Jan. 31, 1956 C. M. GARNER 2,733,012

INSTANTANEOUS LIMITING SWITCH MECHANISM

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Fig. 1.

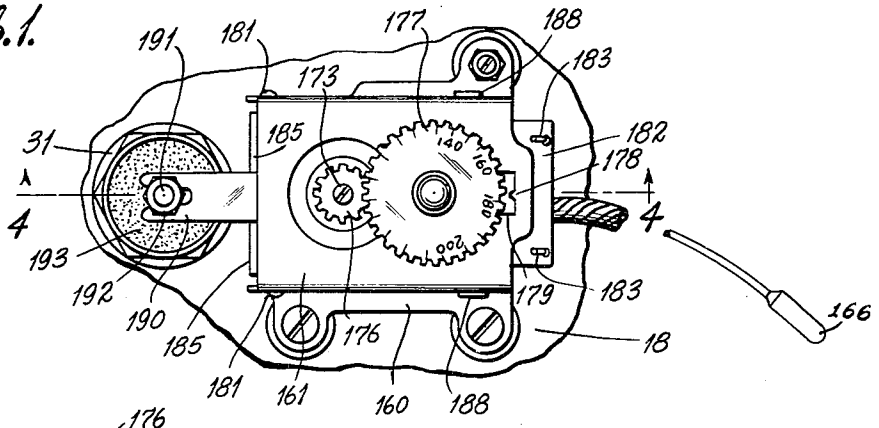

Fig. 2.

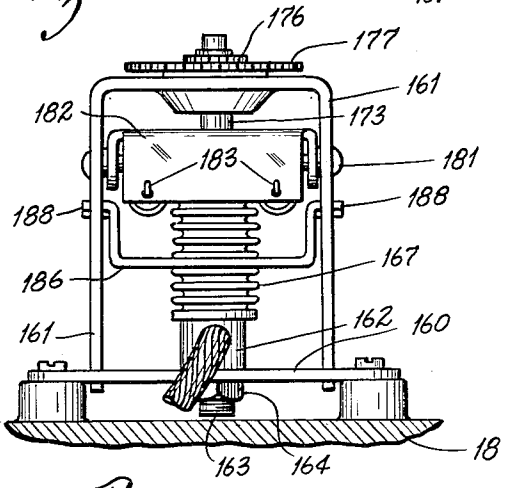

Fig. 5.

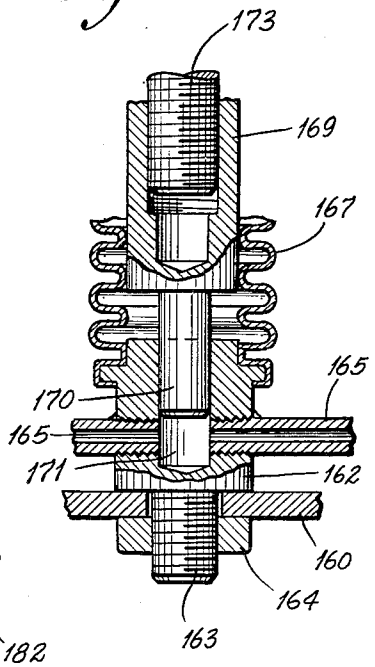

Fig. 4.

