

Nov. 28, 1944.

F. D. JOESTING

2,363,595

CONDITION RESPONSIVE DEVICE

Filed Feb. 3, 1941

2 Sheets-Sheet 1

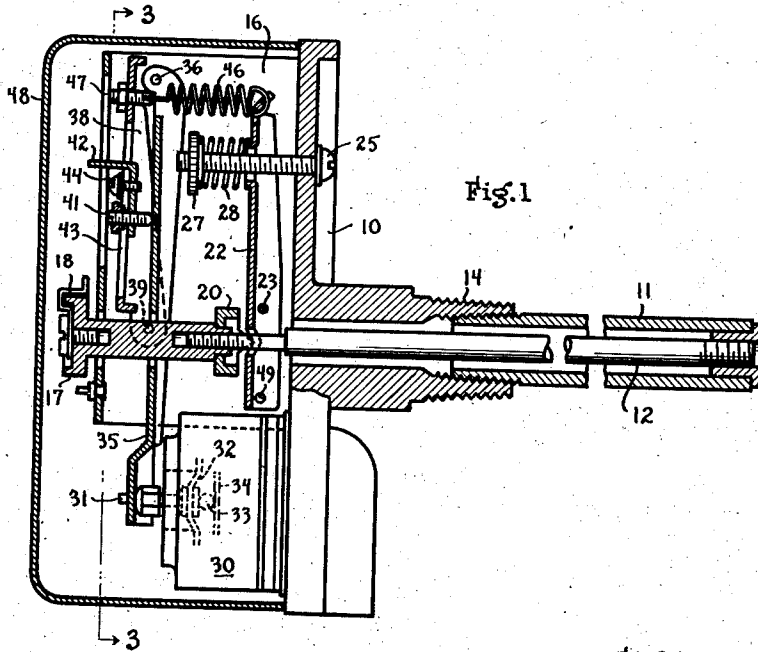


Fig. 3

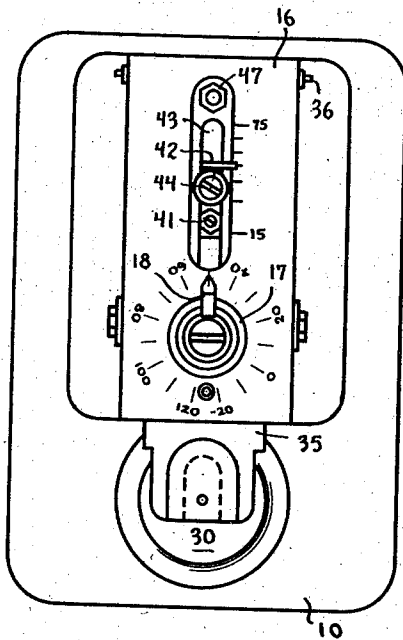
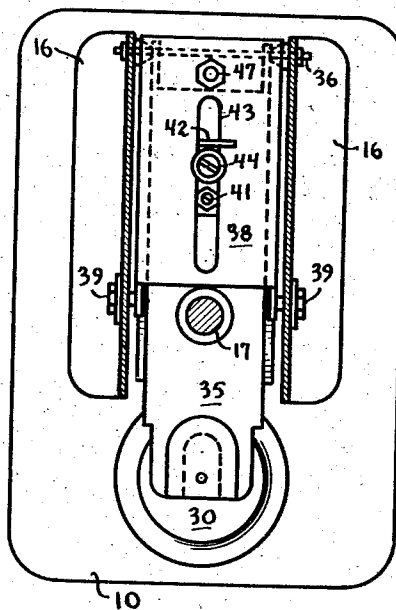


