Nov. 28, 1944. W. H. CARRIER 2,363,944

AIR CONDITIONING SYSTEM CONTROL ARRANGEMENT

Original Filed Aug. 12, 1939 2 Sheets-Sheet 1

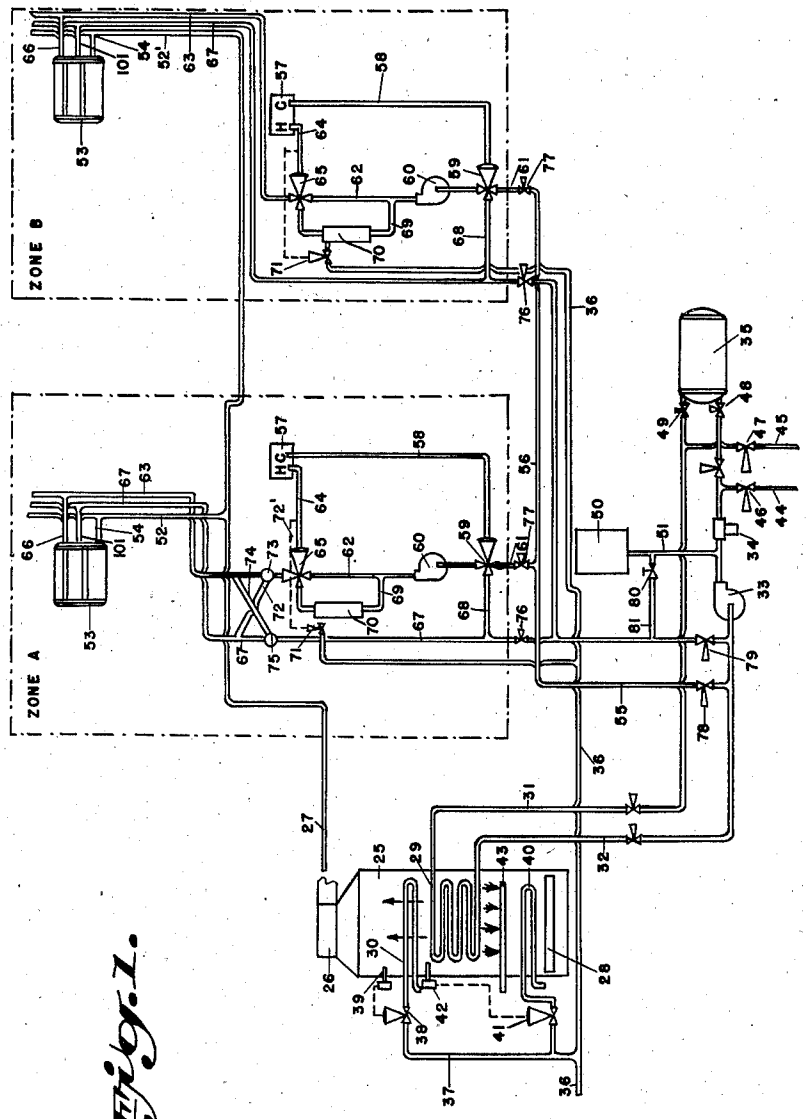


Fig. 1.

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Fig. 2.