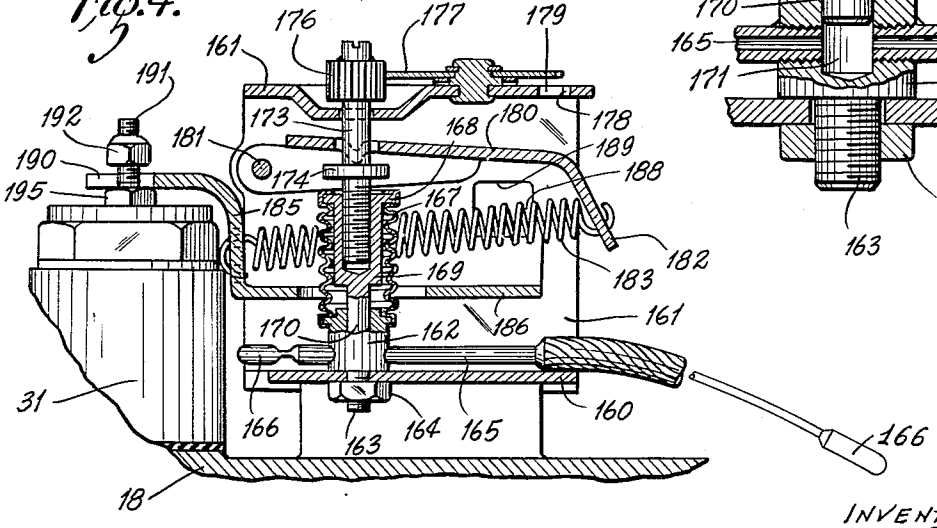

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Fig. 3.

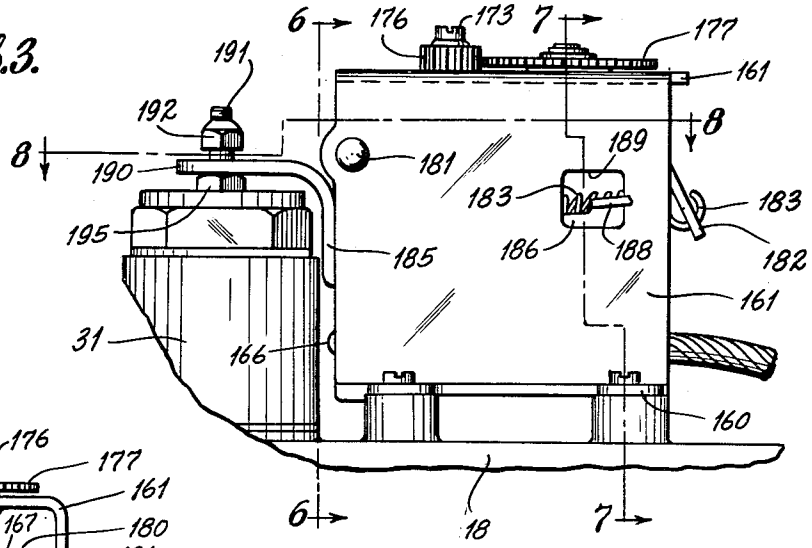


Fig. 6.

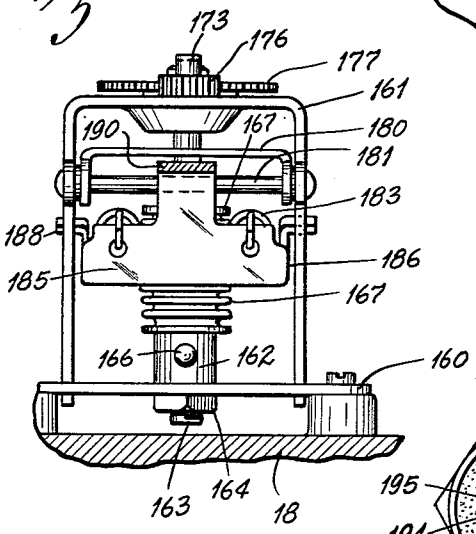


Fig. 8.

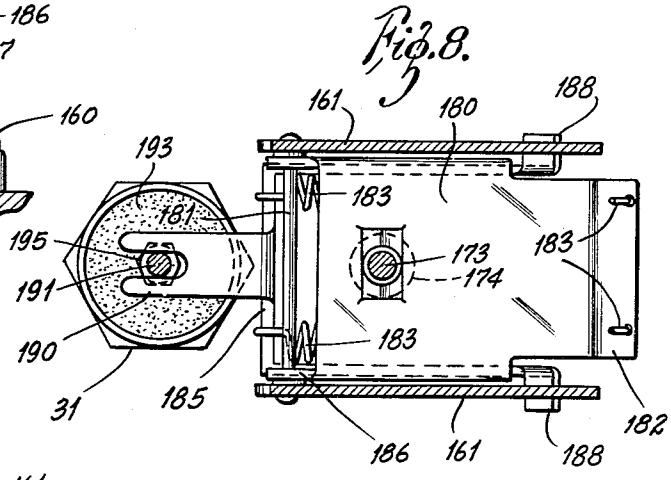


Fig. 7.