Fig. 2



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2 Sheets-Sheet 2

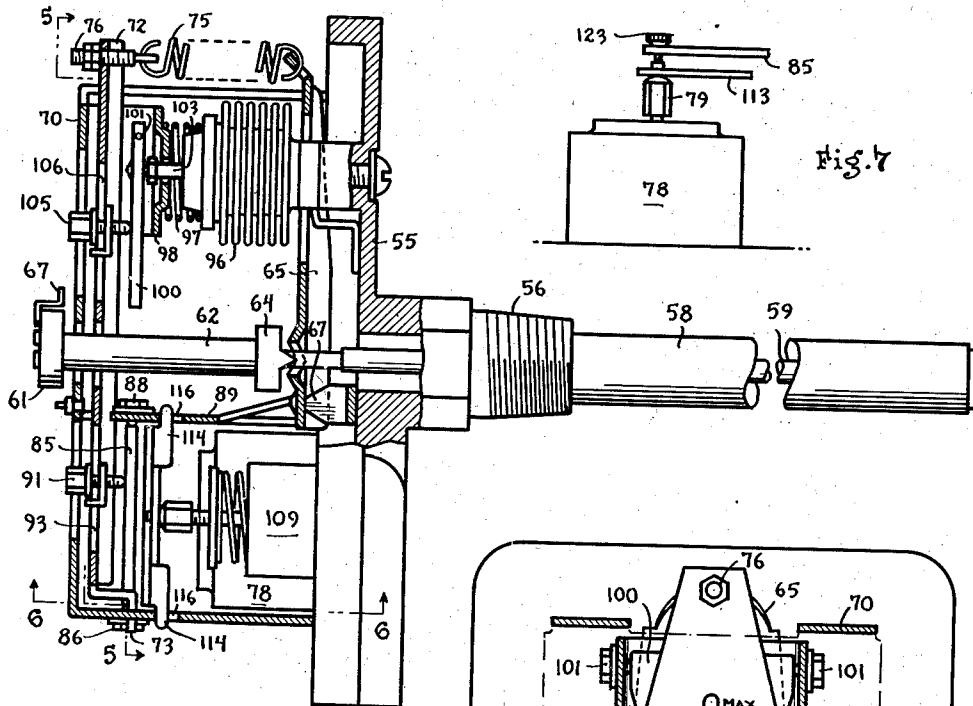


Fig. 4

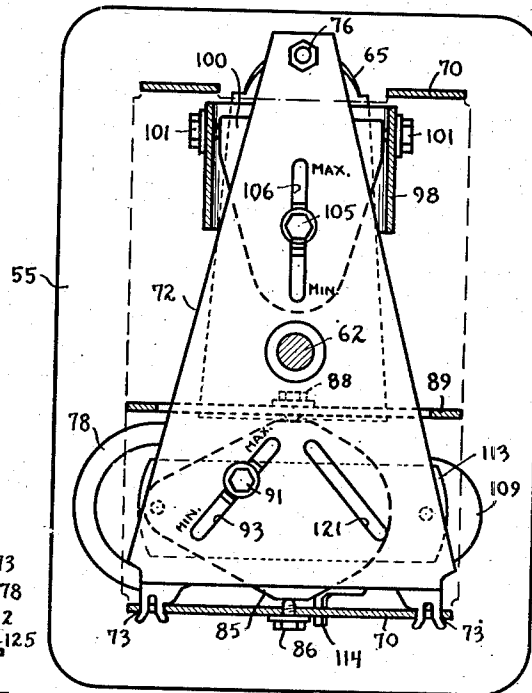


Fig. 5

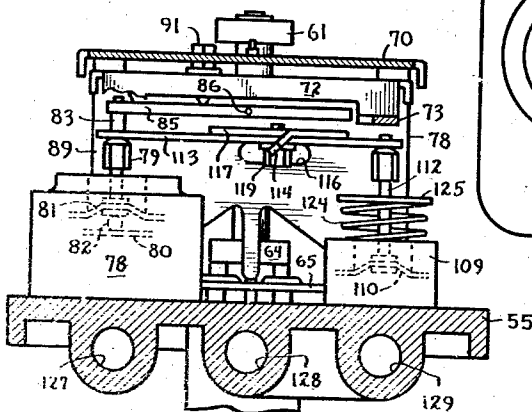


Fig. 6

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2,363,595

CONDITION RESPONSIVE DEVICE

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Application February 3, 1941, Serial No. 377,112

8 Claims. (Cl. 236—86)

The present invention relates to the structure of a control instrument for use with air conditioning equipment and is particularly directed to an instrument adapted to vary the pressure of a control fluid in accordance with variations in a condition such as temperature, pressure or humidity.

The invention has as one of its objects the provision of a control instrument in which both the control point and the operating differential may be adjusted to the desired values.

Another object of the invention is to provide an instrument the control point of which may be determined by a separate condition responsive instrument.

Another object is to provide an instrument utilizing a rod and tube thermostatic element or any other condition responsive element of a relatively non-resilient type for operating a control valve which must be capable of assuming a predetermined position at all values of the condition within the operating range of the instrument.

Another object is to provide an operating differential adjustment for such an instrument, the setting of which may be changed with substantially no effect on the control point.

Another object is to provide a condition responsive device in which the pressure of the fluid being controlled acts to assist the condition responsive element in positioning the control valve.