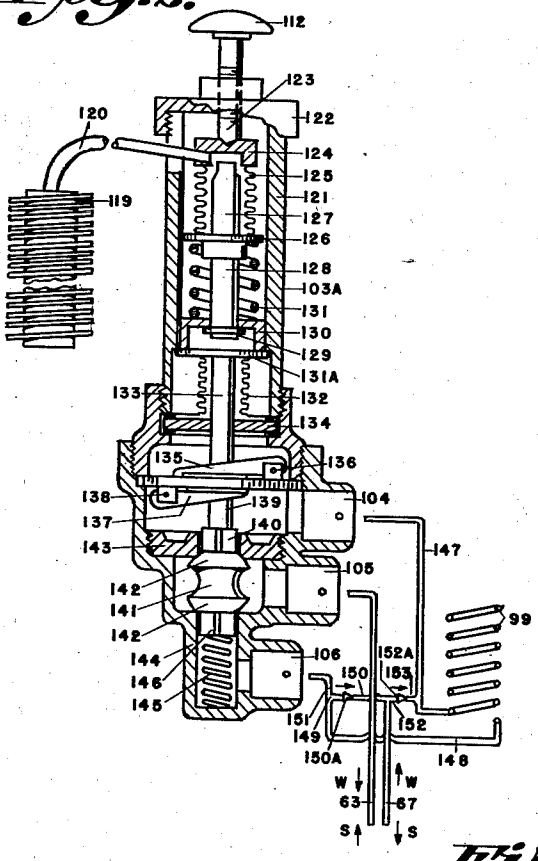


Fig. 3.

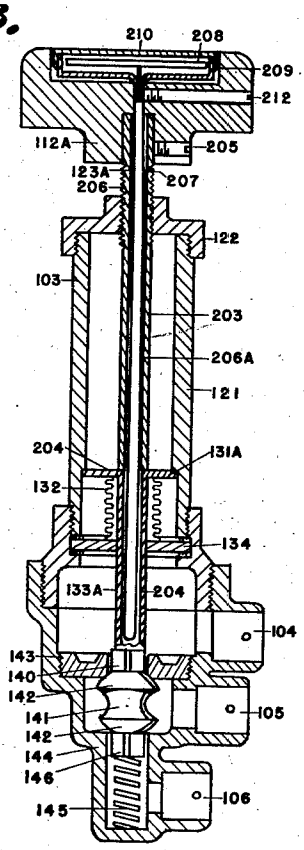
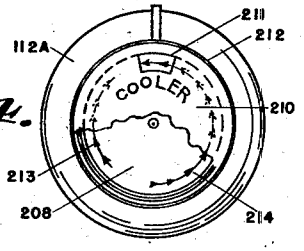


Fig. 4.



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UNITED STATES PATENT OFFICE

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AIR CONDITIONING SYSTEM CONTROL ARRANGEMENT

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Original application August 12, 1939, Serial No. 289,749. Divided and this application July 7, 1942, Serial No. 450,052

6 Claims. (Cl. 257—3)

This invention relates to air conditioning and is a division of application Serial No. 289,749 filed August 12, 1939.

The general object of the invention is to provide an arrangement including improved valve mechanism for use in an air conditioning system where fluid from a central source is routed to a plurality of individual units serving different zones to be conditioned.

A feature of the invention resides in the provision of a valve mechanism in combination with a flow system for apportioning fluid between different circuits so that desired air conditions may be produced and maintained in different zones regardless of changes in load affecting said zones.

The valve mechanism and flow arrangement will be described in connection with a high pressure air conditioning system in which air is delivered at a relatively high static pressure of the order of five inches of water to a primary air main serving a plurality of units. Each unit is provided with a heat exchange device to which heating or cooling fluid may be routed as desired under control of applicant's valve mechanism and system of fluid flow control.

Secondary air, induced by the discharge of the primary air within each unit, flows through and in contact with the surface of the heat exchanger therein, to be heated or cooled depending upon the character and amount of fluid circulated through the heat exchanger.

Thus, a simple and efficient system is provided wherein the primary air may be outside air in volume limited to the ventilation requirements of the conditioning areas, whereas the secondary air is heated or cooled to the proper degree, so that when mixed and discharged with the primary air a final volume will be delivered as required to provide prescribed air conditions in a given area.

Fig. 1 diagrammatically illustrates a typical system embodying applicant's invention;

Fig. 2 is a diagrammatic view illustrating, in section, a valve adapted to modulate the cooling or heating action of local air conditioning units in response to changes in load requirements, and diagrammatically illustrates the piping connections and flow arrangement to and between the control valve and the heat exchange coil of a local unit;

Fig. 3 is a diagrammatic view, in vertical section, of a manual control valve adapted to be employed in carrying out the invention, and

Fig. 4 is a view in plan of the control knob of the valve of Fig. 3.