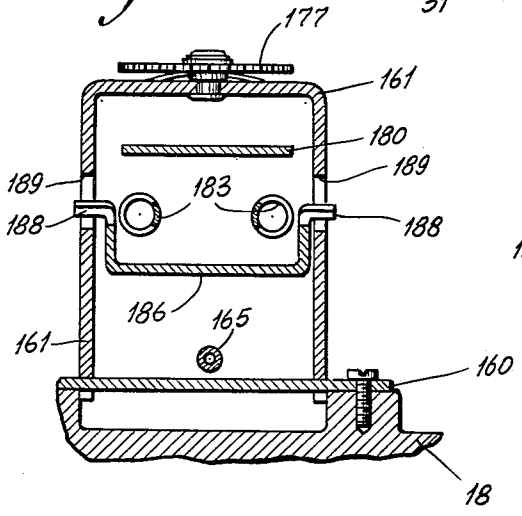
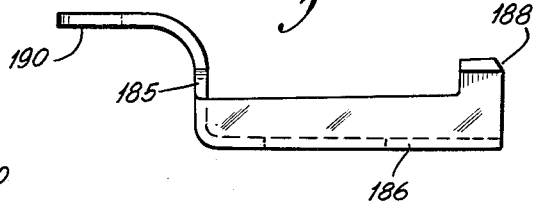


Fig. 9.



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INSTANTANEOUS LIMITING SWITCH MECHANISM

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Application March 15, 1952, Serial No. 276,783

5 Claims. (Cl. 236—48)

The present invention relates to an adjustable limit switch which is adapted to be used in connection with a valve or any other device having a reciprocal member which is adapted to be moved between two limiting positions.

Broadly, it is an object of the invention to provide a limit switch which is adapted to be used with a valve and which has a snap action or instantaneous action between the two limiting positions of the member which is adapted to be controlled by a limiting switch.

A further object of the invention is to provide a limiting switch which is adjustable and is comprised of a simple and rugged mechanism that is adapted to be constructed from readily available components.

A further object of the invention is to provide a limit switch which is adapted to operate in response to changes of pressure in a control member.

Other objects will appear in the description to follow. The present invention is described in connection with a valve, but it is to be understood that this is for purposes of illustration only and that it is not limited thereto.

In the drawings:

Fig. 1 is a plan view of the limit switch;

Fig. 2 is an end elevation of the device shown in Fig. 1 taken from the right end thereof;

Fig. 3 is a side elevation of the device shown in Fig. 1 as applied to a valve;

Fig. 4 is a vertical section along the line 4—4 of Fig. 1;

Fig. 5 is an enlarged diametrical section to the connection into the bellows for the limit switch mechanism;

Fig. 6 is a vertical section along the line 6—6 of Fig. 3;

Fig. 7 is a vertical section along the line 7—7 of Fig. 3 showing additional parts of the limit switch mechanism;

Fig. 8 is a horizontal section along the line 8—8 of Fig. 3 showing parts of the limit switch mechanism;

Fig. 9 is a side elevation of an operating lever of the limit switch mechanism.

Referring now to the drawings and Fig. 4 in particular, the limit switch is shown as being used to control a valve 31 and is mounted on a plate supporting member 18.

The plate 160 supports a tubular head 162 which has a threaded end 163 adapted to pass through the plate 160 and to be secured thereto by a nut 164. This head 162 receives the end of a tube 165 that is connected to a bulb 166, diagrammatically shown in Figures 1 and 4. This bulb will be located at a point that reflects critical temperatures.

