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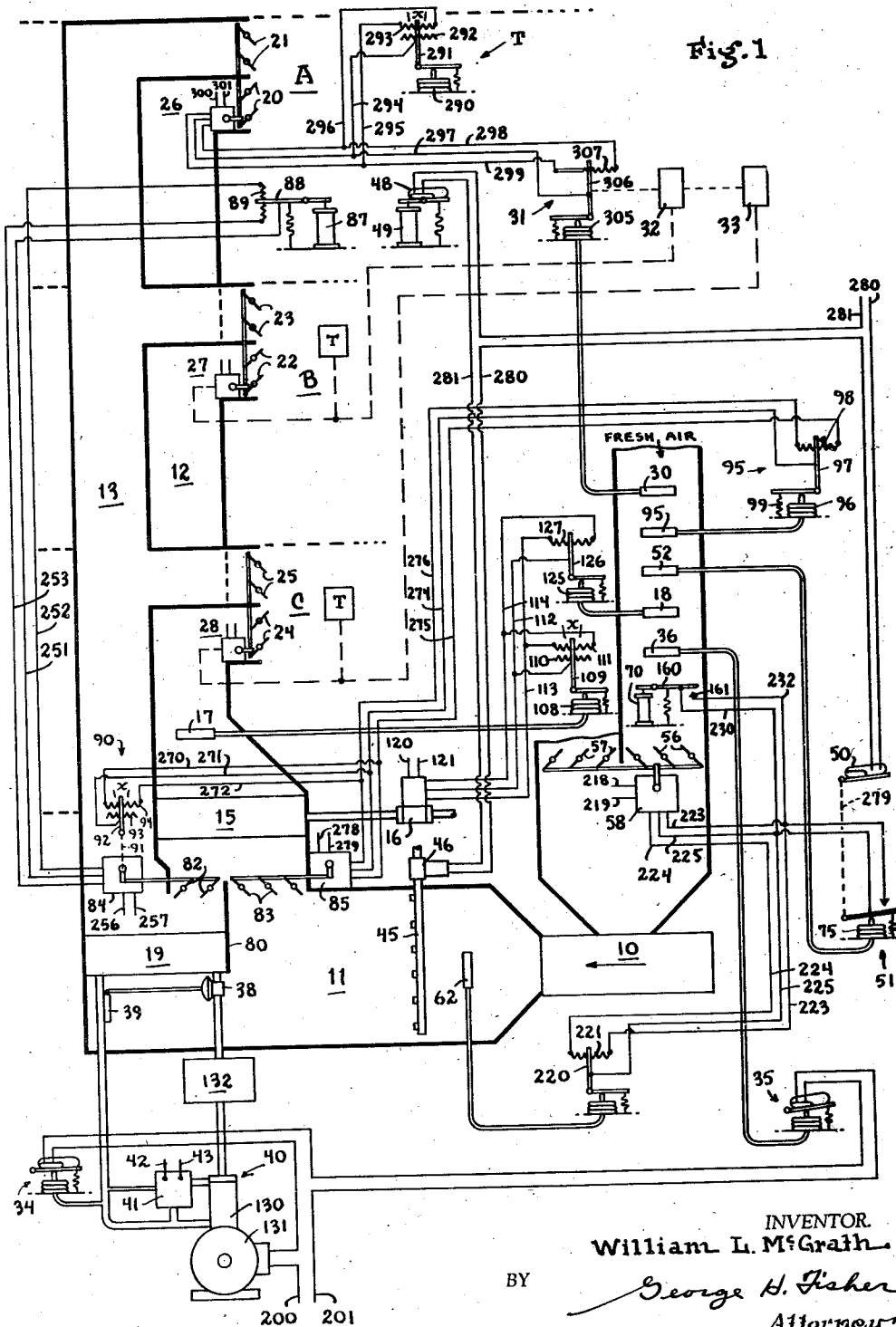
W. L. McGRATH