First considering the general arrangement illustrated in Fig. 1, representing an air conditioning system to which applicant's invention may be applied, the numeral 25 designates generally a casing containing air conditioning apparatus of any desired type, and disposed at any desired point in or proximate a building to be conditioned. A fan 26 draws air through the casing, preferably from the outdoor atmosphere, whereby the air is conditioned in desired manner during its passage through the casing 25, and then discharges this air at relatively high static pressure into the primary high pressure air main 27.

The conditioner casing 25 preferably includes a filter 28, a cooling coil 29 and a reheating coil 30. Cold brine or other suitable conditioning medium is supplied to the coil 29 through supply line 31 and is withdrawn therefrom through return line 32 under the influence of pump 33 which returns the liquid through strainer 34 to a cooler 35, of any desired type, from which the cooled refrigerant is returned to line 31. Any desired means may be used to regulate suitably the temperature of the cooled refrigerant. Reheating coil 30 receives a heating medium, such as steam, from supply main 36 through branch line 37 under the control of valve 38 controlled by thermostat 39. The valve 38 admits steam to the coil 30 in a quantity sufficient to maintain the temperature of the air leaving the casing 25 at a desired point, thus reducing the relative humidity of the air leaving the cooling coil 29. Preferably the conditioner casing 25 contains also a preheating coil 40 adapted to receive steam from main 36 under the control of valve 41 controlled by a thermostat 42 disposed within the conditioner casing, the preheating coil 40 being intended for use under winter operating conditions. The conditioner casing preferably also contains humidifying sprays or the like 43 operative under winter operating conditions to increase the moisture content of air passing through the conditioner casing.

The pipes 44 and 45, respectively connected to pipes 32 and 31, and respectively served by valves 46 and 47, may be used for connecting into the circuit of the cooling coil 29 a connection to a source of well water, ice-water storage tank, or a cooling tower or the like for use when the wet bulb temperature of the outdoor air is sufficiently low to permit the use of evaporative cooling instead of the refrigeration normally supplied in any desired manner to the cooler 35. It will be understood that when the valves 46 and 47 are opened, the valves 48 and 49, respectively located in lines 32 and 31, will be closed.

Preferably a closed expansion tank 50 is connected by line 51 to the refrigerant return line 32, the closed expansion tank containing a quantity of compressible medium such as air and being employed at a low point in the liquid circulating system. It will be understood that if desired an open expansion tank may be used at a high lever in the system in the same man-

ner as employed, for example, in connection with hot water heating systems.

For purposes of illustration, one section of the system indicated within dotted lines is designated zone A while the other section within dotted lines is designated zone B. It is to be understood that each zone of the conditioning system may comprise any number of local condition units, and that any number of zones may be provided.

The air delivered by the fan 26 to the primary air distributing main 27 is at a relatively high static pressure, of the order of 5" of water. A portion of this air is diverted from the primary main 27 and passes to a vertical riser 52 of zone A and a corresponding riser 52' of zone B. Each vertical riser delivers air to a plurality of units designated generally as 53, through lateral connections 54. The primary air thus delivered to each unit serves to induce a relatively great circulation of secondary air and to promote desired circulation of air in the conditioned enclosures.

A pipe 55 connects with the cold water return line 32 and is adapted to deliver cold water or brine from said return line to cold water supply header 56, which, in turn, is adapted to supply this water to the different local units 53 of the various zones.

Each zone is provided with a control instrument, generally designated 57, which may be conveniently located at any desired point either within or without the enclosures of the zone served thereby, and comprises a device known as the Aerotherm, manufactured by Webster-Tallmadge & Co. Inc.

