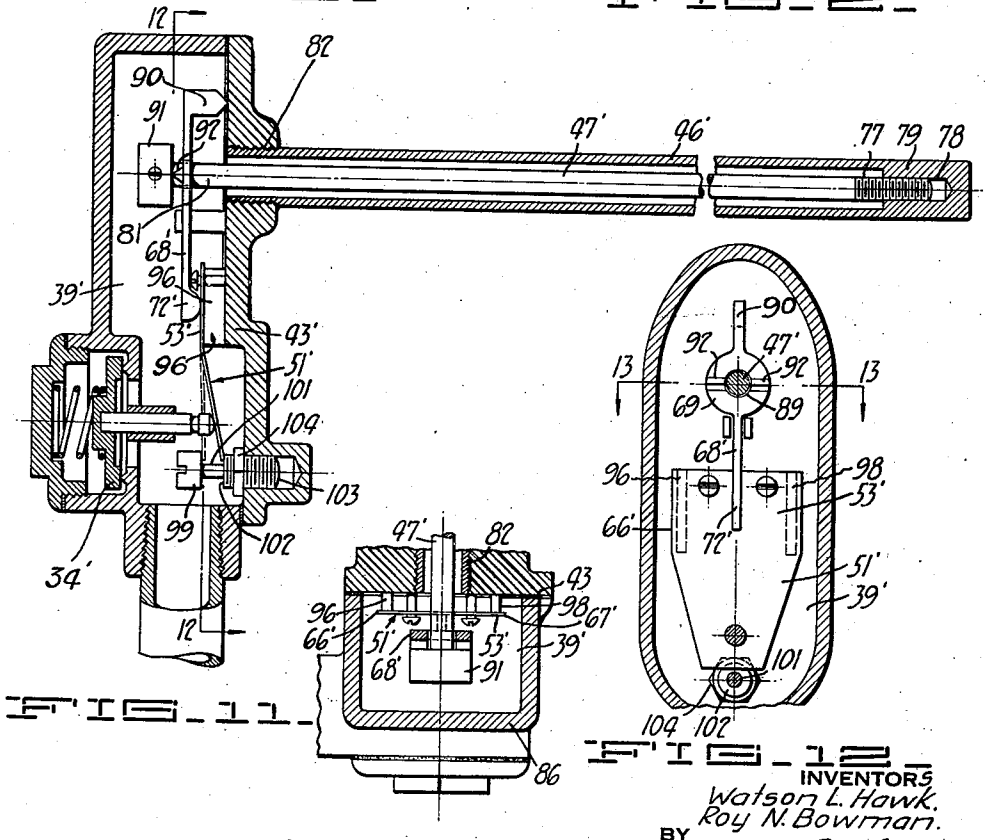

FIG. 11

FIG. 12

FIG. 13

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THERMOSTATICALLY OPERATED VALVE MECHANISM

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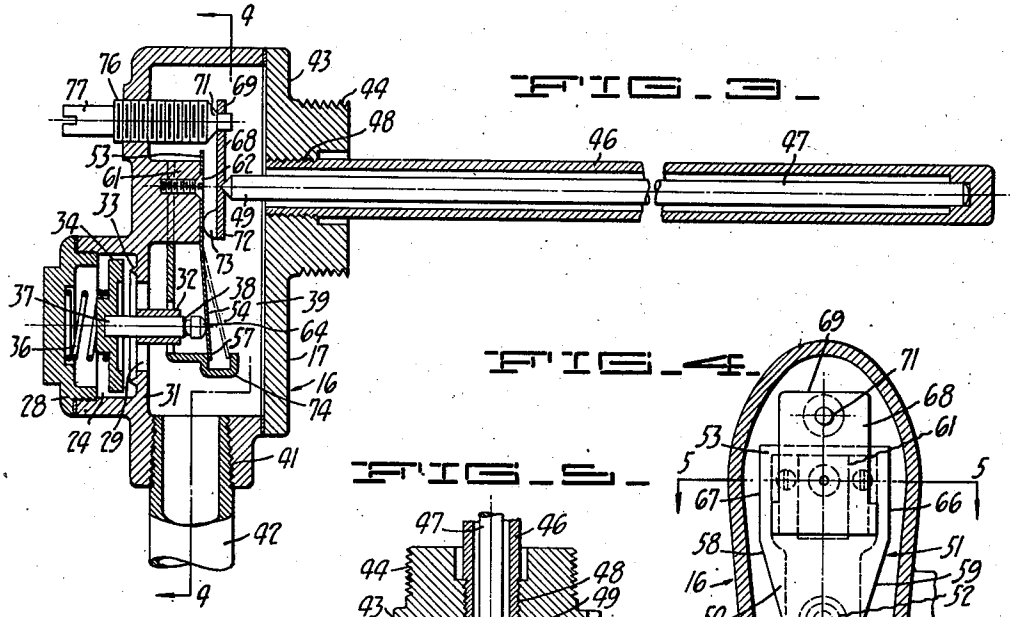