2,372,839

AIR CONDITIONING SYSTEM

Filed Dec. 6, 1941

3 Sheets-Sheet 1



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AIR CONDITIONING SYSTEM

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3 Sheets-Sheet 2

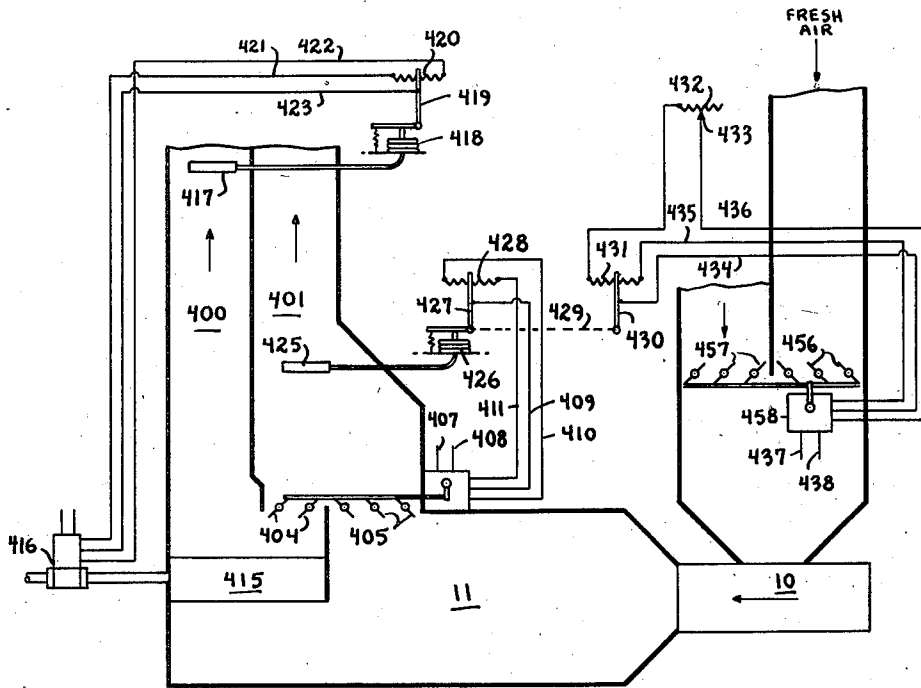


Fig. 2

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3 Sheets-Sheet 3

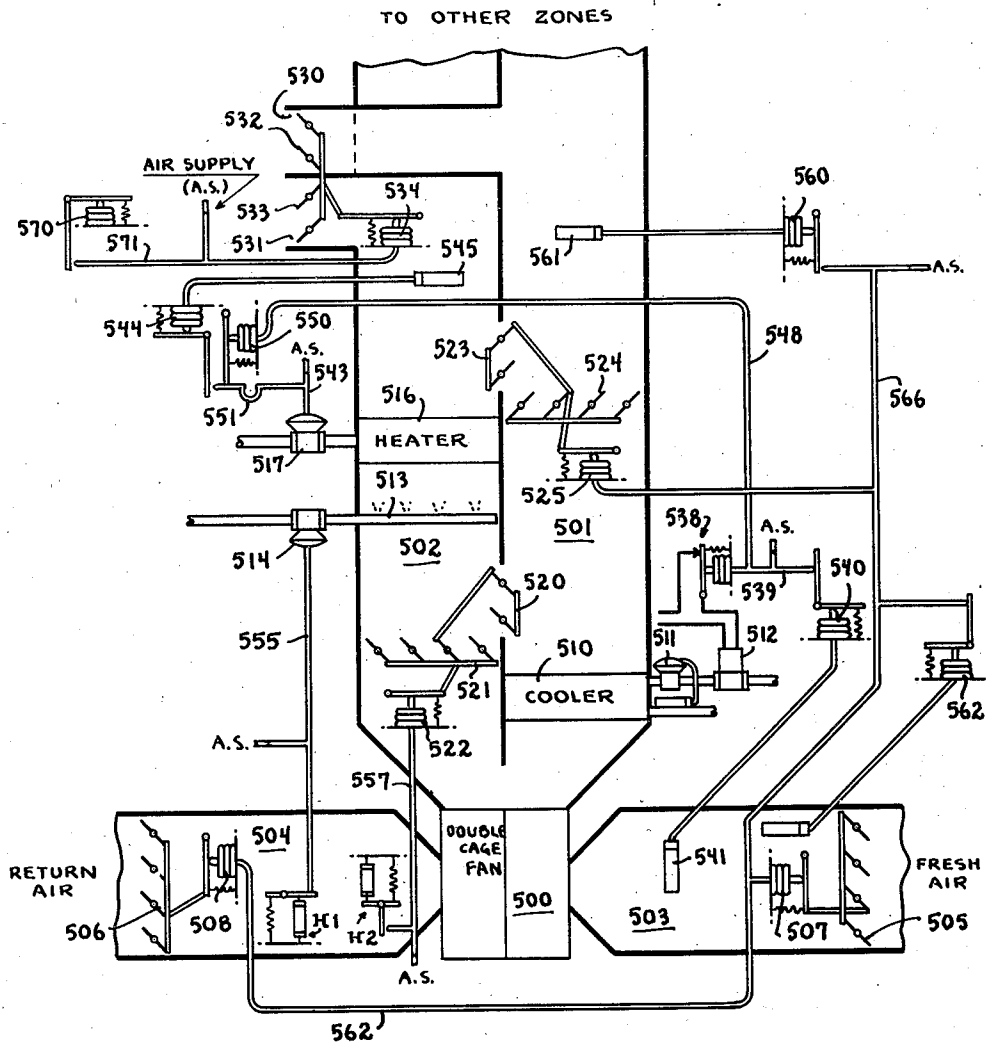


Fig. 3

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UNITED STATES PATENT OFFICE

2,372,839

AIR CONDITIONING SYSTEM

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Application December 6, 1941, Serial No. 421,867

18 Claims. (Cl. 257-3)

This invention relates in general to a year around air conditioning system for a zone, or for a plurality of zones, and in particular to a system of the type in which the supply of conditioned air for each of a plurality of zones is furnished by individually varying the relative proportions of air simultaneously admitted to each zone from separate supplies of cool and warm air which serve as common sources of supply for each of the zones. The invention particularly relates to a novel and improved humidification control employed in conjunction with a system of the type in which each of the zones is conditioned by regulating the proportions of air simultaneously supplied from a warm air duct and cool air duct. Thus my invention embodies new and novel improvements in conditioning systems of the type disclosed in the patent to G. D. Guler, No. 2,238,688.

One object of the invention is to control the humidity in a forced air system employing a warm air duct and a cool air duct by dehumidifying and cooling the air supplied to the cool air duct and diverting a regulated portion of the dehumidified and cooled air for mixture with the air supplied to the warm air duct under the control of a humidity responsive means.