When the control device 57 serving zone A indicates a demand for cooling of the enclosures served by the local units 53 of zone A, control line 58 leading from the control device 57 serves to open the three-way or proportioning valve 59 so that the pump 60 draws cold water from the header 56 upwardly through pipe 61 and delivers this cold water through pipe 62 to the cold water riser 63. Under such operating conditions the control device 57, through control line 64, operates to adjust the proportioning valve 65 in such manner that flow from the pipe 62 to the pipe 63 is unimpeded. Thus, cold water may be delivered from the pipe 63 to each of the units 53 through lateral connections such as 66, and this water may then be returned through pipe 67 to the cold water return line 32 at the suction side of the pump 33. When the control device 57 reflects a demand for maximum cooling, the valve 59 will be adjusted so that the pump 60 draws water only from header 56, and in this case also all of the water returning from the local units through the pipe 67 will pass to the water return line 32. However, if the cooling load is less than maximum, the proportioning valve 59 will be adjusted to an intermediate position determined by the cooling load, in which the pump 60 will draw water not only through pipe 61 from the header 56, but also through by-pass line 68 leading from the water return line 67. It will be understood that the control device 57, by varying the proportions of water drawn from the supply header 56, and from the return line 67, will effect a variation in the temperature of the water delivered to the units in accordance with variations in load requirements.

Under winter operating conditions, or whenever heating is required, as indicated by the control device 57, the proportioning valve 59 is so adjusted that the pump 60 draws water only through the by-pass connection 68 from line 67. The water then delivered from the pump passes to the proportioning valve 65 through line 62 or line 69, or both, in varying proportions controlled by the valve 65 under control of device 57. The line 69 contains a heater 70 which receives steam from header 36 under the control of valve 71, the valve 71 preferably being controlled by the control device 57 as indicated by the dotted line 72 leading to the control line 64. The valve 71 is normally fully open whenever heating is required, the modulation of heating effect being accomplished by the routing of different portions of water through the heater 70 and through the pipe 62.

Under summer operating conditions the water discharged from the valve 65 passes to the units through line 63 and is returned therefrom through line 67. However, under winter operating conditions when automatic control of the local units 53 is employed, as in zone A, it is preferred to reverse the circulation. Thus, under winter operating conditions, hot water delivered from the proportioning valve 65 is routed through cross-over pipe 72 to pipe 67 by suitable adjustment of three-way valve 73, and water returning from the local units passes through pipe 63, thence through cross-over pipe 74 by suitable adjustment of three-way valve 75, and then returns to the inlet of pump 60 through line 68.

Suitable shut-off valves 76 and 77 are provided for isolating the entire piping arrangement of each zone from the central conditioning apparatus if this should be desired.

Under winter operating conditions when no cooling is required, the circulation through the cooling coil 29 of the central station conditioner 25 is interrupted and in such case the shut-off valves 78 and 79 are closed to isolate the central station water circulating system from the water circulating system of the various zones. However, under winter operating conditions, or whenever the central station water circulating system is inoperative, the valve 80 in line 81 is opened to make available to the water circulating systems of the various zones the function of the expansion tank 50. When the central station water circulating system is operative and is operatively connected with the water circulating systems of the various zones, valve 80 is closed.

The piping and control arrangement for zone B, in which the units are controlled manually, is substantially as described in connection with zone A, except that it will be noted that valves 73 and 75, and the cross-over pipes 72 and 74, are omitted. In all other respects, the piping arrangement and basic control scheme is the same as described in connection with zone A, and therefore no detailed description is deemed required with respect to zone B.

In the operation of the central station conditioning apparatus, the primary air is reduced to a low dewpoint. When water or brine is used for this purpose in the manner illustrated in Fig. 1, the heat exchange surface is so designed that the brine returning from the coil 29 is at a higher temperature than the air leaving the conditioner casing 25. Since it is the brine from return line 32 which is supplied to the local units 53 to effect cooling thereat, it will be appreciated

that the brine delivered to the local units will generally always be above the dewpoint of the air in the conditioned enclosures so that no moisture will be condensed in the local units. This is true in all cases except on starting up of the system in a humid atmosphere or where there is a relatively high latent heat load in the conditioned enclosure tending abnormally to increase the moisture content of the air therein.

