March 29, 1932. J. H. GRAYSON 1,851,277

THERMOSTAT

Filed Feb. 21, 1929

Fig. 1.

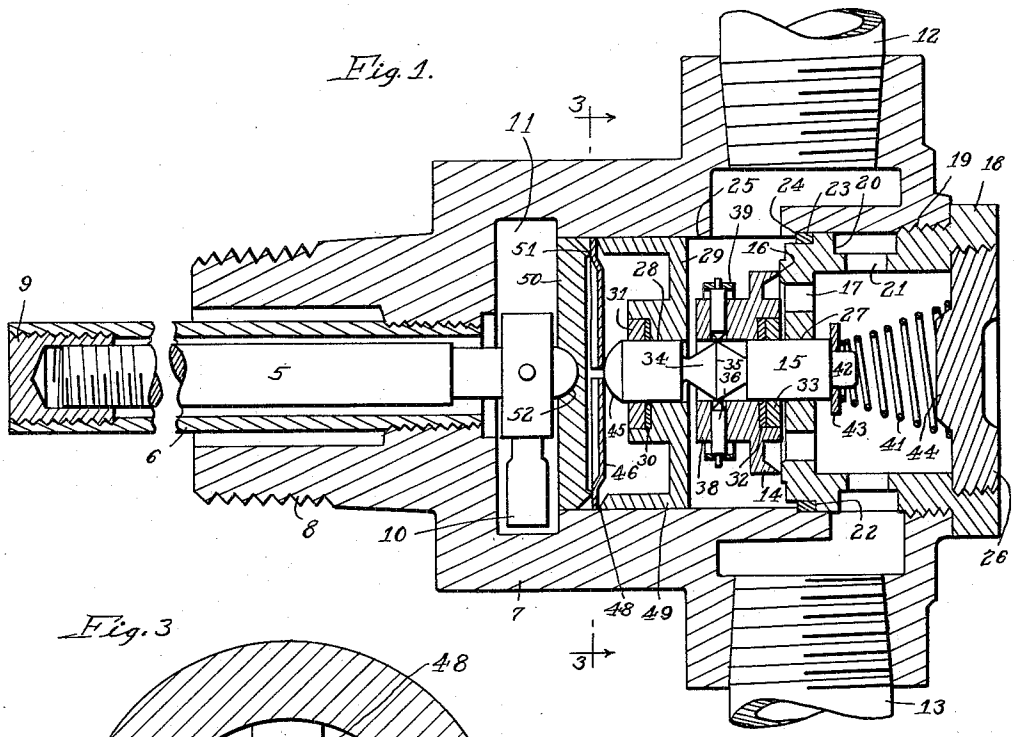


Fig. 3

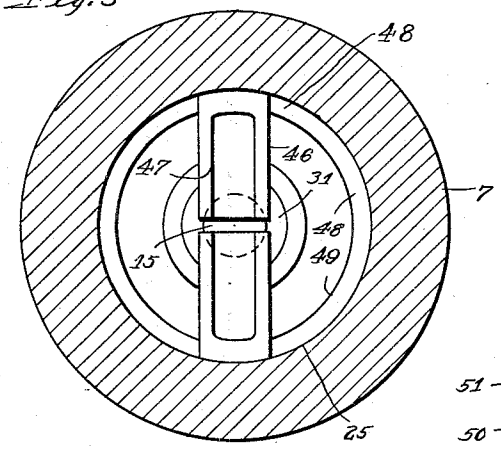


Fig. 2

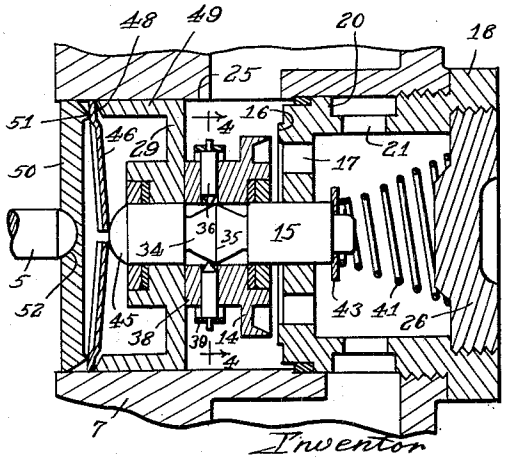
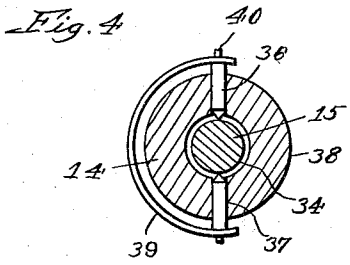


Fig. 4



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Patented Mar. 29, 1932

1,851,277

UNITED STATES PATENT OFFICE

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THERMOSTAT

Application filed February 21, 1929. Serial No. 341,608.