A further object of the invention is the provision of means for preventing draft effects in a zone, or zones, due to the zone controller requiring the admission of air from a cool air duct during periods when the cool air duct temperatures would normally be relatively very low. This condition is encountered during periods of relatively low outdoor temperatures and particularly in connection with installations wherein a minimum amount of fresh air must be assured at all times pursuant to ventilation requirements. In the absence of such requirements the condition is also encountered during periods of relatively very low outdoor temperatures.

A further object of the invention is to eliminate the objectionable draft effects while at the same time avoiding any necessity for the use of limit controls for each of a plurality of zones being conditioned and avoiding duplication of heating means. One particular object is to prevent the occurrence of draft effects by decreasing the volume of air circulated in the zones during periods in which relatively low outdoor temperatures prevail.

In carrying out my invention I provide a plurality of volumes of separately and variously treated air in which air from at least one of the treated volumes is in varying proportions diverted to and mixed with the air of a second volume to either treat or assist in the treatment of the second volume of air. The proportion of air diverted from the first to the second volume is controlled by a condition responsive means in-

dicative of a condition existing in either one of the volumes of air, or in a zone being conditioned. The zone conditioning is accomplished by regulating the proportionate amounts of these separate volumes of air simultaneously admitted to a zone or to each of the zones and may be under the control of means responsive to or indicative of a condition existing in a zone, or in each of the zones being conditioned. In accordance with my invention the humidity is controlled by cooling and dehumidifying one volume of air admitted to a cool air duct and diverting a portion of the dehumidified and cooled air into a warm air duct for mixing with a second volume of air prior to treatment thereof by a heat exchanger in the warm air duct. The heat exchanger may operate to maintain a predetermined temperature in the warm air duct and a temperature responsive means for controlling the operation of this heat exchanger may be modified in operation by means responsive to outdoor temperature.