Each local unit 53, containing a heat exchanger coil 99 may be served by a valve 103a as shown in Fig. 2. The control element which is preferably used in conjunction with valve 103a comprises a length of finned tubing 119 of the type commonly used in the construction of heat exchangers. The length of the control element may approximate 8" and the diameter of the tube may be of the order of ½". One end of the tube is sealed and the other end connects with a pressure tube 120 which extends within the housing 121 of the valve 103a. The control element 119 is filled with a volatile fluid adapted to expand and contract with changes in temperature, such as ether, and the control element 119 is placed so that the control element reflects the temperature within the enclosure served by the unit. The control element is preferably shielded in any desired manner from the heating or cooling effect of the coil 99 so as to insure more accurate control.

Through the top cap 122 of the valve there extends adjustable rod 123 bearing against a flanged disc or the like 124. The rod 123 is provided with a control handle 112 for use in adjusting the setting of the valve.

The flange 124 is secured in a gas-tight manner to the upper extremity of an expansible bellows 125, the lower extremity of the bellows being secured in a fluid-tight manner to a disc 126. The pressure tube 120 leads from the interior of the thermal element 119 to the interior of the bellows 125 so that as the temperature affecting the control element 119 is varied, the bellows 125 is caused correspondingly to expand and contract. A stud 127 extends within the interior of the bellows to decrease the free volume in the bellows, as this insures a more prompt and sensitive operation of the valve. The disc 126 is connected to a rod 128 extending downwardly therefrom and bearing a flange 129 at its lower extremity. The rod 128 extends within a cup-shaped member 130 and the flange 129 provides for retention of the rod 128 within the member 130 so that as the rod 128 is raised the member 130 will be raised correspondingly. A spring 131, extending between the bottom of disc 125 and the top of member 130, tends to maintain maximum separation of these two elements. The lower portion of member 130 carries a disc 131a to which there is connected, in a fluid-tight manner, a sealing bellows 132, and also a rod 133 extending through a plate 134 to which the bellows 132 is connected. Thus, the operating fluid of the thermal element is prevented from escaping within the valve and also the water or brine controlled by the valve is effectively prevented from escaping within the valve.

The rod 133 bears downwardly upon a lever 135 pivoted at 136. The free end of the lever 135 bears downwardly upon a lever 137, pivoted at 138, at a point proximate the fulcrum 138. The lever 137 is adapted to actuate the valve stem 139 which is operably connected through a star-shaped guide 140 to a valve closure member 141, comprising a pair of oppositely arranged faces 142. The arrangement of levers 135 and 137 is employed for the purpose of multiplying the motion of the primary control rod. Thus for a given movement of the valve rod 133 the corresponding movement of valve rod 139 may be four or five times as great. This amplification makes for increased sensitivity and refinement of control and makes it possible to maintain within very close limits the desired temperature in the conditioned enclosure.

The valve seat serving the upper face 142 is formed in a partition plate 143 provided between the upper connection 104 and the center connection 105 of the valve. The seat 144, cooperating with the lower face 142 of the valve member 141, is disposed between the central connection 105 and the bottom connection 106 of the valve. Spring 145, operating on valve guide 145, biases the valve in an upward direction.

Under summer operating conditions, or whenever cooling is required, a temperature higher than that desired required an increased flow of cooling medium through the valve. Under winter operating conditions, however, a temperature higher than normal calls for a decreased rate of flow of heating medium through the coil. To render the local unit entirely automatic so that its single valve may provide for the accurate control of temperature under both summer and winter operating conditions, the flow of conditioning fluid to and from the local unit is reversed as explained above in connection with three-way valves 73 and 75 and cross-over connections 72 and 74.