A further object is to provide a condition responsive device which may be changed readily from "direct acting" to "reverse acting."

Further objects of the invention will be apparent from the specification and from the drawings, in which

Figure 1 is a sectionalized view of a rod and tube actuated pneumatic control incorporating certain features of the invention,

Figure 2 is a front elevation of the instrument shown in Figure 1 and having the cover removed,

Figure 3 is a sectional view similar to Figure 2, taken on line 3—3 of Figure 1,

Figure 4 is a sectional view of another embodiment of the invention. This instrument is of the type known in the art as a "submaster" control,

Figure 5 is a sectional elevation taken substantially on line 5—5 of Figure 4, and

Figure 6 is a sectional view taken substantially on line 6—6 of Figure 4.

Figure 7 shows the valve unit arrangement of the device of Figures 4, 5 and 6 when the control is set up to separate "reverse acting."

The instrument shown in Figures 1 to 3 of the drawings is of the type known in the art as a "master" control and is adapted to vary the air pressure in a branch air line for the purpose of varying the control point of a "submaster" control. The device employs a rod and tube thermostatic element which operates a three way valve through a system of levers and a spring is incorporated in the linkage in order that the valve may assume its intermediate position at various positions of the thermostatic element.

Referring to Figures 1 to 3 of the drawings, the instrument is provided with a base 10 to which is secured a tube 11 and a rod 12 of a "rod and tube" thermostatic element. The base 10 is provided with a screw-threaded portion 14 by means of which the instrument may be mounted on a duct, such as used in air conditioning systems or in a water pipe, tank or the like. The rod and tube element is positioned on the inside of the duct, pipe or tank while the remainder of the device extends outside. Suitably secured to the front part of the base 10 is a frame 16 on which the various levers, hereinafter to be described, are pivoted. An adjusting knob 17 extends beyond the frame 16 and is provided with a pointer 18 which cooperates with suitable indicia on the front surface of the frame 16 for indicating the control point of the instrument. The adjusting knob 17 at its inner end is screw-threaded internally and cooperates with screw-threads on the outer end of the rod 12 so that rotation of the knob 17 changes the effective length of the rod and tube element.

A collar 20 is carried by a shoulder on the inner end of the adjusting knob 17 in order to transmit movements of the thermostatic element to a primary lever 22 which is pivoted in the frame 16 on a pin 23. The collar 20 is provided with a pair of knife-edges which engage V-shaped notches in the lever 22. Since the tube 11 of the thermostatic element has a higher coefficient of expansion than the rod 12, as the temperature increases the rod 12 will be moved to the right as seen in Figure 1 which will cause the primary lever 22 to rotate counterclockwise about the pin 23.

A screw 25 extends through the base 10 and through an opening in the lever 22. A nut 27 on the screw 25 serves as an abutment for a compression spring 28 which acts on the lever 22 tending to rotate said lever in a clockwise direction and cause the lever 22 to engage the knife-edges on the collar 20 at all times. The

function of the spring 28 will be more fully pointed out hereinafter.

A three-way valve unit 30 is secured to the lower portion of the base 10. This valve unit 30 is similar to the valve unit described in detail in my co-pending application, Serial No. 350,003, filed August 2, 1940, now Patent No. 2,326,226 dated August 10, 1943. Briefly, the unit includes a pressure inlet valve which is opened as the actuating rod 31 is depressed, and an exhaust valve which is opened as the actuating rod 31 is moved outwardly or to the left as seen in Figure 1 and a diaphragm 32 which is subject on its under side to branch line pressure. Under the diaphragm 32 is a ball 33 which serves to position a valve operating lever 34. The three-way valve is not shown but may be of any of the usual types. It is preferably of the type described in my above mentioned co-pending application. Between the position in which the inlet valve is opened and the position in which the exhaust valve is opened is a neutral position in which branch line pressure is maintained at a constant value. In operation the unit will be in neutral position with both inlet and exhaust valves closed except when the temperature is changing and a change in branch line pressure is called for.