This invention relates to a snap action thermostat adapted for use with water heaters and similar devices, the same being especially designed to suit the requirements of gas operated devices of that general description.

The principal object of my invention is to provide a thermostat which is extremely quick in its action, will function within a very short temperature range, can be easily adjusted to suit requirements, and can be easily taken apart and put together again whenever it is desired to clean or inspect the same. Still more particularly, it is the object of this invention to provide a snap action thermostat which does not require the use of a spring metal diaphragm but embodies a mechanism which will maintain the valve in wide open position up to the instant it is snapped closed and will likewise maintain the valve tightly closed up to the instant it is snapped open, another advantage of this mechanism being in the fact that extreme temperature conditions cannot possibly result in any injury thereto.

According to my invention the valve is slidably mounted on a plunger suitably mounted for reciprocation in the center of the valve seat, said plunger having a portion thereof profiled in the form of a double cone, preferably coaxial with the rest of the plunger, and having one, two or more pins slidably mounted in radial bores in the hub of the valve having their inner ends pointed and spring pressed into engagement with the double cone cam surface on either side of the middle thereof, whereby to hold the valve yieldingly but with appreciable pressure either in the open or closed position, slight movement of the plunger in one direction serving to cause the valve to snap open, and slight movement in the other direction causing the valve to snap closed by reason of the pins being caused to ride over the middle or high point of the cam surface from one side to the other. The plunger is arranged to be operated positively in one direction by the movable thermostatic element through the medium of any suitable movement amplifying means and is arranged to be returned by spring action.

These and other features of the device of my invention will be discussed in the following specification in which reference is made to the accompanying drawings, wherein—

Figure 1 is a section through a thermostatically controlled gas valve for a water heater, embodying my invention, the valve being shown closed;

Fig. 2 is a similar view of a part of Fig. 1 showing the parts changed in position corresponding to the open position of the valve;

Fig. 3 is a cross-section on the line 3—3 of Fig. 1, and

Fig. 4 is a cross-section on the line 4—4 of Fig. 2.

The same reference numerals are applied to corresponding parts throughout the views.

The thermostat in connection with which I illustrate my invention comprises the usual rod and tube elements 5 and 6 respectively, the one being substantially non-expanding because of its low coefficient of expansion, and the other being expansible by reason of its comparatively high coefficient of expansion. I prefer to make the element 5 of a rod of invar, which, as is well known has substantially no expansion or contraction with changes in temperature, and prefer to make the element 6 of a brass or copper tube so as to expand and contract with temperature variations. The tube 6 is threaded or otherwise suitably fixed in the cast hollow valve body 7 inside the externally threaded plug portion 8 thereof, by means of which the valve body is arranged to be mounted in the side or bottom of the tank of a gas operated water heater or the like. The rod 5 is adjustably secured at its outer end in the outer end of the tube 6, as by threading into a plug 9, which in turn is preferably threaded and soldered in place in the end of the tube 6 so as to be held against turning. From this description it must be evident that expansion and contraction of the tube 6 causes slight endwise movement of the rod 5 and that a temperature adjustment may be secured by simply turning the rod 5 in the plug 9. For the latter purpose I provide a lever 10 fixed on the inner end of the rod 5 and extending through a slot 11 provided in the side of the body 7 adjacent the plug end 8 thereof.

The valve body 7 is connected between

pipes 12 and 13, the former extending from the gas main and the latter being connected to the burner of the heater. A by-pass connection (not shown) from the pipe 12 to the pilot light of the burner is usually provided. The flow of gas from the pipe 12 to the pipe 13 is arranged to be controlled by means of a disc valve 14 slidably movable on a plunger 15 toward or away from the seat 16 to cover or uncover a plurality of ports 17 provided in the inner end of the hollow plug 18 threaded into the valve body 7, as shown at 19. The plug 18 is cylindrical and intermediate its ends has an annular groove 20 formed on the outside thereof with which a plurality of ports 21 provided in the wall of the plug have communication. In this way it is not necessary to have the plug 18 assume any certain position in the body 7 to permit the flow of gas from the pipe 12 to the pipe 13 through the ports 17 and 21. The inner end of the plug 18 is slightly reduced to provide an annular shoulder 22 thereon for the purpose of compressing packing 23 between the plug and an annular shoulder 24 formed by a slight enlargement of the cylindrical bore 25 of the body 7, whereby to prevent any leakage of gas through the valve body about the plug. A plug 26 is threaded in the outer end of the plug 18 to seal the valve body.