Considering the piping arrangement serving heat exchanger coil 99, under summer operating conditions, as explained in connection with Fig. 1, cooling medium is supplied through line 63, and thus enters the valve through the central connection 105. Assuming a demand for cooling to exist, the high temperature affecting the control element 119 will cause depression of the valve 141 and thus some of the liquid entering the valve at connection 105 will flow upwardly and out of the valve through 104 and through line 147 to the heat exchange coil 99. The conditioning medium passing from the coil is routed through line 148 to junction 149 and then passes through pipe 150, containing check valve 150a, to line 67 and is thus returned from the local unit. The portion of the conditioning medium supplied to the valve which is not so routed, passes downwardly in the valve past the valve seat 144 and is discharged through connection 106 to line 151 through which it passes to junction 149, where this fluid is joined with the fluid discharged from the conditioning coil 99 and is returned therewith to the line 67. As more conditioning is required under summer operating conditions, more cold liquid is circulated through the conditioning coil 99 and less is bypassed through 106, and as less conditioning is required less cold liquid will be supplied to the coil 99 and more will be bypassed through 106.

Under winter operating conditions reverse operation occurs, and in this case an increased temperature affecting the thermal control element 119 results in decreased supply of conditioning medium, which is then at a relatively high temperature, to the conditioning coil. Under winter operating conditions, conditioning medium is supplied through line 67 and passes through the branch line 152 containing check valve 152a, to junction 153. Part of the conditioning medium travels through the pipe 147 and enters the valve

at connection 104 and passes downwardly therein and is discharged from the valve through connection 105. The other portion of the conditioning fluid passes from the junction 153 to the conditioning coil 99, is discharged therefrom through line 148 and through connection 151, and enters the valve at 106 and is discharged therefrom through central opening 105 together with the fluid which was bypassed through connection 147. As the temperature affecting the thermal control element 119 rises, the valve 141 will be lowered and hence more of the conditioning fluid will be bypassed from 104 to 105, and correspondingly less of the conditioning fluid will pass through the coil 99 and the lower portion of the valve from 106 to 105. Conversely, if the temperature is lower than desired, more of the heating fluid will be routed through the conditioning coil and a lesser quantity will be bypassed.

When the valve controlling the action of the heat exchange coil 99 is controlled manually, there is no necessity for reversing the flow of the conditioning medium through the pipes 63 and 67 as in the case of automatic control in the manner just described, since an operator can readily turn the valve in either direction as required to bring about the desired change in the conditioning action. Thus, under summer operating conditions, when the local unit is supplied with cooling medium, if the temperature in the enclosure served by the unit is too high the operator will depress the valve 141 so as to permit increased flow of cooling medium from opening 105 to opening 104 serving the pipe 108, which delivers conditioning medium to the coil 99; and if the temperature is too low the operator will adjust the valve to raise the valve member 141 so that a lesser quantity of cooling medium flows through the conditioning coil 99. Under winter operating conditions, when heating medium is supplied to the conditioning unit, the operating is merely reversed. Thus, when the temperature in the enclosure is too high, the operator will raise the valve 141 to diminish the supply of heating medium to the coil 99 through the pipe 108, and if the conditioned enclosure is too cold, the valve 141 will be depressed to permit a greater supply of conditioning medium to the coil 99 through the connection 108.

Fig. 3 illustrates a modified valve construction adapted to be employed when manual control of the heating and cooling effect at the local units is desired. The valve 103 is essentially the same as the valve illustrated in Fig. 2 except for the omission of the expansible bellows and the multiplying mechanism which become unnecessary and may be eliminated in the case of manual operation. Thus, the valve includes a casing 121, a top cap 122 and an actuating stem 123*a*, the valve stem 123*a* being hollow to provide a longitudinally extending channel 203 therewithin. The bottom of the rod 123*a* bears against an adjustably positioned plate 131*a* and is adapted to cause displacement of this plate. The plate 131*a* is connected to the partition plate 134 by a sealing bellows 132, as in Fig. 2. A rod 133*a* extends downwardly from the plate 131*a* and is movable therewith to actuate the valve closure member 141. The plate 131*a* is provided with a central opening and the rod 133*a* is provided with a channel 204 extending therewithin and constituting an extension through the plate 131*a* of the channel 203 within the valve stem 123*a*. The handle 112*a* is secured to the valve stem 123*a* in any desired manner as by means of a set screw 205 so that as the handle is rotated, the valve stem is correspondingly rotated and raised or lowered by means of the threads 206 to provide the desired adjustment of position of the valve closure member 141.