FIG. 3.

FIG. 4.

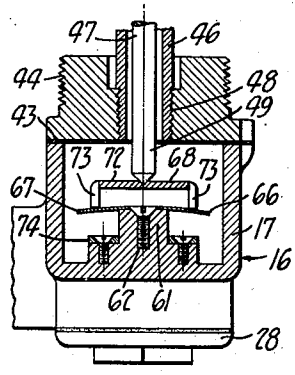

FIG. 5.

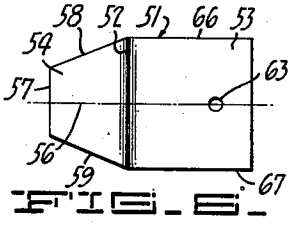

FIG. 6.

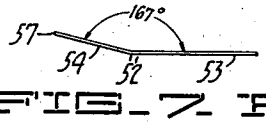

FIG. 7.

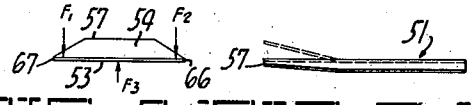

FIG. 8.

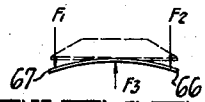

FIG. 9. FIG. 10.

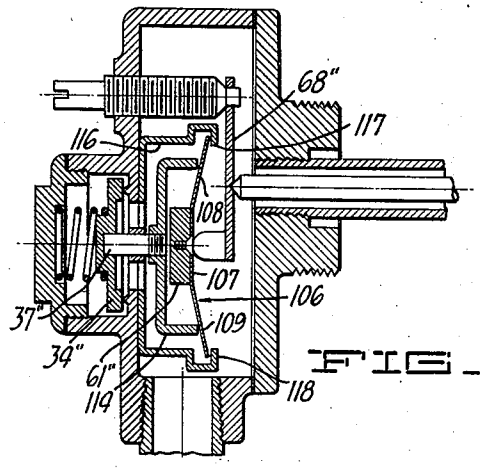

FIG. 14.

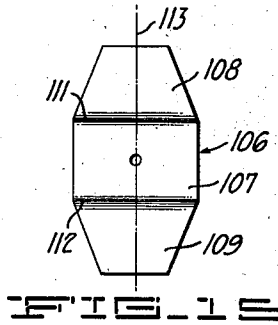

FIG. 15.

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UNITED STATES PATENT OFFICE

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THERMOSTATICALLY OPERATED VALVE MECHANISM

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Application November 17, 1941, Serial No. 419,444

5 Claims. (Cl. 236—48)

The invention relates to thermostatically operated snap-acting valve mechanisms and more particularly to the construction of the "clicker" or snap-acting device and valve combination.