A secondary lever 35 is pivoted in the frame 16 on a pin 36 and at its lower end engages the valve actuating rod 31. An auxiliary lever 38 is pivoted in the frame 16 on a pair of pivots 39. It will be noted that the levers 35 and 38 are disposed in generally parallel relationship. An abutment is provided between levers 35 and 38 in the form of a screw 41 which extends between the two levers but which is secured to an angle member 42 which is adjustable lengthwise on the auxiliary lever 38 by loosening a clamping screw 44 which secures the angle member 42 to the lever 38. The auxiliary lever 38 is provided with a longitudinal slot 43 in which the angle member 42 and the screws 41 and 44 may be moved. The outer end of the angle member 42 extends through an opening in the frame 16 and cooperates with suitable indicia thereon for indicating the operating differential or "throttling range" of the instrument. It will be noted that longitudinal adjustment of the abutment between the two levers may be made without altering the length of the screw 41. As illustrated in Figure 1, the screw 41 has been adjusted so that the levers 35 and 38 are not exactly parallel but so that the two levers are slightly closer together at their upper extremities. Therefore, as the abutment between the two levers is moved upwardly, the lever 38 will rotate slightly in a counter-clockwise direction if it be assumed that the lever 35 remains stationary. The purpose of this arrangement will be described hereinafter.

The upper ends of the primary lever 22 and the auxiliary levers 38 are connected by means of a tension spring 46 which engages a knife-edge portion of the lever 22 and is held in the lever 38 by means of an adjusting screw 47. Therefore, it will be seen that as the primary lever 22 is moved in a clockwise direction the spring 46 will be tensioned, and this force will be transmitted through the auxiliary lever 38 and the secondary lever 35 to depress the valve actuating rod 31 and open the inlet valve.

A suitable cover 48 is provided to enclose the lever and valve mechanisms.

As previously mentioned, the instrument of

Figures 1 to 3 is of the type known in the art as a "master" control. Such a control is adapted to vary the air pressure in a branch line through a suitable range of pressures as the temperature varies through a predetermined range. A common use for such an instrument is in adjusting the control point of a "submaster" thermostat located inside a space being cooled during the summer months in such a way that the indoor temperature will be maintained at a temperature less than outdoor temperature by an amount which increases as the outdoor temperature increases. Hence, a relatively wide differential must be provided in this instrument. As shown in Figure 2, the angle member 42 cooperates with suitable indicia indicating the throttling range in degrees of temperature.

The device as described is of the "reverse-acting" type which means that as the temperature increases the pressure in the branch line will be decreased. As mentioned previously the spring 28 exerts enough force in a clockwise direction to hold the lever 22 in engagement with the knife-edges on the collar 20 at all times. This spring acts in opposition to and in stronger than the spring 46, enabling the spring 46 to produce 15 pounds per square inch pressure in the branch line when the knife-edges on the collar 20 are exerting no force on the lever 22. The throttling range of the instrument is selected by movement of the angle member 42, the outwardly extending portion of this member indicating the number of degrees through which the temperature must vary in order to vary the branch line pressure from one extreme to the other. If the range of branch line pressure is from three to thirteen pounds and the instrument set up as shown in Figure 2, the branch line pressure will be thirteen pounds when the temperature is 50° and three pounds when the temperature is 95° since the differential adjustment is set at 45°.

It will be noted that as the abutment between the levers 35 and 38 is moved upwardly the changes in force transmitted by the spring 46 to the valve actuating rod 31 will result in smaller changes of force at the valve than when the abutment between these levers is moved to lower positions. Therefore, greater changes in temperature will be required to change the force transmitted to the valve when the abutment is moved to the upper positions than when it is moved to lower positions. Hence, the operating differential or throttling range is greater when the abutment between the levers 35 and 38 is moved upwardly. Changes in temperature at the rod and tube element serve to position the upper end of the primary lever 22 and therefore change the force transmitted by the spring 46 to the auxiliary lever 38, and this force will depend on the temperature alone for any given setting of the control point and throttling range adjustments since the secondary lever 35 always balances out at the same position. As previously pointed out, when the lever 35 is moved to the right, the inlet valve of the valve unit 30 is opened admitting pressure beneath the diaphragm 32 and when this pressure has been built up to exactly counter-balance the force applied by the lever 35 the inlet valve will be closed and the lever 35 returned to its original position. Likewise, if the force applied by the lever 35 to the valve actuating rod 31 is decreased, the branch line pressure existing under the diaphragm 32 will be sufficient to move the

exhaust valve to open position and the pressure under the diaphragm will be exhausted until the force due to the branch line pressure under the diaphragm exactly equals the force applied by the secondary lever 35. It will be seen therefore that the spring 46 comprises a resilient member between the valve actuating rod, which always balances out at the same position, and the thermostatic element whose position depends on temperature. Changes in temperature result in changes in branch line pressure without any change in position of the auxiliary lever 35.