Within the channels 203 and 204 there is positioned the stem 207 of a thermal indicator having a rotating disc 208 mounted at the top thereof and within a recess 209 formed in the top of the handle 112*a*. The recess is covered by a closure plate 210 which is provided with an aperture 211 through which a portion of the indicator plate 208 may be seen. A screw 212, or similar means, is employed to rotate the stem of the thermal indicator as the handle 112*a* is rotated so that the relative positions of the indicator disc 208 and the valve handle 112*a* may remain unaffected except by changes in temperature affecting the stem 207. Since thermal indicators of this type are well known in the art and in themselves do not constitute a part of the present invention, no detailed description thereof is deemed required here. One type of thermal indicator of the character indicated is manufactured by the Weston Electrical Instrument Company of Newark, New Jersey, the instruments manufactured by this company, however, being generally provided with a dial pointer rather than a disc as here disclosed. As will be understood, the thermo-responsive stem 207, extending within and through the body of the valve, will respond to changes in the temperature of the fluid passing through the valve and thus will change the position of the disc 208 in accordance with such changes in temperature. The upper face of disc 208 is provided with two sets of arrow indicators pointing in opposite directions and arranged throughout different arcuate portions of the indicator disc. When the conditioning medium circulated through the valve is cold, one portion of the indicator disc 208 will appear opposite the aperture 211, this portion bearing the arrows 213. The word "Cooler" appears upon the cover disc 210 proximate the aperture, and when the arrows 213 are visible through the aperture 211, this will indicate that to provide cooler conditions in the enclosure the valve handle should be turned in a clockwise direction. This will depress the valve closure member 141 and permit more conditioning medium to enter the pipe 128 and thus pass to the conditioner coils. If the room is too cool under such operating conditions the valve will be turned in a reverse direction to diminish the amount of cooling medium passing to the conditioning coil. When the conditioning medium supplied to the valve is warm another portion of the indicator disc 208 will appear through the aperture 211, the arrows 214 then indicating the direction in which the valve should be turned to provide a desired change in temperature within the enclosure. Thus, when heating medium is supplied to the valve, turning the valve in a counter-clockwise direction will render the enclosure cooler by raising the valve closure device 141 and diminishing the supply of heating medium to the conditioner coils, whereas, turning the valve handle in a reverse or clockwise direction will depress the valve closure member 141 and cause more heating medium to pass to the conditioner coils. It will be apparent to those skilled in the art, that instead of the word "Cooler" the word "Warmer" might be applied on the valve handle, in which case the arrows will each point in a direction opposite to that shown in the drawings, and that variations may be made in the physical embodiment of the invention

without departing from the concept herein disclosed.

I claim:

1. A fluid control arrangement for an air conditioning system comprising a heat exchange device, a valve structure for controlling the flow of heating fluid to said device under winter operating conditions and the flow of cooling fluid to said device under summer operating conditions, a thermal element and means operative responsive to variations in temperature under winter and summer operating conditions affecting said element for causing said valve structure to operate, said valve structure including a first port, a second port, a third port, a double seated port control member, the flow of fluid through said three ports being regulated by the action of said port control member, and means operative upon a rise in temperature under summer operating conditions for routing cooling fluid from a source of supply in part in a flow circuit including said second port, third port, heat exchange device and a return line, and in part through said second port, first port and the same return line, the proportions of fluid passing through said flow circuits being varied responsive to changes in conditions affecting the thermal element, said means being operative upon a rise in temperature under winter operating conditions to route heating fluid through a different flow circuit including the same ports and heat exchange device.