The plunger 15 is slidably received at one end in a center hole 27 provided in the inner end of the plug 18 and at the other end in a center hole 28 provided in a plug 29 having a press fit in the bore 25 of the body 7. A graphite-asbestos washer 30 is disposed in a recess in the plug 29 and fits snugly about the plunger 15 for a gas-tight joint, said washer being suitably held in place by a metallic washer 31 having a press fit in the same recess therein. Similarly, another graphite-asbestos washer 32 is mounted in a recess in the face of the valve 14 and has a close fit on the plunger 15 to prevent the leakage of gas between the valve and plunger when the valve is closed, a metallic washer 33 being also provided to hold the washer 32 in place. The plunger 15 is suitably cylindrical at both ends where it fits in the center holes 27 and 28, but has the intermediate portion thereof formed to provide a double cone cam, as indicated at 34, the middle or high point 35 thereof being defined by the bases of the two cones occupying the same plane. Now, one, two, or more, but preferably two, diametrically opposed, pins 36 are slidably received in radial guide holes 37 provided in the hub 38 on the back of the valve 14 and have conically pointed inner ends arranged in engagement with the double cone cam 34 on either side of the high or mid point 35 of the latter. These pins are spring pressed inwardly suitably by means of a single semicircular or crescent shaped leaf spring 39 which has the reduced ends 40 of said pins passed through holes provided in the ends thereof to receive the same. The pressure of the spring 39 on the pins 36 tending to cause the latter to move inwardly, results in the movement of the valve 14 in either direction on the plunger 15 depending on which side of the mid or high point 35 of the double cone cam 34 the ends of the pins 36 happen to engage. When the pointed ends of the pins 36 engage the cam 34 to the right of the mid point 35, as shown in Fig. 1, the valve 14 moves to the right until it engages the seat 16, being then held in such closed position under a definite appreciable pressure for which the spring 39 is, of course, responsible. On the other hand, let us assume that while the valve is closed, the plunger 15 is moved to the right from the position shown in Fig. 1, just enough to bring the mid point 35 of the cam 34 to the right of the pointed ends of the pins 36. When that occurs, the pointed ends of the pins 36 ride down the opposite inclination of the cam 34 on the left hand side of the mid point 35 and cause the valve 14 to move to the left to the open position shown in Fig. 2, the movement being limited by the engagement of the hub 38 of the valve with the plug 29. It will now be shown how the plunger 15 is arranged to be moved positively to the right under the action of the thermostatic element 5, and is arranged to be returned under spring action.

A coiled compression spring 41 is provided inside the plug 18 and has its one end fitting over the reduced end 42 of the plunger 15 and engaging a washer 43 passed over the said reduced end whereby to tend normally to urge the plunger 15 toward the left, the other end of the spring 41 fitting about and held in position by a small boss 44 provided for the purpose on the inside of the plug 26. The opposite end of the plunger is rounded, as shown at 45, and has the inner ends of a pair of non-resilient levers 46 engaging the same, said levers being struck from sheet metal and suitably ribbed longitudinally, as indicated at 47, to lend stiffness. The outer ends of said levers rest on an annular, beveled seat 48 provided on the edge of an annular flange 49 formed on the plug 29. The beveling of the seat 48 insures contact of the levers 46 therewith only at their extreme outer ends and also allows the levers a certain amount of freedom for rocking motion with respect to the seat required in operation. A cylindrical plunger or follower 50 is slidably received in the end of the bore 25 and has a circular knife-edged shoulder 51 arranged to have line contact with the levers 46 near the outer ends thereof, or, more specifically, at points on the circumference of a circle of a radius slightly less than that of the plunger. The plunger has a central recess 52 on the back thereof in which the rounded end of the thermostatic element 5 engages. Since the

levers 46 are supported at their extreme outer ends and are borne against by the plunger 50 at points near the outer ends, it will be evident that the levers will have rocking motion communicated thereto in the movement of the rod 5 and, since the inner ends of the levers 46 bear against the end of the plunger 15, the latter will be given amplified movement, which, however, is always proportionate to the amount of movement, of the rod 5.