The head 162 receives one end of a bellows 167. The other end of this bellows is connected to a head 168 of a reciprocable member 169, this member having a depending guide pin 170 at its lower end, which is adapted to fit loosely in a bore 171 in the head 162, thereby to restrain lateral movement or buckling of the non-rigid bellows. The bellows 167 is in communication with the tube 165, via that annular space between the loose fitting element 170 and the wall of the bore 171, so that it will receive the expanding fluid from the bulb.

The reciprocable or expansible member 169, at its upper end, receives a threaded actuating stud 173, having a flange 174 thereon. It will be seen that the stud 173 is threaded into the member 169 and has a kerf at its outer end, so that the position of the flange 174, relative to the upper end of the bellows 167, may be varied. Means for indicating the relative positions of the upper end of the bellows 167 and the flange 174 is provided, and comprises a gear 176 rigidly attached to the upper end of the stud 173 and a larger meshing gear 177 pivoted on the top of the inverted U-bracket 161. The upper surface of the gear 177 is graduated (Fig. 1), and these graduations register with a pointer 178 formed in the edge of an opening 179 stamped into the top of the U-shaped bracket 161.

The flange 174 on the actuating member 173, is adapted to be engaged by depressed portions on a primary lever 180 mounted for rocking on a spindle 181 fastened in the supporting bracket 161. The primary lever 180 has a depending rearward extension 182 that receives one end of each pair of coil springs 183, that constitute toggle springs. The other end of each of these coil springs is attached to a vertical portion 185 of a secondary lever 186.

The secondary lever 186 constitutes a valve actuating lever. It is of the shape shown in Fig. 9, its back portion being generally channel-shaped with outstanding knife-edged bearings 188 at its inner end. These knife-edged bearings are adapted to fit into relatively large openings 189 in the two side portions of the bracket 161. These openings 189 have angular crotches into which the knife-edged bearings 188 fit for rocking movement. It will be seen that the coil springs 183 urge the knife-edged bearings into engagement with the crotches.

The forward end of the valve actuating lever 186 has the vertical portion 185 thereon, as already mentioned. From this portion 185, an actuating end 190 projects. This end 190 has a forked outer end which straddles the threaded upper end of the valve rod or stem 191. This rod passes down through a suitable opening in the valve 31 which may be of a conventional type having a reciprocal valve member operable between two spaced valve seats. The valve rod 191 receives a nut 192 above the forked end 190 of the secondary lever 186, which nut is adjustable thereon. The rod 191 passes through a flexible diaphragm 193, that is sealed across the recessed top of the valve 31. The rod 191 is clamped to the diaphragm by a suitable removable washer and nut arrangement 195.

The actuating mechanism for the valve 31 thus includes the bellows 167, the stud 173 and its flange 174, the primary lever 180, the secondary lever 186, the nuts 192 and 195, and the stem or rod 191, together with the springs 183. This constitutes an over-center snap-action mechanism, with the modification that the springs 183 exert a constant clockwise force upon the primary lever 180, as well as reversing forces on the secondary lever 186. The temperatures of raising and lowering the valve 62 are adjustable. The operation will be set forth hereafter.

Operation

The limit valve switch is designed to operate when the temperature at a chosen critical point, such as a furnace bonnet, exceeds the value for which the limit mechanism is set. Thereupon, the limit switch mechanism will be operated with an instantaneous or snap-action so as to operate the valve 31 to the desired position.

The valve 31, during normal operation, when the temperatures at the bulb (not shown) which is connected to passage 165 in the limit switch mechanism, are below the critical value, will be in an inoperative position. Under such circumstances, the bellows 167 will be contracted, and the stud 173 and its flange 174 will be in a downward position. The force of the springs 183 is con-

stantly eccentric and clockwise (Fig. 4) on the primary lever 180, so that it rocks against the flange 174. Its right end (Fig. 4) and its axis of force upon the secondary lever 186 will be below the knife-edges 188, so that its force acts counterclockwise upon the secondary lever 186, and holds the end 190 thereof downward against the nut 195, that, in turn, keeps the valve 31 in a non-operated position.