In the thermostat art, various types of snap-acting or so-called "clicker" devices have been used in the chain of movement between a temperature responsive element and a control member such as a valve or switch. Many devices, however, which are successful for moving a contact arm of an electric switch with snap-action, are not successful for opening and closing a valve for the reason that in the latter case a great deal more force and power is required to open the valve with snap action to overcome the greater inertia of the valve parts and the resistance of the usual fluid back pressure and valve closing spring urging the valve to its seated or closed position. An object of the present invention is to provide a clicker device of the character described which although very simple in its construction and operation, will nevertheless possess sufficient power in its snap movement to properly open a gas valve and to hold the valve in open position.

Another object of the invention is to provide a snap acting mechanism of the character described which will have sufficient throw to insure an abundant flow of gas through the open valve.

A further object of the invention is to provide a mechanism of the character described having improved sensitivity thereby affording a so-called "short range" thermostat operating upon a temperature differential of well under 10° Fahr. where desired.

Yet another object of the invention is to provide mechanism of the character described having an improved adjustable control for the operating temperature of the device.

Still another object of the invention is to provide a thermostatically operated gas valve mechanism of the character above which will withstand extreme temperature changes and may be subjected to freezing temperatures without injury to the mechanism.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings:

Figure 1 is a front elevation of a thermostatically operated gas valve mechanism constructed in accordance with the present invention.

Figure 2 is a plan view of the mechanism illustrated in Figure 1.

Figure 3 is a vertical sectional view of the mechanism taken substantially on the plane of line 3—3 of Figure 1.

Figure 4 is a vertical sectional view taken at substantially right angles to the plane of Figure 3 and as indicated by the plane of line 4—4 of Figure 3.

Figure 5 is a cross sectional view of the mechanism taken substantially on the plane of line 5—5 of Figure 4.

Figure 6 is a plan view of the clicker strip used in the present mechanism.

Figure 7 is a longitudinal edge view of the clicker strip.

Figure 8 is an end elevation of the clicker strip.

Figure 9 is a side elevation of the clicker strip as shown in a snapped position with respect to Figures 6–8.

Figure 10 is an end elevation of the clicker strip in its snapped position.

Figure 11 is a vertical sectional view of a modified form of construction of the mechanism.

Figure 12 is a vertical sectional view taken at substantially right angles to the plane of Figure 11 and as indicated by the plane of line 12—12 of Figure 11.

Figure 13 is a cross-sectional view of the modified form of mechanism and is taken substantially on the plane of line 13 of Figure 12.

Figure 14 is a vertical sectional view of a further modified form of the invention.

Figure 15 is a plan view of the clicker strip used in the form of the invention illustrated in Figure 14.

The thermostatically operated gas valve mechanism of the present invention consists briefly of a snap-acting device consisting of a strip of resilient material bent along a transverse axis to define intersecting planar portions, the combination of temperature responsive means and an abutment engaging one of these portions and operative upon an increase in temperature to arch the portion in intersecting relation to the transverse bend, whereby the opposite end portion of the strip is caused to snap into a straight line position with the first portion with the snapping

end portion arched in conformity with the first portion so as to form a straight rigid longitudinal member, and an organization of parts including a valve and means connecting the valve to the free end portion of the strip and arranged whereby such end portion in snapping to its straight arched position, will open and hold open the valve. Other important features of construction will appear in the following detailed description of the mechanism.

With reference more specifically to the accompanying drawings, the thermostatically operated gas valve mechanism is housed in a casing **16**, here formed as a cast body, (see Figures 1 and 2) having two main portions **17** and **18** each of hollow construction and connected by a hollow bridge piece **19**. The body portion **18** is formed at the lower end thereof with a gas inlet opening in which is fitted a gas supply conduit **21**, and is further provided in the interior thereof with a valve chamber and a manual shut-off valve, not shown, operated by a handle **22** at the top of the body portion **18**. Above the shut-off valve, the hollow passage **23** in the bridge portion **19** connects with the interior gas passage in the body **18** and leads off laterally through the bridge piece **19** into a valve chamber **24** at the front of the body portion **17**. A pilot gas passage also leads off from the interior gas passage of the body portion **18** above the shut-off valve and a conduit **26** is connected to the body for conveying gas to the pilot burner. Also preferably, a pilot shut-off valve is incorporated in this latter passage and operated at the exterior of the body by means of a lever **27**. The construction of the body portion **18** and the several passages and valves above mentioned, form no part of the present invention and are more or less standard construction and practice and hence a detailed showing of the same has not here been made. It is sufficient for present purposes to merely note that in the normal operation of the device, gas will flow from conduit **21** into the interior of the body part **18** and then laterally through passage **23** into the valve chamber **24**.