As previously pointed out, the distance between the lower ends of levers 35 and 38 is greater than the distance between the upper ends of these levers. By distance between the levers is meant the distance between the surfaces of these levers engaged by the abutment screw 41 and the angle member 42. It will be seen therefore that as the screw 41 is moved upwardly, the tension of spring 46 will increase, assuming, of course, that the primary lever 22 and the secondary lever 35 remain stationary. This arrangement is provided so that as the operating differential of the instrument is changed there will be substantially no change in the control point of the device as indicated by the pointer 18. If the levers 35 and 38 were exactly parallel and the differential adjustment moved to a position giving a high differential, a given force applied to the auxiliary lever 38 would result in a smaller force at the valve unit and the branch line pressure would be varied. As illustrated in Figure 1, moving the differential adjustment upwardly will result in an increased tension of spring 46 which will substantially counteract the effect in the decrease in leverage. Although this arrangement employing two straight levers enables the differential to be adjusted with very little change in the control point, it would be necessary to provide one of these levers with a curved surface in order to exactly compensate for changes in leverage. It should be pointed out that a given angle between the levers 35 and 38 will enable the control point to remain constant as the differential adjustment is varied only at one place in the control range and that branch line pressure will be varied by movements of the differential adjustment if the temperature is at any value other than the control point selected.

The instrument as shown in Figure 1 and as previously described is a "reverse acting" instrument. The instrument may be changed to operate "direct acting" by removing the pin 23 by means of which the primary lever 22 is pivoted in the frame 16 from the position shown above the knife edges and reinserting it in the frame 16 and the lever 22 in the hole 49 on the opposite side of the rod element. Further, the screw 25, nut 27 and compression spring 28 are removed as they are not necessary in the "direct acting" instrument since the spring 46 now tends to rotate the lever 22 about the pivot 49 to engage the knife edges. In this case it will be seen that increases in temperature will result in the primary lever 22 being rotated in a clockwise direction which will tension the spring 46 and move the auxiliary lever 38 and secondary lever 35 to the right, which will open the pressure supply valve within the valve unit 30 to increase the branch line pressure. Otherwise the device operates the same when set up to operate "direct acting" as previously described in connection with the "reverse acting" instrument.

In Figures 4 to 7 is shown another embodiment of the invention. This device is of the type known in the art as a "submaster" control and is designed to maintain the temperature in an enclosure at a value depending on the value of a second condition such as the temperature to which a "master" control responds.

The instrument includes a base 55 which is provided with a screw-threaded portion 56 which may serve to mount the instrument on the wall of a duct or in a water pipe, tank or the like. As in the case of the "master" control, heretofore described, the temperature sensitive element comprises a rod and tube member having a high expansion tube 58 secured to the base 55 and a low expansion rod 59 which is enclosed within the tube 58 for the greater part of its length. An adjusting knob 61 has a portion 62 which is threaded internally to cooperate with threads on the outer end of the rod 59. A collar 64 abuts the portion 62 and is provided with a pair of knife edges which engage suitable V-shaped notches in a primary lever 65. A pair of knife edges 67 are mounted on the base 55 and engage the lower end of the primary lever 65. The knob 61 is provided with a pointer 67 which cooperates with suitable indicia (not shown) for indicating the control point of the instrument. A frame 70 is suitably mounted on the base 55 and extends beneath the knob 61 and the pointer 67 and may be provided with the indicia above referred to. An auxiliary lever 72 is mounted at its lower end in the frame 70 at the pivots 73 which comprise openings in the frame 70 through which portions of the lever 72 extend. A tension spring 75 extends between the primary lever 65 and the auxiliary lever 72 and is secured in a knife edge to the lever 65 and secured to the auxiliary lever 72 by means of the screw 76.

A valve unit 78 is mounted on the base 55 and is similar to the valve unit described in connection with Figures 1 to 3. This valve unit includes an actuating rod 79, a diaphragm 81, and a ball 82 which serves to transmit movements of the diaphragm 81 to a valve positioning lever 80. Internal portions of the valve which are not shown include a pressure inlet valve and an exhaust valve which may be opened selectively by positioning the actuating rod 79 and the diaphragm 81. The valve actuating rod 79 includes an extension 83 which engages a secondary lever 85 which is pivoted in the frame 70 by means of the pivot 86 and is further pivoted by means of a pivot 88 in a supporting partition 89 which extends between the base 55 and the frame 70. An abutment screw 91 extends between the auxiliary lever 72 and the secondary lever 85 and serves the purpose both of transmitting the force exerted by the lever 72 to the lever 85 and of providing an adjustable differential for the instrument. For this purpose the screw 91 may be moved in the slot 93 which is shown in Figure 5 as being a diagonal slot cut in the auxiliary lever 72. As the screw 91 is moved downwardly, the abutment between the levers 72 and 85 approaches the axis on which the auxiliary lever 72 is pivoted, and when the screw 91 is moved upwardly it approaches the axis on which the secondary lever 85 is pivoted.