When expansion of the bellows 167 elevates the flange 174, the primary lever 180 rocks its outer end 182 upward, and displaces the right end of the force axis of the springs 183. The force on the secondary lever will remain counterclockwise until the force axis of the springs is moved across to above the knife-edges 188, whereupon the secondary lever will rapidly move clockwise, its speed increasing with degree of upward movement of its left end (Fig. 4). It will cause its end 190 to engage the nut 192, to shift the valve 31 with a snap-action. Thereafter, overtravel of the primary lever 180 causes no further movement of the secondary lever, but merely moves the right end of the springs upwardly. The maximum of such movement is always less than enough to remove all counterclockwise leverage of the springs upon the primary lever.

As will appear, shifting of the valve 31 to its operative position in response to the operation of the limit switch mechanism will cause a shut down of the supply of fuel to the furnace (not shown) and hence cooling. When the bulb (not shown), which is responsive to the critical temperature in the furnace and which is connected to the passage 165 in the limit switch mechanism, cools, the bellows 167 will contract, lowering the stud 173 and its flange 174. The constant clockwise force (Fig. 4) of the springs 183 on the primary lever 180 will cause it to follow the flange 174 by rocking clockwise. After any overtravel is absorbed, the downward movement of the right end of the primary lever will begin its over-center function. The left end of the springs 183, at the portion 185 of the secondary lever, will be positioned by the nut 192. When the descent of the right end of these springs crosses their force line over to below the knife-edges 188, the secondary lever will quickly rock counterclockwise, its end 190 shifting to the nut 195, and causing the valve 31 to be returned to its non-operating position so as to allow passage of fuel to the furnace.

The temperature value at which the valve 31 is operated by the limit switch mechanism is a function of the adjustment of the stud 173, since the lower position of the nut 195 on the valve stem is fixed. The position for elevating the valve is constant so far as the relative positions of the primary lever, the secondary lever, and the springs are concerned.

The temperature at which the valve 31 is lowered is a function of the adjustment of the upper valve stem nut 192. When the valve is raised, the nut 192 fixes the left end of the force line of the springs 183, which is that point adjustably fixed by the selected positioning of the nut 192. Hence, to move the force line across the knife-edges 188, the right end of the primary lever 180 must move the right end of the springs 183 more or less, as is determined by the aforesaid selection of the position of the nut 192. The greater the movement of the primary lever, the greater is the differential between the temperature at which the limit mechanism causes closing of the valve 31, and the temperature at which it permits reopening thereof.

Although the limit switch has been described in connection with a valve, it is to be realized that this is for purposes of illustration only and that the invention can be used in connection with any appropriate reciprocable member for which proper control is desired. Other changes and modifications of this invention will be apparent from the above description to those skilled in the art and this invention is to be limited only to the scope of the appended claims.

What is claimed is:

1. In a fluid valve, a valve housing, a valve reciprocable therein between two positions, a valve stem projecting from the housing, an actuating mechanism including a support, power means oppositely movable, abutment means moved by the power means, a first lever pivoted onto the support and engageable by the abutment means, a second lever pivotable on the support, the levers overlapping and extending in opposite directions from their pivots, a spring connecting the levers, it being connected to the second lever between said second lever and the pivot of the first lever, and connected to the first lever on the side adjacent the second lever, the first lever being movable between limits to displace said last connection from one side to the other of the pivot of the second lever, said limits being effective to maintain a line of force exerted by said spring in a direction such that it does not intersect a line between the connection of said spring with the first lever and its pivot, whereby the first lever is always urged in one direction by the spring, and the other lever is moved with a snap action upon movement of the first lever, and an adjustable connection between the second lever and the valve stem to provide a differential between the position of the power means for shifting the valve in one direction and the position for shifting it in the other.