In operation, it will be evident from the foregoing description that when the tubular thermostatic element 6 is hot and consequently slightly elongated, the rod element 5 is retracted to the left with reference to the body 7, and the plunger 15 is moved under action of spring 41 to the position shown in Fig. 1, in which the pointed inner ends of the pins 36 engage the cam 34 to the right of the mid point 35 thereof. The spring 41 keeps the plunger 15 under a substantially constant end thrust toward the levers 46. The valve 14 remains closed until the tubular thermostatic element 6 cools off enough to result in sufficient contraction thereof for the rod element 5 to move to the right and force the plunger 15 to the right against the action of the spring 41 enough to cause the pointed inner ends of the pins 36 to ride over the mid point 35 from the right hand side thereof to the left hand side, whereupon the spring 39 causes the valve 14 to snap open. Obviously, the mid point 35 of the cam will be defined by a sharp edge. Consequently, there can be no fluttering of the valve; it will remain fully closed up to the instant that it snaps open, and, conversely, it will remain fully opened up to the instant that it snaps closed. The more or less sharply defined mid point 35 of the cam 34 and the more or less sharpened cone pointed ends of the pins 36, as well as the guides 37 that cause the pins to move truly, in a predetermined plane, cooperate to make the valve function within an extremely short temperature range. Now, while it is apparent that a very slight movement of the plunger 15 will suffice to snap the valve from open to closed position, or vice versa, it will also be seen that an excessive amount of movement of the plunger 15 cannot possibly result in damage to any part of the mechanism; if, after the valve has been opened, as shown in Fig. 2, the plunger 15 is given still further movement by reason of additional contraction of the tubular thermostatic element 6, the valve will still remain open, and the same is true in the closing of the valve, additional movement of the plunger having no effect whatever. This point is of considerable importance from the standpoint that extreme temperature conditions will not result in injury to the device. If it is desired at any time to take the device apart for the purpose of inspection or cleaning, it is a simple matter to remove the plug 18 to get at the valve seat 16; the spring 41 remains caged in the plug 18 so that there is no chance of an inexperienced person getting the parts replaced improperly. If any adjustment of the device is desired at any time, that is taken care of by simply moving the lever 10. "Hot" or "Cold" markings may be provided on the outside of the valve body 7 adjacent the projecting end of the lever 10 and in that event, the shifting of the lever toward "Hot" results in unscrewing the rod element 5, and vice versa in the shifting of the lever toward "Cold".

It is believed the foregoing description imparts a good understanding of the various features of my invention. While I have illustrated and described the application thereof to a valve for a gas-operated water heater, it should be understood that there are numerous other applications. Furthermore, as regards the various details of construction and arrangement illustrated, it should be understood that various changes might be made without seriously departing from the invention. For example, I do not limit myself to the use of the particular movement amplifying means herein shown, namely, the plunger 50 and levers 46, inasmuch as a compound fulcrum, such as is commonly employed in thermostatic devices of this kind, might be employed to transmit amplified movement to the plunger 15 in the movement of the rod 5.

I claim:

1. In a thermostatic device of the character described, a casing, a valve or other element therein to be operated, the same having an integral enlarged hub portion, said hub having an elongated hole therein for bearing support of the valve on a plunger, a plunger in said casing received in the hole in the hub portion of said valve so that the latter is slidably mounted thereon for reciprocation toward and away from a seat therefor in said casing, and means housed in the hub portion providing an operating connection between the plunger and the valve whereby the latter is arranged to be moved in one direction in the event of a predetermined movement of the plunger relative thereto in the opposite direction.

2. In a thermostatic device of the character described, a casing, a valve or other element therein arranged to be operated and having a hub portion, a plunger in said casing concentric with the valve and having the hub portion of the latter slidably mounted thereon to serve as a guide therefor, said plunger having means for operating the same, said plunger having a double cone cam thereon within the hub of the valve with respect to which the valve is slidable on the plunger, the cones of said cam having their bases in the same plane to provide the high portion of the cam, one or more pins slidably

mounted in transverse bores provided in the hub of the valve having their inner ends engaging the double cone cam on either side of the high portion, depending on the position of the valve, and spring means urging the pins inwardly into engagement with the cam.