The operation of the device as thus far described is as follows: Of an increase in temperature the rod 59 will move the primary lever 65 in a clockwise direction to increase the tension on the spring 75. This will move the auxiliary lever 72 slightly in a clockwise direction as seen in Figure 4. Referring now to Figure 6, the abutment

screw 91 will be moved downwardly which will result in a counter-clockwise rotation of the secondary lever 85 to move the valve actuating rod 79 downwardly. This will result in opening the pressure inlet valve to increase the branch line pressure and increase the upward force on the diaphragm 81 until there is sufficient pressure beneath the diaphragm to return the valve to neutral position and reclose the inlet valve. Likewise, on a decrease in temperature, the tension of the spring 75 will be reduced so that the auxiliary lever 72 will be moved slightly in a counter-clockwise direction as seen in Figure 4, and the secondary lever will be moved in a clockwise direction as seen in Figure 6. This will result in the valve actuating rod 79 being raised and the exhaust valve being opened to reduce the pressure in the branch line beneath the diaphragm 81 until the exhaust valve is again closed.

It will be seen that the operating differential of the device will be at a maximum when the screw 91 is moved to its uppermost position as seen in Figure 5 since in this position the greatest change in the tension of spring 75 will be required to produce a given change in force on the valve actuating rod 79. Similarly, the operating differential will be decreased as the screw 91 is moved downwardly so that the spring 75 has a greater leverage on the secondary lever 85. It may be pointed out here that the levers 72 and 85 may be so formed and the separation of the levers 72 and 85 as determined by the effective length of the screw 91 which serves as an abutment between these two levers may be so selected that as screw 91 is moved in the slot 93 to adjust the differential of the device, the tension of the spring 75 will be varied to eliminate any change in the control point. This construction was heretofore described in connection with the device of Figs. 1, 2 and 3.

As previously noted, this instrument is of the "sub-master" type and for that purpose it is provided with a bellows 96 which is secured at one of its ends to the base 55 and at its opposite end operates against a compression spring 97 which is supported by a bracket 98 which in turn is suitably secured to the frame 70. A lever 100 is pivoted at 101 in the bracket 98. A rod 103 extends between the bellows 96 and the lever 100 for the purpose of transmitting the force exerted by the bellows to the lever. A screw 105 is mounted in a slot 106 in the auxiliary lever 72. This screw serves as an adjustable abutment between the auxiliary lever 72 and the lever 100. As the screw 105 is moved downwardly, the force due to a given pressure in the bellows 96 tending to rotate the auxiliary lever 72 in a counter-clockwise direction is reduced.

The bellows 96 is supplied with pressure from the branch line of a "master" control, and as the pressure is increased in this bellows the branch line pressure as determined by the valve unit 78 will be reduced and the control point of the instrument will be raised when the various parts of the instrument are arranged as shown in the drawing and as heretofore described. The amount of change in control point for a variation in pressure within the bellows 96 from three to thirteen pounds (as is commonly the range of pressures derived from the "master" control) is known as the "reset range" and may be varied by adjustment of the screw 105 in the slot 106.

In order to reduce the load on various parts of the device a booster is provided for the valve unit 78. This booster comprises a booster unit 109 mounted on the base 55 and includes a diaphragm

110 subject on its lower side to branch line pressure, which is the same pressure as that existing under the diaphragm 81 in the valve unit 78. The diaphragm 110 is adapted to exert a force upwardly through a rod 112 on a booster lever 113. The booster lever is pivoted by means of knife edges 114 in the frame 70 and the supporting partition 89. The knife edges 114 abut the frame 70 and the partition 89 on the upper edges of slots 116. The knife edges 114 are carried by a plate 117 which is adjustable lengthwise of the booster lever 113 when the screw 119 is loosened. Since the same pressure is exerted beneath the diaphragm 110 in the booster unit 109 and the diaphragm 81 in the valve unit 78, and since these two forces oppose each other through the booster lever 113, the amount of boosting effect obtained may be varied by positioning the knife edges 114 lengthwise of the lever 113. If the lever 113 were pivoted midway of its length, the boosting effect would be 100% and substantially no force would be required to move the valve actuating rod 79 downwardly. As the knife edges 114 are moved farther toward the right, as seen in Figure 6, the boosting effect is lessened. The force required to be exerted downwardly on the valve actuating rod 79 to balance a pressure of 10 pounds per square inch beneath the diaphragm 81 may in this way be reduced from 18 ounces to approximately 5 ounces. Thus, the force which must be transmitted by the rod and tube element through the various levers is materially reduced. In this way the control may be rendered much more accurate in its operation, and at the same time smaller and less expensive parts may be used. Likewise, the standard valve unit utilized in various other instruments such as the "master" control of Figures 1 to 3 may be employed as the valve unit 78 of this device.