With reference to Figure 3, it will be seen that the inlet gas chamber **24** in the body part **17** is closed on the front side thereof by a plug **28** threaded into the chamber, and that the gas is discharged from the chamber by way of a plurality of discharge openings **29** provided in the base wall **31** of the chamber about a central valve stem support **32**. Formed in the base wall **31** around the openings **29** and facing into the chamber, is an annular valve seat **33** which is adapted to engage the forward face of a valve **34** mounted in the chamber between the seat **33** and the inside wall of the plug **28**. A helical spring **36** is compressed between the plug and the valve for normally urging the valve to the seat **33**. The valve is mounted for movement to and from its closed position against the seat **33** by means of a valve stem **37** carried by the valve axially thereof and mounted for reciprocation through a cylindrical opening provided in the valve stem support **32**, the opposite free end **38** of the valve stem projecting through the support **32** and into an adjacent interior compartment **39** in the body portion for operation by the valve opening means. Gas is discharged from the compartment **39** in the open position of valve **34** by way of an opening **41** in the base of the body, and to which is connected a conduit **42** leading to the gas burner of the heating system which the present valve mechanism is designed to control.

The device as illustrated in Figures 1 to 10 and 14 and 15 of the accompanying drawings is designed for use with a storage type of hot water heater and is accordingly formed on the rear side **43** of the body portion **17** with a threaded plug part **44** which is adapted to be threaded into a suitable opening formed in the side of the hot water tank. A thermal connection with the hot water in the tank is here obtained in the customary manner by means of a rod and tube thermostat including a tube **46** of copper or other heat expanding metal and a rod **47** of ferrous (invar) metal or other material having a low coefficient of heat expansion. The tube **46**, as will be noted, is threaded into a passage **48** centrally through the plug **44** so as to rigidly secure the inner end of the tube to the body, the majority of the length of the tube thereby projecting from the plug for direct engagement with the hot water in the tank. The rod **47** extends axially through the tube **46** and the outer end of the rod is fastened to the outer end of the tube whereby the rod and tube move as a unit thereat, thereby producing a relative movement between the inner end **49** of the rod and the inner end of the tube and the body. By reason of this construction and as will be readily understood, an expansion of the tube **46** caused by an increase of temperature of the water in the tank will cause a movement of the inner end **49** of the rod to the right, as viewed in Figure 3, and contrawise a contraction of the tube **46** caused by a cooling of the water in the tank will cause a movement of the inner end **49** of the rod to the left.

In accordance with the present construction, means is provided for transmitting the relative movement of the inner end of the rod to the valve **34** whereby upon cooling of the water in the tank to a predetermined temperature, the valve will be opened to fire the burner under the water heater and when the water in the tank has been heated to a predetermined temperature, the valve will be closed. Due to the fact that the available movement at the inner end **49** of the rod is relatively small compared to the necessary movement of the valve, the rod movement is amplified in its transmission to the valve and also for reasons well understood in the art, a snap-acting device is incorporated in the chain of movement so as to cause the gas valve **34** to snap open and to snap closed after the rod end **49** has moved a predetermined distance.