3. A device as set forth in claim 2 wherein the double cone cam has a sharply defined high portion and wherein the one or more pins have their inner ends conically pointed to ride abruptly from one side to the other over the high portion of the cam.

4. A device as set forth in claim 2 wherein the pin is mounted for substantially radial movement, and wherein the spring means for operating the same comprises a substantially semi-circular leaf spring fitting about the valve hub and suitably held in place in such position and having the outer end of the pin operatively connected with one end thereof.

5. A device as set forth in claim 2 wherein two diametrically opposed pins are provided mounted for substantially radial movement with reference to the valve and wherein the spring means comprises a single substantially semi-circular leaf spring fitting about the valve hub substantially concentric therewith and having the opposite ends thereof operatively connected with the outer ends of said pins and tending normally to urge the pins inwardly toward each other.

6. In a thermostatic device of the character described, the combination with a thermostatic element arranged to move in the event of temperature variation, of a casing providing a substantially cylindrical bore therein, there being a valve seat about a valve port provided at one end of said bore, a valve in said bore movable toward and away from the seat, a plunger reciprocably mounted in said casing having the valve slidably mounted thereon to serve as a guide therefor, spring means acting against one end of said plunger tending normally to move the same in one direction, one or more levers disposed radially with reference to the bore engaging the other end of the plunger at their inner ends and having their outer ends suitably supported in said bore, another plunger slidably received in said bore and having the thermostatic element engaging the back thereof to communicate movement thereto, the front of said plunger having an annular shoulder projecting therefrom arranged for engagement with the levers near the outer ends of the latter whereby in the movement of said plunger amplified movement is communicated through the levers to the first mentioned plunger, and means providing an operating connection between said plunger and valve whereby when the former is moved in one direction the latter is moved in the opposite direction.

7. A structure as set forth in claim 6 wherein the thermostatic element constitutes the inner element of a thermostat and is threadedly mounted at its outer end in the outer end of the outer element to permit endwise adjustment of the inner element with respect to the outer element by the turning of the former with reference to the latter, the said casing having an opening in one side thereof adjacent the end of said adjustable thermostatic element, and a part attached to said element and operative through said opening.

8. A structure as set forth in claim 6 including a hollow plug removably mounted in one end of the bore in said casing and providing the valve seat and port on the inner wall thereof, the first mentioned plunger being slidably received in a center guide opening provided in the inner wall of said plug, said plug having the plunger actuating spring mounted therein, and a closure for said plug providing an abutment for the outer end of said spring.

9. A structure as set forth in claim 6 including a hollow plug removably mounted in the one end of the bore in said casing and having the valve seat and valve port provided in the inner wall thereof, the first mentioned plunger being slidably received at one end in a center guide opening provided in the inner wall of said plug, and another plug stationarily mounted in said bore and having a center guide opening slidably receiving the other end of said first mentioned plunger.

10. In a thermostatic device of the character described, the combination with a thermostatic element arranged to move in the event of temperature variation, of a casing providing a mounting for said element, said casing having a substantially cylindrical bore therein, a hollow plug removably mounted in the one end of said bore provided with a valve port in the inner wall thereof and a valve seat about said port, there being a center guide opening in the inner wall of said plug, a plunger slidably received in said guide opening, spring means in said plug acting against the end of said plunger tending normally to move it in one direction, means operated by the thermostatic element and operatively related to the other end of said plunger arranged to move the latter in the opposite direction against the action of said spring, a valve slidably mounted on said plunger for movement toward and away from the valve seat, and means providing an operating connection between the plunger and the valve whereby when the former is moved in one direction the latter is moved in the opposite direction.

11. A device as set forth in claim 10 including another part stationarily mounted in the bore of said casing behind the valve, said part having a center guide opening slidably receiving said pluunger, the said

part serving to limit movement of the valve away from its seat.

12. In a thermostatic device of the character described, a casing, a valve or other element therein arranged to be operated and having a hub portion, a plunger in said casing concentric with the valve and having the hub portion of the latter slidably mounted thereon to serve as a guide therefor, said plunger having means for operating the same, said plunger being annularly recessed within the hub of the valve to provide a double cone cam over which the valve hub is arranged to slide on the plunger, the cones of said cam having their bases in the same plane to provide the high portion of the cam, one or more pins slidably mounted in radial holes provided in the hub of the valve having their inner ends engaging the double cone cam on either side of the high portion, depending on the position of the valve, and spring means urging the pins inwardly into engagement with the cam.