2. A device of the character described for operating a reciprocable member between two selected positions with a snap-action and having a reciprocable power means, a base, a first lever pivoted to the base and adapted to be engaged by the power means, a second lever pivotable on the base, biasing means connecting said levers, means limiting the rocking movement of the second lever in both directions, said power means being adapted to rock pivotally the first lever to shift the biasing means and cause the force line of the biasing means between the levers to move across from one side of the pivot of the second lever to the other side, to cause rocking of the second lever, the limiting means for the second lever limiting its movement to maintain the line of force exerted by said biasing means always on the same side of a line between the connection of the biasing means with the first lever and the pivot of the first lever, and an adjustable connection including spaced stop means on the operated reciprocable member to provide a differential between the position of the power means for shifting the operated reciprocable member in one direction and the position for shifting it in the other.

3. A device of the character described for operating a reciprocable member between two selected positions with a snap-action having a support, reciprocable power means, a first lever pivoted onto the support and engageable by the power means, a second lever pivotable on the support, the levers overlapping and extending in opposite directions from their pivots, biasing means connecting the levers connected to the second lever between said second lever and the pivot of the first lever, and connected to the first lever on the side adjacent the second lever, the first lever being movable by said power means between limits in one direction only to displace said last connection from one side to the other of the pivot of the second lever, said limits being effective to maintain a line of force exerted by said spring in a direction such that it does not intersect a line between the connection of said spring with the first lever and its pivot whereby the first lever is always urged in one direction by the biasing means, and the other lever is moved with a snap-action upon movement of the first lever, said power means comprising a reciprocable piston connected through a sealed conduit to a bulb element whereby changes in temperature at the bulb cause a corresponding change in pressure and operation of the piston.

4. A device of the character described for operating a reciprocable member between two selected positions with a snap-action having a support, reciprocable power means, a first lever pivoted onto the support and engageable by the power means, a second lever pivotable on the support,

the levers overlapping and extending in opposite directions from their pivots, biasing means connecting the levers connected to the second lever between said second lever and the pivot of the first lever, and connected to the first lever on the side adjacent the second lever, the first lever being movable by said power means between limits in one direction only to displace said last connection from one side to the other of the pivot of the second lever, said limits being effective to maintain a line of force exerted by said spring in a direction such that it does not intersect a line between the connection of said spring with the first lever and its pivot whereby the first lever is always urged in one direction by the biasing means, and the other lever is moved with a snap-action upon movement of the first lever, said power means comprising a piston connected through a sealed conduit to a bulb element whereby changes in temperature at the bulb cause a corresponding change in pressure and operation of the piston and an adjustable connection comprising spaced stop means on the operated reciprocable member to limit movement of the second lever to provide a differential between the position of the power means for shifting the valve in one direction and the position for shifting it in the other.

5. In a fluid valve, a valve housing, a valve reciprocable therein between two positions, a valve stem projecting from the housing, an actuating mechanism including a support, power means oppositely movable, abutment means moved by the power means, a first lever pivoted onto the support and engageable by the abutment means at the bottom of said lever, a second lever situated beneath said lever having a knife edge bearing against a

bearing surface of said support so as to be pivotable thereon, the levers overlapping and extending in opposite directions from their pivots, a spring connecting the levers and biasing said second lever at its knife edge against the bearing surface of the support, said spring being connected to the second lever between a top portion, spaced from said knife edge and the pivot of the first lever, and being connected to the first lever at the bottom thereof at a point spaced from its pivot, the first lever being movable between limits to displace said last connection from one side to the other of the pivot of the second lever, said limits being effective to maintain a line of force exerted by said spring in a direction such that it does not intersect a line between the connection of said spring with the first lever and its pivot, whereby the first lever is always urged in one direction by the spring, and the other lever is moved with a snap action upon movement of the first lever.

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