The snap-action device, or as sometimes referred to as the clicker, consists of a sheet or strip **51** of resilient material such as spring steel and is bent along a transverse line or axis **52** so as to define substantially planar end portions **53** and **54** which intersect at the transverse line **52**. We have found that best operation of the clicker is obtained when the planar portions **53** and **54** are disposed at an obtuse angle with respect to line **52** of approximately 167°, as illustrated in Figure 7. Now if distorting forces are applied to one of the planar portions, such as portion **53**, so as to cause the latter to arch or curve about a longitudinal line or axis **56**, the arch formed in the portion **53** will intersect the transverse line of bend of line **52** and if the portion **53** is arched sufficiently, the opposite end portion **54** will spring into a straight line position along the longitudinal axis **56** and be

held in arched form continuous with portion 53. As the distorting forces applied to portion 53 are released and this portion permitted to return to its normal planar position, the end portion 56 will spring to its normally inclined planar position by reason of the inherent set in the strip.

The foregoing operation of the clicker is illustrated in Figures 7 to 10 of the drawings. In Figure 8 the distorting forces tending to arch the portion 53 are illustrated as F_1 and F_2 depressing the opposite edges of the strip portion 53 and F_3 operating in an opposite direction at the center of the strip. The effecting of the arching of the member is illustrated in Figure 10. In accordance with the present invention the forces F_1, F_2 and F_3 are continuously applied in accordance with and proportional to the thermostatic movement of the rod end 49, while the movement of the opposite end portion 54 of the strip is sudden and discontinuous and effected only after forces F_1, F_2 and F_3 have moved a predetermined distance.

With reference to Figures 7 to 10, it will be noted that the forces F_1, F_2 and F_3 move but a relatively small distance to produce a substantially greater movement of the free end portion 54 of the strip, whereby amplification of movement is obtained. We have also found that the operation of the strip is substantially improved when the free end portion 54 is narrowed in width toward the free end 57 thereof. Thus we prefer to taper the side edges 58 and 59 of the end portion 54 from the bend line 52 towards the free edge 57.

While the strip provides a positive snap action throw of the end portion 54 in opposite directions as aforementioned, we have found that the portion 54 moves into its arched straight line position, as illustrated in Figures 9 and 10, with considerably more vigor than its return snap movement to its normal planar position, as illustrated in Figures 7 and 8. In its arched position, the end portion 54 is very rigid to laterally applied forces by reason of its arched conformation. As above mentioned, in the opening and closing of a gas valve of the present character, a substantially greater force and more energy is required to open the valve with snap action than to close the valve with snap action, by reason of the gas pressure and valve closing spring both operating to urge the valve to its seated position and to hold the valve in seated position. In view of the foregoing and as an important feature of the present construction, the clicker mechanism is so arranged as to produce an opening of the valve 34 upon snap movement of end portion 54 to its arched straight line position, whereby the maximum force and energy is made available for opening the valve.

Applying the above to the present structure, and with special reference to Figures 3, 4 and 5, it will be noted that the base portion 53 of the strip is mounted centrally thereof on a relatively narrow abutment 61 which extends longitudinally centrally of the strip. The base portion 53 may be secured to the abutment in any desirable manner, as for example by means of a screw 62, here threaded into the abutment and engaging through an opening 63 in the strip. As will be seen from Figures 3 and 5, the abutment 61 is formed as an integral portion of the front wall of the casing and is arranged in longitudinal alignment with the valve stem 37, whereby with the strip supported as aforesaid, the opposite free end portion 54 of the strip is in juxta-position with the outer end 38 of the valve stem and is adapted to engage the valve stem in snapping over to a straight line position to open the valve. Preferably in order to permit adjustment of the operative connection between the strip and the valve stem, a screw 64 is threaded into the end 38 of the valve stem for engagement with the strip portion 54. In this instance the abutment 61 serves to provide force F_3, as illustrated in Figures 8 and 10, and by reason of the narrowness of the abutment, see Figure 5, the side edges 66 and 67 of the strip portion 53 are unsupported and may be moved in the direction of the abutment to arch the base portion of the strip as above described.