13. In a device of the character described, the combination of a casing having a longitudinal bore, a plug entered in said bore to define one end of a valve chamber, another plug entered in the bore to define the other end of the valve chamber, the last mentioned plug being provided with a valve port and a valve seat about said port, there being guide openings in alignment with one another in said plugs, a plunger slidably received in said guide openings, means for operating the plunger back and forth, a valve slidably mounted on said plunger in the valve chamber and arranged by engagement with the first plug to have the movement thereof away from the seat limited, and means in the sliding joint between the valve and plunger providing an operating connection between the plunger and valve whereby when the former is moved in one direction the latter is moved in the opposite direction.

14. A device as set forth in claim 13 wherein the means for operating the plunger back and forth includes a coiled compression spring mounted within a hollow portion of the second plug and acting against the end of the plunger projecting into said plug through the guide opening in the inner wall thereof.

15. A device as set forth in claim 13 wherein the bore of the casing is enlarged at one end for reception of one of said plugs, thereby providing an annular shoulder in the bore, the device including a packing member received in the bore in abutment with the annular shoulder, there being an annular shoulder on said plug arranged to abut the packing member from the opposite side to compress said member between the shoulders whereby to seal the joint at the plug.

16. In a device of the character described, the combination of a casing having a bore provided therein, a valve seat in said bore defining one end of a valve chamber, a plug entered into the bore to define the other end of the valve chamber, a plunger slidably mounted in said plug and extending into the valve chamber, means for operating the plunger back and forth, a valve for cooperation with the valve seat slidably mounted on the plunger in the valve chamber, and means in the joint between the valve and plunger providing an operating connection between the plunger and valve whereby when the former is moved in one direction the latter is moved in the opposite direction.

17. In a device of the character described, the combination of a casing having a bore provided therein, a hollow plug removably mounted in said bore provided with a valve port in the inner wall thereof and a valve seat about said port, there being a center guide opening in the inner wall of said plug, a plunger slidably received in the guide opening, means for operating the plunger back and forth, a valve slidably mounted on the plunger and arranged to move toward and away from the valve seat, and means in the joint between the valve and plunger providing an operating connection between the plunger and valve whereby when the former is moved in one direction the latter is moved in the opposite direction.

18. In a device of the character described, the combination of a casing having a bore provided therein, there being a valve seat in said bore at one end of a valve chamber, a plug entered in said bore and defining the other end of the valve chamber, a plunger slidably received in an opening in said plug and extending into the valve chamber, one or more levers disposed radially with reference to the plug having their outer ends suitably supported on the plug and their inner ends engaging the end of the plunger, means for communicating amplified movement to the plunger by communicating movement to the levers near their outer ends, and a valve mounted on the plunger in the valve chamber for cooperation with the valve seat.

19. In a device of the character described, the combination of a casing having a bore provided therein, there being a valve seat in said bore at one end of a valve chamber, a plug entered in said bore and defining the other end of the valve chamber, a plunger slidably received in an opening in said plug and extending into the valve chamber, one or more levers disposed radially with reference to the plug having their outer ends suitably supported on the plug and their inner ends engaging the end of the plunger, means for communicating amplified movement to the plunger by communicating movement to the levers near their outer ends, a valve slidably mounted on the plunger in the valve chamber for cooperation with the valve seat, the same being limited in its

movement away from the valve seat by engagement with the plug, and means in the joint between the valve and plunger providing a reversing operating connection whereby when the one element is moved in one direction the other element is moved in the opposite direction.

20. In a valve, a casing, a valve therein arranged to be operated and having a hub portion, a plunger in said casing concentric with the valve and having the hub portion of the latter slidably and rotatably mounted thereon to serve as a guide therefor, said plunger having means for operating the same, said plunger having an annularly recessed portion thereon within the hub portion of the valve conformed to a double cone cam shape with respect to which the valve hub is slidable and rotatable, the cones of said cam having their bases in the same plane to provide the high portion of the cam, and a plurality of pins radially disposed with reference to the hub in a plane exactly parallel with the bases of the cones and slidably received in radial holes provided in the hub of the valve with the inner ends thereof riding on the cam, and spring means for urging the pin inwardly into engagement with the cam.