For the prevention of draft effects in a zone being conditioned during periods when the temperature in a cool air duct would otherwise be sufficiently low to produce such effects a first volume of air in the conditioner is heated for maintaining the air in the warm air duct at a predetermined high temperature and a second volume of air is admitted to the cool air duct. A portion of the heated volume of air is diverted to and mixed with the volume of cool air. A means responsive to the temperature in the cool air duct is employed to control the amount of air diverted thereto from the volume of warm air and to assure the existence of a temperature that is sufficiently high to avoid the production of the draft effects. In this manner the diverted warm air may be employed to maintain a predetermined minimum temperature in the cool air duct and this temperature is sufficiently high that draft effects will be avoided.

A particular object of the invention is the provision of a double duct type of air conditioning system in which the volume of air in a first duct is maintained at a predetermined temperature that is lower than that maintained in the second duct. A regulated mixture of fresh and recirculated air is admitted to the conditioner. A controlled heat exchange cooling and dehumidifying means is maintained for the air admitted to the first volume. A portion of the cooled and dehumidified air is mixed with the air supply for the second volume of air under the control of a humidity responsive means to provide for any required dehumidification of the two volumes of air and the humidity responsive means likewise controls a means for humidifying the second volume of air. The air supplied the second volume and thus controlled for humidity is subjected to a con-

trolled heating means which heats and maintains this volume at a predetermined temperature. A portion of the heated volume of air is mixed with the cooled and dehumidified air of the first volume under the control of thermostatic means for the purpose of treating and maintaining the volume in the cool air duct at the desired value of temperature lower than that maintained in the second duct. The thermostatic controller means is likewise employed to control the means for regulating the mixture of fresh and recirculated air which is admitted to the conditioner. This controller may be compensated for outdoor conditions. A plurality of zones, or a single zone may be conditioned in accordance with the individual zone requirements of humidity and temperature by admitting thereto a mixture of the two treated volumes of air. A means for regulating the mixture of the two treated volumes may be provided and this means is preferably controlled by individual zone temperature condition responsive means, although various type of condition responsive means including humidity responsive means may be employed. My invention provides year around air conditioning in which a plurality of zones may be individually conditioned and wherein certain of the zones may require heating and others simultaneously require cooling.

Other objects and advantages of my invention will be apparent from the embodiments thereof described below and illustrated in the drawings.

Figure 1 is a schematic diagram of one form of my air condition system.

Figure 2 is a schematic diagram of a modification of my invention as illustrated in Figure 1 and relating particularly to a system which provides for the elimination of draft effects in the zones being conditioned.

Figure 3 is a schematic diagram of a preferred form of my invention which as illustrated employs pneumatic controls.

Referring to Figure 1, the fan 10 supplies air to a plenum chamber 11 from which it is fed to the warm air duct 12 and the cool air duct 13. A heater 15 is located in the warm air duct and is regulated by a motor operated valve 16 in accordance with the temperature in the warm air duct. The valve motor is controlled by the temperature responsive bulb 17 and this control may be modified in accordance with outdoor temperature under the control of the temperature responsive bulb 18 in such a manner that for winter operation as the outside temperature decreases a higher warm air temperature is maintained. The valve operating motor may be of the type illustrated in Patent No. 2,028,110 issued to D. G. Taylor on January 14, 1936.

The air admitted to the cold air duct 13 is cooled and dehumidified by the cooling means 19 of a system which may be operated to dehumidify and maintain a desired low temperature in the cool air duct, as hereinafter referred to.

Conditioned air is supplied to a plurality of zones A, B, and C in accordance with the individual requirements of the several zones by regulating the proportion of air simultaneously supplied to each zone from the warm and cool air ducts. A set of reverse acting proportioning dampers 20, 21 in zone A; 22, 23 in zone B; and 24, 25 in zone C, each of which is actuated by a modulating motor 26, 27 and 28 respectively, is employed to proportion the air admitted to each of the respective zones from the warm and cold air ducts. The motors 26, 27 and 28 may be of

the type illustrated in the patent to D. G. Taylor referred to above. A temperature responsive element generally referred to by the reference character T is located in each of the zones for controlling the respective damper operating motors. Each of these zone controllers may be compensated to vary the zone control in accordance with variations in outdoor temperature to increase the temperature in the zones upon increase in outdoor temperatures when the system is operating on the summer cycle and to maintain a constant temperature control during operation on the winter cycle. The outdoor temperature responsive bulb 30 is employed to regulate these compensating controllers 31, 32 and 33, in a manner more fully described hereinafter.