The depressing forces on the side edges 66 and 67 of the strip, and corresponding to forces F_1 and F_2, illustrated in Figures 8 and 10, are here provided by means of a movement amplifying lever 68 operatively connected to and actuated by the end 49 of the rod. As will be seen from Figure 3, one end 69 of the lever is mounted on a fulcrum 71, while the opposite end 72 is formed with side projections 73, see Figure 5, which engage the strip adjacent the side edges 66 and 67 to force the strip into an arched position over the abutment 61. The lever is engaged intermediate its length by the free end 49 of the thermostat rod whereby amplification of movement is obtained.

In the operation of the device, when the water in the storage tank has been heated to a predetermined temperature, the rod end 49 will be moved to the right and the stress on the base portion 53 of the strip released sufficiently to permit the opposite end portion 54 of the strip to assume its normal planar position, thereby permitting the valve 34 to seat and close off the gas flow to the burner. As the water in the tank begins to cool, the rod end 49 of the thermostat is forced to the left, thereby urging the base portion 53 of the strip to its arched position and when this movement has continued to a point of instability of the strip, the free end portion 54 of the strip will rapidly snap over into the straight line position aforementioned and open valve 34. In order to obtain a proper opening and closing of the valve, we have found that it is desirable to limit the throwing movement of strip end 54 to something less than its full throw if unrestricted. This means is here in the form of a bracket 74 which is mounted under the free extremity 57 of the strip and is of channel form in cross section, as viewed in Figure 3, so as to limit the throw of the strip end 57 to the internal dimensions of the channel.

As an important feature of the present construction we provide means for adjusting the device to operate at various predetermined temperatures, so that the water in the tank may be maintained at any desired temperature within the range of operation of the device. Such an adjusting means is here effectively provided by the provision of adjusting the position of fulcrum 71, whereby the relationship of the longitudinal position of rod end 49 and the stress on the strip may be adjusted and controlled. As here shown, the fulcrum 71 is provided on the end of a screw member 76 threaded through a wall of the casing and engageable at its outer end 77 to permit adjustment. As will be understood, a threading of the screw into the body will displace the lever toward the end of the rod

whereby the latter at higher temperatures will cause the strip to snap over, and contrawise an unthreading of the screw 76 from the body will retract the lever from the rod, thereby shifting the critical movement of the rod, and the corresponding snapping of the strip, to a point to the left or at a lower temperature.

As will be clear from the foregoing, the provision of an organization of parts wherein the clicker strip operates to strike the valve stem and move the valve to open position in the snap movement of the strip to its arched position, takes advantage of the strongest and most powerful movement of the strip for opening the valve. In this manner, and notwithstanding the use of a relatively light weight strip member, we obtain sufficient snap acting force to insure a rapid snap opening of the valve and the maintaining of the valve in open position until released by the strip. It will further be noted that the free end portion 54 of the strip is of substantial length, whereby the same moves through a considerable length in its snap movement, thus insuring a sufficient opening of the valve for abundant gas flow. As another important feature of the construction, and as mentioned in the foregoing, there is sufficient amplification of movement in the chain of movement from the rod to the valve to obtain desirable sensitivity of the apparatus. Where desired the present apparatus can be designed to operate well under a 10° Fahr. temperature variation. While the apparatus possesses a high degree of sensitivity, the same may nevertheless be subjected to very wide temperature variations without injuring the mechanism. As will be seen from Figure 10 of the drawings, the strip may be arched well beyond its operating position without injuring the strip as might occur should the device be subjected to temperatures far below the operating temperature to which the mechanism is set.