21. In a snap-action mechanism, the combination of a plunger, means supporting the same for endwise movement, a part having a hub portion slidably received on said plunger, the plunger and part thereon being arranged to cooperate so that when the one is given a predetermined movement in one direction relative to the other, the other is arranged to be given abrupt movement in the opposite direction, said plunger having a double cone cam thereon within said hub portion, the cones of said cam having their bases in the same plane to provide the high portion of the cam, one or more pins slidably mounted in transverse bores provided in said hub portion and having their inner ends engaging the double cone cam on either side of the high portion depending on the position of the part with relation to the plunger, and spring means urging the pins inwardly into engagement with the cam.

22. A mechanism as set forth in claim 21 wherein the double cone cam has a sharply defined high portion and wherein the one or more pins have their inner ends conically pointed to ride abruptly from one side to the other over the high portion of the cam.

23. A mechanism as set forth in claim 21 wherein the pin is mounted for substantially radial movement, and wherein the spring means for operating the same comprises a substantially semi-circular leaf spring fitting about the hub portion and suitably held in place in such position and having the outer end of the pin operatively connected with one end thereof.

24. A mechanism as set forth in claim 2 wherein two diametrically opposed pins are provided mounted for substantially radial movement with reference to the hub portion and wherein the spring means comprises a single substantially semi-circular leaf spring fitting about the hub portion substantially concentric therewith and having the opposite ends thereof operatively connected with the outer ends of said pins and tending normally to urge the pins inwardly toward each other.

25. In a valve of the character described, the combination of a casing, a valve seat in said casing in closely spaced relation to a wall provided in said casing, a short plunger guided for movement in and projecting through a center hole in the seat at one end and projecting through a hole in the wall at its other end, spring means coöperating with one end of said plunger tending normally to move it in one direction, and means coöperating with the other end of the plunger to move it in the opposite direction against the action of said spring means, a valve disposed in the space between the wall and seat and having an enlarged hub portion slidably received on the plunger as a guide, said plunger having a double cone cam thereon within the hub of the valve, the cones of said cam having their bases in the same plane to provide the high portion of the cam, one or more pins slidably mounted in transverse bores provided in said hub and having their inner ends engaging the double cone cam on either side of the high portion depending on the position of the valve with relation to the plunger, and spring means urging the pins inwardly into engagement with the cam.

26. A device as set forth in claim 13, wherein the bore of the casing is enlarged at one end for reception of one of said plugs, thereby providing an annular shoulder in the bore, and wherein said plug has an annular shoulder thereon arranged in the entry of the plug in the bore to approach the other shoulder whereby to seal the bore by means of the plug.

27. A device as set forth in claim 17, wherein the bore of the casing is enlarged at one end for reception of said plug, thereby providing an annular shoulder in the bore, and wherein the plug has an annular shoulder thereon arranged in the entry of the plug in the bore to approach the other shoulder, whereby to seal the bore by means of the plug.

28. In a thermostatic device of the character described, a casing, a valve or other element therein to be operated, the same having an integral enlarged hub portion, said hub having a hole therein for bearing support of the valve on a plunger, a plunger in said casing received in the hole in the hub portion of said valve so that the latter is slidably mounted thereon for reciprocation toward and away from a seat therefor in said casing, said plunger being annularly recessed to provide

a double cone cam thereon within the hub of the valve, the cones of which have their bases in the same plane to provide the high portion of the cam, said hub being elongated so that the hole therein is longer than the recessed cam portion of said plunger to provide proper bearing support of the valve in any position thereof on the plunger relative to the cam, one or more pins slidably mounted in transverse bores provided in said hub and having their inner ends engaging the double cone cam on either side of the high portion depending on the position of the valve with respect to the plunger, and spring means urging the pins inwardly into engagement with the cam.

29. In a snap action mechanism, the combination of a plunger, means supporting the same for endwise movement, a part having a hub portion slidably received on said plunger, the plunger and part thereon being arranged to cooperate so that when the one is given a predetermined movement in one direction relative to the other, the other is arranged to be given abrupt movement in the opposite direction, said plunger having an annularly recessed portion providing a double cone cam thereon within said hub portion, the cones of said cam having their bases in the same plane to provide the high portion of the cam, the hub portion being elongated so that it is longer than the recessed cam portion of the plunger whereby to have proper bearing support on the plunger in any position of the part with respect to the cam, one or more pins slidably mounted in transverse bores provided in said hub portion and having their inner ends engaging the double cone cam on either side of the high portion depending on the position of the part with relation to the plunger, and spring means urging the pins inwardly into engagement with the cam.

In witness of the foregoing I affix my signature.

JOHN H. GRAYSON.