As pointed out before, the present device is "direct acting" as described because increases in temperature at the rod and tube will operate through the various levers to increase the branch line pressure. In order to change the device to a "reverse acting" instrument, the screw 91 extending between the auxiliary lever 72 and the secondary lever 85 must be removed from the diagonal slot 93 and inserted in the diagonal slot 121. With the screw 91 in this slot, downward movements of the auxiliary lever 72 as seen in Figure 6, will cause a clockwise rotation of the secondary lever 85. Furthermore, the valve actuating rod 79 must be provided with an extension 123, as shown in Figure 7, by means of which the secondary lever 85 may exert an upward force on the actuating rod 79. A compression spring 124 operates against an abutment nut 125 located on the rod 112 of the booster unit 109. This spring is adjusted, so that it exerts a force on the valve actuating rod 79 and the booster lever 113 which will cause a branch line pressure of 15 pounds per square inch to be maintained when no force is exerted on the actuating rod 79 through the secondary lever 85.

In this case as the temperature increases the primary lever 65 will be moved in a clockwise direction and the tension of spring 75 will be increased which will move the auxiliary lever 72 slightly in a clockwise direction. As seen in Figure 6 (assuming the screw 91 to be in the slot 121) the secondary lever 85 would then be rotated in a clockwise direction and the resulting upward force on the valve actuating rod will open the exhaust valve to reduce the pressure beneath

the diaphragm 81 and in the branch line. In this case when the temperature increases, the secondary lever 85 is moved to oppose the spring 124 which acts on the booster lever.

The spring 124 is incorporated in the instrument, both when it is "direct acting" and when it is "reverse acting." As described above, when the instrument is "reverse acting," the spring 124 supplies the force necessary to maintain maximum branch line pressure. When the instrument is set up to be "direct acting" the abutment nut 125 is adjusted so that the spring 124 exerts only a slight upward force which will slightly preload the various parts.

As seen in Figure 6, the base 55 is provided with three openings 127, 128 and 129 to which pipe lines may be connected. The three lines would include a pressure supply line, a branch line leading to the equipment being controlled and the control line leading to the "master" control. The supply line will lead only to the main valve unit 78, the branch line will lead to both the valve 78 and the booster unit 109, while the "master" control line will lead to the bellows 96.

In certain claims the condition responsive element is described as having a relatively high spring rate. By this phrase I mean that the element is relatively stiff and unyielding. The rod and tube element of the illustrative embodiments is such a condition responsive element. In this type of element changes in the value of the condition result in actual movement of some portion of the element rather than merely in a building up or lessening of force within the element.

While only two embodiments of the present invention have been shown and described, it is to be understood that the various features of novelty may be readily applied to other devices and I am therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a temperature responsive device for controlling the pressure in a control line, a rod and tube thermostatic element, a valve unit including a flexible wall subject on one side to control line pressure and also including means for positioning a three way valve positioned by said flexible wall for controlling the pressure in the control line, a pivoted primary lever positioned by said thermostatic element, a pivoted secondary lever movable with said flexible wall, an auxiliary lever pivoted at a point spaced from the pivot of said secondary lever, said auxiliary lever being disposed generally parallel with respect to said secondary lever, a spring between said primary and auxiliary levers, and a connection between said secondary and auxiliary levers adjustable lengthwise thereof for adjusting the temperature differential necessary to vary the control line pressure through its operating range.

2. Control apparatus of the character described comprising in combination, a condition responsive device having a relatively high spring rate and including a portion whose position is determined by the value of the condition, a control device having a neutral position in which it exerts no control function and which is movable in one direction from its neutral position to exert a control function and in the other direction from neutral to exert an opposite control function, connecting means by which said condition responsive device moves said control device, said connecting means including resilient means, and a pair of levers which at least partially overlap each other

and which are mounted to rotate about different axes, said connecting means also including a device operatively connecting the overlapping portions of said levers, follow up means for returning said control device to its neutral position by balancing the force exerted by said resilient means, said connecting device being adjustable along said levers to adjust the leverage through which force is transmitted from said condition responsive device to said control device for adjusting the differential of operation, said overlapping portions of the levers being slightly out of parallel relation when said control device is in neutral position so that adjustment of said connecting device will vary the tension of said resilient means to compensate for the change in the said leverage and the control point of said apparatus will not be changed upon adjustment of the differential thereof.