The refrigeration machine 40 is operated during the cooling season to make effective the cooling and dehumidifying means 19. The refrigerant compressor is operated in a conventional manner by a control 34 responsive to the return line refrigerant pressure and this control may in turn be regulated by a switching device 35 controlled by the outdoor temperature responsive bulb 36. An expansion valve 38 in the refrigerant supply line for the cooling means 19 may be of a well known type that is influenced by the evaporator outlet temperatures under the control of the bulb 39.

A motor operated refrigerant return line pressure control means 41, of which the terminals 42 and 43 are connected to any suitable source of power, is employed to operate a by-pass reduction valve in a known manner for varying the compressor capacity. The several pressure responsive control means acting in conjunction with the expansion valve control means serve to operate the cooling means 19 to establish a desired temperature in the cool air duct.

A humidifying spray device 45 controlled by solenoid valve 46 is provided for supplying moisture to the air during operation on the winter cycle. This spray device is illustrated as being located in the fan plenum chamber but may preferably be located in the warm air duct. The spray control valve is actuated by switch 48 which may be controlled by any well known form of humidity responsive element 49. This humidity responsive element may be located in a zone or otherwise located to respond to the humidity representative of that existing in the several zones. The spray is further controlled by a switch 50 which is actuated by a connection with a summer and winter operating cycle changeover switch 51, which in turn is controlled by an outdoor temperature responsive bulb 52. This switch may be adjusted to close at a temperature of, for example, 65° F.

Fresh and return air dampers 56 and 57 are of the reverse acting and proportioning type and are positioned by a motor 58 of the type illustrated in the patent to D. G. Taylor referred to above. For the operation of these dampers the temperature responsive bulb 62 located in the air plenum chamber is employed to maintain the temperature therein at a predetermined value of, for example, 65° F., or above.

For operating the fresh and return air dampers 56 and 57 an "economizer" humidity responsive control 70 is provided which serves to improve the operating characteristics of the system. The outdoor humidity responsive device 70 is placed in control of the fresh and return air dampers when the outdoor temperature re-

sponsive device 52 actuates bellows 75 to oper-

ate switch 51. The switch 51 is actuated at a predetermined temperature of, for example, 75° F. to place outdoor humidity responsive device 70 in control of the fresh and return air dampers for the purpose of closing the fresh air damper 56. The fresh and return air dampers are also operated in accordance with outdoor humidity to maintain as nearly as possible a relative humidity of 60% or lower. During those periods when the outdoor humidity is excessively high including such periods during which it is raining, the fresh air damper will be moved to a closed position when the relative humidity exceeds the desired value and thus decrease the dehumidification requirements of the system. The humidity responsive device 70 is employed to actuate a switch 160 which serves to close the fresh air damper 56 when the outside air rises to a value of, for example, 60 degrees relative humidity or above. The dampers are normally controlled in a modulating manner by the thermostat 62 to maintain a desired value of, for example, 65° F. in the plenum chamber 62. The control of the fresh and return air dampers is further described below.

An improved temperature and humidity control is provided by dehumidifying and cooling a first volume of air which flows from the fan plenum chamber 11 below partition 80 and in heat exchange relation with the cooling and dehumidifying means 19. All of the air supplied to the cool air duct 13 is obtained from this volume of air. The air supplied to the warm air duct 12 is made up by proportioning the amount of air supplied from the fan plenum chamber 11 and that which is diverted from the volume of cooled and humidified air. The proportions of the two volumes of air admitted to the warm air duct is regulated by the reverse acting dampers 82 and 83 which are positioned by the motors 84 and 85 respectively. The motors may also be of the type illustrated in the patent to D. G. Taylor referred to above. The damper 82 is positioned by the motor 84 under the direct control of a humidity responsive element 87 which may be located in the zone or otherwise positioned to respond to humidity conditions representative of those existing in the zones.