2. A fluid control arrangement for an air conditioning system comprising a heat exchange device, a valve structure for controlling the flow of heating fluid to said device under winter operating conditions and the flow of cooling fluid to said device under summer operating conditions, a thermal element and means operative responsive to variations in temperature under winter and summer operating conditions affecting said element for causing said valve structure to operate, said valve structure including a first port, a second port, a third port, a double seated port control member, the flow of fluid through said three ports being regulated by the action of said port control member, and means operative upon a fall in temperature under winter operating conditions for routing heating fluid from a source of supply in part in a flow circuit including said heat exchange device first port, second port, and a return line, and in part through said third port, second port, and back to the same return line, the proportions of fluid passing through said flow circuits being varied responsive to changes in conditions affecting the thermal element, said means operative upon a fall in temperature under summer operating conditions for routing cooling fluid in a different flow circuit including said heat exchange device and ports.

3. In a fluid control arrangement of the character described, a first conditioning medium line, a second conditioning medium line, means for routing heating conditioning medium through said lines under winter operating conditions and cooling conditioning medium through said lines under summer operating conditions, a heat exchanger connected to said lines, a proportioning valve structure, a multi-seat valve in the structure, a first fluid port, a second port, a third port, all said ports connecting said lines to passages controlled by said valve, and means operative responsive to variations in atmospheric conditions during certain seasons of the year for routing heating conditioning medium from one of said lines in a desired ratio with one part flowing through said heat exchanger and two of said ports and the remainder of the medium flowing through one of said last two mentioned ports and the third port, the ratio being varied responsive to variations in the position of said valve, said means being operative responsive to variations in atmospheric conditions during other seasons of the year for routing cooling conditioning medium in a different flow arrangement through the same ports and exchanger.

4. In a fluid control arrangement according to claim 3, means for routing a constant volume of fluid substantially at a constant rate through said lines, and means for assuring the flow of different proportions of said fluid through said ports in the desired directions.

5. A valve arrangement of the character described comprising a housing structure, an upper section of said structure containing an actuating element, a driving rod in said section, a volatile fluid in said element arranged to move said rod responsive to expansion and contraction of said fluid, a conditioning fluid lower section of said structure, a driven rod in said lower section, a valve closure member connected to said driven rod, an intermediate section connected to said upper and lower sections, a sealing bellows for preventing the volatile fluid in the upper section and conditioning fluid from the lower section from escaping within the valve, movement multiplying mechanism in the structure for relaying a movement of the driving rod to the driven rod, three fluid passages in the lower section, said valve closure member being located in one of said passages and operative responsive to movement of the driven rod to apportion the flow of fluid in desired ratio from a single source through said passages.

6. A valve arrangement of the character described comprising a valve housing a first passage, a second passage, a third passage, all said passages being formed in the housing and connecting with each other, a double seated closure device in the second passage, means operative responsive to changes in atmospheric conditions for actuating said device in such manner that fluid could be permitted to flow between said second and one of the other passages while barred from flowing between said second and the remaining passage, a heat exchanger for conditioning air, fluid supply and return lines, and a plurality of conduits connecting said lines to said passages and exchanger, means operative under summer operating conditions, upon a rise in atmospheric temperature, for routing an increasing volume of cooling fluid through the first of said passages feeding the heat exchanger and bypassing the remainder of the cooling fluid fed to the valve around the heat exchanger through the third passage, means operative under winter operating conditions, upon a fall in atmospheric temperature, for routing an increasing volume of heating fluid through the third passage feeding the heat exchanger and bypassing the remainder of the heating fluid fed to the valve around the heat exchanger through the first passage, the direction of fluid flow through said fluid supply and return lines under winter operating conditions being the reverse of that under summer operating conditions.

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