A modified form of the invention has been illustrated in Figures 11 to 13 wherein the clicker device as above described with slight modification has been adopted for use in a safety pilot shut-off valve mechanism. In such a construction the thermostat tube 46' is mounted in juxtaposition to the pilot burner of a main gas burner and is heated by such pilot burner and is operative upon accidental extinguishment of the pilot burner to contract and cause the closing of a valve 34' in the main burner gas line to thereby prevent the flow of gas to such main burner until the pilot light has been reestablished. One principal difference between this form of device and that illustrated in the embodiment of the invention above, is that the rod 47' in the safety pilot shut-off is operated in tension rather than in compression, as in the first form of the invention. As will be seen from Figure 11 the outer end 77 of the rod is threaded into a receiving socket 78 in the outer end 79 of the thermostat tube 46', whereby the longitudinal position of the rod in the tube may be adjusted by relative rotation, thus determining the operating temperature of the device. The opposite end 81 of the rod projects from the inner end 82 of the tube into the interior compartment 39' of the body and passes through an opening in an amplifying lever 68' intermediate the latter's length and is operatively connected to the lever at the forward side thereof by means of a collar 91 pinned to the rod and engaging the forward side of the lever through the medium of fulcrums 92. In this embodiment, the clicker strip 51' is supported at the rear wall 43' of the compartment 39' and is engaged by the lower end 72' of the amplifying lever 68', the latter being fulcrumed against the rear wall at its upper end 90 whereby upon expansion of tube 46' and corresponding tensioning of rod 47', the lever will be rotated in a counterclockwise direction, as viewed in Figure 11, to apply an operating force to the base part 53' of the clicker strip. In this form of the invention the base portion 53' of the clicker strip is supported against a pair of transversely spaced abutments 96 and 98 which engage the strip adjacent the side edges 66' and 67' thereof, and the lever end 72' engages the strip centrally between the projections 96 and 98, whereby upon movement of the lever against the strip, the latter will be forced to an arched straight line position as above described to open and hold open the valve 34'. In accordance with the foregoing and with reference to Figure 11, it will be seen that so long as the pilot burner remains ignited the rod 47' will be placed in tension, drawing the collar 91 against the lever thereby holding the strip in its straight line valve opening position. Upon extinguishment of the pilot flame, and attendant cooling and contraction of tube 46', the force on the strip will be released thereby permitting the same to assume its normal bent position as shown in full lines in Figure 11, thus permitting the valve to move to its seated position under the influence of the gas pressure and the valve closing spring. It will be noted in this adaptation of the invention that a severe cooling of the instrument can at no time subject the clicker strip to an unreasonable distorting force because the colder the instrument the less force is applied to the clicker strip.

In this form of the invention as in the previous form, the opening movement of the valve and the amount of movement permitted the free end portion of the strip, is preferably adjustably controllable. As will be seen from Figure 11, the lower end of the strip is here confined between the head 99 and the screw 101 and the end 102 of a sleeve 103 carrying the screw and in turn threadably carried by the rear wall of the body. The position of the end 102 of the sleeve is fixed by means of a lock nut 104 mounted on the sleeve and engaging the wall, and the position of the head 99 of the screw is determined by the relative threaded engagement of the screw and sleeve. As aforementioned, the spacing between the screw head and the sleeve end is preferably adjusted to something less than the full normal throw of the free end of the strip.

A further modified form of the invention has been illustrated in Figures 14 and 15 wherein the clicker strip 106 is so arranged that a distorting force applied to a center portion 107 thereof will cause the end portions 108 and 109 to move with snap action, whereby movement may be taken from both ends of the strip. As here shown, the end portions 108 and 109 are bent from the plane of the center portion 107 along spaced transverse lines or axes 111 and 112 whereby the arching of the center portion 107 about a longitudinal line or axis 113 will cause the end portions 108 and 109 to spring into a straight line arched position. With reference to Figure 14, it will be seen that the center portion 107 is mounted upon a central abutment 61'' and is operated by a movement amplifying lever 68'', as in the first embodiment, and the end portions 108 and 109

are arranged in juxta-position to a yoke member 114 secured to the valve stem 37''. The amount of movement permitted the free ends 108 and 109 is limited by a bracket member 116 having channel portions 117 and 118 arranged about the free strip ends in a similar manner to that shown in connection with the first embodiment. In this form of the invention it will be noted that as the water in the tank is heated to a predetermined temperature, the distorting force on the center portion of the disc is relieved whereby the strip end portions 108 and 109 spring to their normal position, thereby permitting a seating of the valve 34''. On the other hand as the water in the tank cools, the distorting force is applied to the center portion 107 of the disc, causing the latter to arch along line or axis 113 and after a predetermined distortion of the center portion, the strip end portions 108 and 109 will spring into a straight line arched position thereby striking and displacing the yoke 114 and opening the valve 34'' with snap action.