The motor 85 for positioning the damper 83 is regulated primarily by a master potentiometer controller 90. The potentiometer controller 90 is actuated by a shaft 91 in accordance with the positioning of motor 84 and the shaft positions a slider arm 92 with respect to a center tap resistance 93 and the potentiometer resistance 94. The operation of this controller is such that as the slider arm is moved a distance X, the motor 85 is actuated between positions for fully opening and closing the damper 83. In the winter operating cycle when outdoor temperatures are relatively low it is desirable to decrease the volume of air circulated in the conditioning system. In order to restrict the air flow, the control for the damper 83 is compensated by an outdoor temperature responsive device 95. The outdoor temperature responsive device 95 actuates the bellows 96 to position a pivoted and biased potentiometer slider arm 97 with respect to the potentiometer resistance 98. The operation of this potentiometer serves to vary the control asserted by the master controller 90 in such a manner that as the slider arm 97 moves to the left upon decrease in temperature the dampers are operated in a closing

direction for a given position of the master controller. In other words, the device 95 effectively adjusts the range X to raise or lower the control range of the master control 90 in accordance with variations in outdoor temperature.

In operation on the winter cycle the relative humidity is normally low with the result that the humidity responsive control 87 operates the motor 84 to close the by-pass damper 82. The master potentiometer controller 94 for positioning the damper 83 is accordingly positioned at one end of its effective control range on the potentiometer resistances 92 and 93. The damper motor 85 is then regulated to throttle the flow of air in the system as outdoor temperature decreases by the operation of the outdoor temperature responsive device 95. In this way during the winter operating cycle the volume of air circulated in the air conditioning system is decreased in a manner proportional with decreasing outdoor temperatures.

The operation of the system is as follows: The fan 10 may be operated in a continuous or other well known manner, not shown, for circulating the air in the system. The heater 15 in the warm air duct is regulated by the motor operated valve 16 for which current is supplied by the leads 120 and 121. This motor is controlled by the temperature responsive capsule 17 located in the warm air duct which actuates the bellows 108 for positioning a potentiometer slider arm 109 with respect to the center tap resistance 110 and a potentiometer resistance 111. Movement of the potentiometer slide arm serves to vary the resistance inserted between the common wire 112 of the potentiometer motor control circuit and the wires 113 and 114 of the motor control circuit with a resultant operation of the motor. Upon a decrease in the temperature in the warm air duct, the potentiometer slider arm 109 is moved to the right and the valve motor is correspondingly operated in an opening direction for maintaining the temperature in the warm air duct within a predetermined range of, for example, 80° F. to 100° F. Operation of the slider arm 109 a distance X serves to operate the valve between the fully open and the fully closed position and would normally serve to maintain a given temperature within the predetermined temperature range. However, the control potentiometer 109 is compensated by an outdoor temperature responsive means 118 in order to vary the temperature maintained in the warm air duct within the predetermined temperature range and to increase the temperature maintained in the warm air duct as the outdoor temperature decreases below a predetermined value of, for example, 60° F. The compensating temperature responsive capsule 118 actuates a bellows 125 to operate the biased and pivoted potentiometer slider arm 126 with respect to the potentiometer resistance 127. The potentiometer slider arm 126 is connected to the common wire 112 of the heater valve motor control circuit. The wire 113 of the motor control circuit is connected to the left end of the potentiometer resistance 127 and the wire 114 of this control circuit is connected to the right end of the potentiometer resistance 127. During operation on the winter cycle when the heating demands on the system are at a maximum, the fresh air responsive compensating device 118 will operate potentiometer slide arm 127 to the right in response to a decrease in temperature. This serves to operate the motor for further opening the valve and for increasing the temperature

maintained within the range of 80° F. to 100° F. by varying the control range of the master controller 109. In this manner the temperature in the warm air duct is maintained at a temperature of 80° F. when the outdoor temperature is above 60° F. and within a temperature range of from 80° to 100° during the winter operating cycle at a particular temperature determined by the outdoor temperature responsive means 18.