3. Control apparatus of the character described comprising in combination, a condition responsive device having a relatively high spring rate and including a portion whose position is determined by the value of the condition, control valve means for controlling the pressure in a control line, said valve means having a neutral position in which the control line pressure remains the same and which is movable in one direction to increase the control line pressure and in the opposite direction to decrease the control line pressure, connecting means by which said condition responsive device moves said control valve means, said connecting means including resilient means, and a pair of levers which at least partially overlap each other and which are mounted to rotate about different axes, said connecting means including a connecting device operatively connecting the overlapping portions of said levers, follow up means responsive to the control line pressure for returning said valve means to neutral position by balancing the force exerted by said resilient means, said adjusting device being adjustable along said levers to adjust the leverage through which force is transmitted from said condition responsive device to said valve means for adjusting the differential of operation thereof, said overlapping portions of the levers being slightly out of parallel relation when said control device is in neutral position so that adjustment of said connecting device will vary the tension of said resilient means to compensate for the change in the said leverage and the control point of said apparatus will not be changed upon adjustment of the differential thereof.

4. In a condition responsive device for controlling the pressure in a control line, a condition responsive member having a relatively high spring rate, an element, the position of which is determined by the value of the condition through response of said member thereto, valve means for determining the pressure in the control line, a lever pivoted on an axis at one angle for positioning said valve means, an auxiliary lever pivoted on an axis at a different angle than said first angle, resilient means connecting said element and said auxiliary lever, and an abutment between said levers positionable along a line at an angle intermediate said one angle and said different angle for adjusting the operation differential of the device.

5. In a condition responsive device for controlling the pressure in a control line, a condition responsive member having a relatively high spring rate, an element, the position of which is determined by said member as it responds to the

value of the condition, valve means for determining the pressure in the control line, a valve actuating lever for positioning said valve means, an intermediate lever pivoted on an axis at right angles to the pivot for said valve actuating lever, resilient means connecting said element and said intermediate lever, an abutment between said intermediate lever and said valve actuating lever positionable along a path that approaches one of said pivots as it recedes from the other for adjusting the operating differential of the device, and an expansible chamber subject to control line pressure tending to rotate said valve actuating lever.

6. In a condition responsive device for controlling the pressure in a control line, a condition responsive member, an element, the position of which is determined by said condition responsive member, valve means for determining the pressure in the control line, a pivoted valve actuating lever for positioning said valve means, an intermediate lever disposed generally parallel with respect to said valve actuating lever having a pivot spaced lengthwise of said intermediate lever from the pivot for said valve actuating lever, resilient means connecting said element and said intermediate lever, a connection between said levers, a first expansible chamber subject to control line pressure for positioning said valve actuating lever and a second expansible chamber adapted to be subjected to varying pressures from a source independent of said control line and acting against one of said levers for varying the control point of the device by changes in pressure of said second expansible chamber against said one of said levers.

7. In a condition responsive device for controlling the pressure in a control line, a condi-

tion responsive member, an element connected therewith, the position of which is determined by the value of the condition affecting said member, a first expansible chamber subject to control line pressure, valve means for controlling the pressure in the control line, means connecting said element with said expansible chamber and said valve means, a lever, and a second expansible chamber subject to said control line pressure and acting through said lever in opposition to said first expansible chamber, the leverage of said lever being less for said second expansible chamber than for said first expansible chamber for thereby reducing the force required by said condition responsive member to actuate said valve means.

8. In a condition responsive device for controlling the pressure in a control line, a condition responsive member, an element connected therewith, the position of which is determined by the value of the condition affecting said member, a first expansible chamber subject to control line pressure, valve means for controlling the pressure in the control line, means connecting said element with said expansible chamber and said valve means, a lever, and a second expansible chamber subject to said control line pressure and acting through said lever in opposition to said first expansible chamber, the leverage of said lever being less for said second expansible chamber than for said first expansible chamber thereby reducing the force required by said condition responsive member to actuate said valve means, and means for varying the relative effects of said first and second expansible chambers by changing the leverage relationship thereof with respect to said first and second expansible chambers.

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