We claim:

1. In a snap acting mechanism for opening and closing a valve, a sheet of resilient material having substantially planar portions intersecting along a substantially straight line, temperature responsive means and an abutment engaging one of said portions and operative upon a change in temperature to arch said portion in intersecting relation to said line whereby to cause said other portion to snap into a continuous arched position with respect to said first portion, and an organization including a valve and means connecting said valve to said other portion arranged whereby said portion in snapping to arched position will open and hold open said valve, said other portion having a free end and a stop engaging said free end in one of the positions of said other portion.

2. In a snap acting mechanism for opening and closing a valve which is spring-pressed to assume a closed position, a sheet of resilient material having substantially planar portions intersecting along a substantially straight line, temperature responsive means and an abutment engaging one of said portions and operative upon a change in temperature to arch said portion in intersecting relation to said line whereby to cause said other portion to snap into a continuous arched postion with respect to said first portion, and an organization including a valve and means connecting said valve to said other portion arranged whereby said portion in snapping to arched position will open and hold open said valve against the resistance of the valve spring, said other portion having a free end, and a stop engaging said free end in one of the positions of said other portion.

3. In a snap acting mechanism for opening and closing a valve which is spring-pressed to assume a closed position, a sheet of resilient material bent along a transverse line to provide substantially planar portions intersecting at said line, temperature responsive means and abutment means engaging one of said portions and operative upon a change of temperature to arch said portion in intersecting relation to said line whereby to cause said other portion to snap into a continuous arched position with respect to said first portion and upon a reverse change in temperature to permit return of said first portion towards its planar position whereby said second portion will snap into its normal inclined planar position, said second portion being adapted for connection to said valve for opening same against the resistance of the spring when said first portion is arched as aforesaid and closing the valve upon snap action of said second portion in reverse direction, said second portion having a free end and means for controlling the amount of valve opening comprising a stop engaging the free end of said second portion.

4. In a snap acting mechanism of the character described, an elongated strip of resilient material formed with a bend along a transverse axis to define substantially planar end portions inclined to each other, means for supporting one of said portions at substantially the transverse center thereof with the other of said portions in juxtaposition to a valve to be operated, a thermostatic element adapted to move upon temperature changes, a lever engaged by said element and having spaced pressure points engaging said first portions adjacent the transverse edges thereof on opposite sides of said supporting means to cause an arching of said first portion about said supporting means and in intersecting relation to said axis to produce a sudden movement of said other end portion into a substantially straight line arched position with respect to said first portion.

5. A thermostatically operated gas valve comprising, a casing having a valve compartment defined in part by the front wall of said casing, a gas valve mounted in said compartment and supported for movement to and from a seated passage closing position, a valve stem carried by said valve and extending axially therefrom, an elongated strip of resilient material being bent along a transverse axis to provide substantially planar end portions inclined to each other, means along the longitudinal center of the strip for supporting one of said portions on said front wall with the other of said portions in juxtaposition to said valve stem, a screw member threaded through said front wall in substantially aligned position with respect to said valve stem and said supporting means, a lever having one end thereof fulcrumed upon the inner end of said screw member and the opposite end thereof engaged with said first strip portion and having points at opposite sides coacting with said supporting means to distort said first strip portion into an arched form intersecting said axis to cause snap action of the opposite end portion of said strip, and a thermostatic element movable according to temperature changes carried by the rear wall of said casing and adapted for mounting within a hot water tank or the like and having one end thereof engaged with said lever to produce the aforesaid distortion of said first strip portion.

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