The refrigeration system 40 is of a type well known in the art and includes a compressor 130 operated by a motor 131 for supplying refrigerant to a condenser 132. The refrigerant is in turn supplied to the dehumidifying and air cooling means 19 under the control of a well known type of expansion valve 38. The expansion valve 38 is of a type that responds to the refrigerant return line temperature under the control of the temperature responsive means 39. The refrigeration control valve operates to maintain a desired temperature for the cooling means 19. The return line pressure responsive control and by-pass reduction valve 41 serve to vary the compressor capacity and in conjunction with the valve 38 controls the temperature in the cool air duct. The cooling and dehumidifying system is made effective for operation on the summer cycle by an outdoor temperature responsive capsule 36 operating through a bellows for actuating the pivotally mounted and biased mercury switch 35 to complete a circuit which permits operation of the refrigerant compressor from the line wires 200 and 201. The switch 35 is adjusted to permit operation of the refrigerant compressor motor for the summer cooling cycle at a desired temperature at, for example, 65° F. The operation of the compressor motor 131 is additionally regulated in order to maintain a desired pressure in the refrigerant return line. For this purpose a refrigerant return line pressure responsive cut-off device 34 operates through a bellows to actuate the pivotally mounted and biased mercury switch in control of the compressor motor.

The fresh and return air dampers 56 and 57 are operated in a proportioning manner and also in a manner to serve as a conditioning "economizer." To serve this further "economizer" purpose the damper motor 58 is operated to close the fresh air damper 56 if the outdoor temperature exceeds a predetermined value and also if the outdoor humidity exceeds a predetermined value as mentioned above. With the switch 51 in the position illustrated, the temperature responsive means 62 located in the fan plenum chamber then operates to control the positioning of the fresh and return air damper actuating motor 58. The temperature responsive means 62 actuates a bellows for positioning a pivotally mounted and biased potentiometer slider arm 220 with respect to the potentiometer resistance 221. The potentiometer slider arm 220 is connected to the center or common wire of the balanced motor control circuit. The ends of the potentiometer resistance 221 are connected by wires 224 and 225 to the outer terminals of the motor 58 to complete the motor control circuit. Movement of the potentiometer slider arm 220 to the left along the potentiometer resistance 221 resulting from an increase in temperature in the fan plenum chamber decreases the resistance in the motor control circuit which includes the wires 224 and 225 while increasing the resistance in the circuit which includes the wires 223 and 225 with the result that motor 58 is operated to position the fresh and return air dampers for ad-

mitting a greater proportion of fresh air. In this manner the fresh and return air dampers are so regulated as to maintain the predetermined temperature in the fan plenum chamber when possible by reason of existing outdoor and return air temperatures.

When the outside temperature exceeds the predetermined value of 75° F., the temperature responsive capsule 52 operates the bellows 75 to close the switch 51 and complete a circuit to the damper motor 58 which serves to shunt the external resistance from the portion of the motor control circuit which includes the wires 223 and 225. This accordingly unbalances the motor control circuit and actuates the motor to close the fresh air damper 56 to minimize the cooling demands on the system.

Should the outdoor relative humidity rise to exceed the predetermined value of 60 per cent the humidity responsive device 70 operates to close switch 160 and likewise complete a circuit to the damper motor 58 to shunt the resistance in the portion of the control circuit that includes the wires 223 and 225. This switch 160 also accordingly serves to actuate the motor 58 in a manner to close the fresh air damper 56. This control of the fresh air damper serves to reduce the dehumidification requirements of the system to a minimum particularly in summer when the outdoor humidity is frequently very high.

During operation on both the summer and winter cycles the flow of air to the warm air duct is regulated by the reverse acting dampers 82 and 83 which are positioned by the motors 84 and 85, respectively. In the summer operating cycle dehumidification is normally required and operation of the cooling means 19 is necessary for both cooling the air supplied to the cool air duct and for dehumidification purposes. The air supplied to the warm air duct 12 through the dampers 82 and 83 is primarily controlled by the humidity responsive element 87. The humidity responsive device 87 positions the pivoted and biased potentiometer slider arm 88, and this arm is connected to the center or common control wire 251 of the damper operating motor 84. The potentiometer resistance 89 is connected by the wires 252 and 253 to the motor 84. Energy is supplied to the motor from the line wires 256 and 257. The position of the slider arm 88 is varied in accordance with the humidity as the element 87 expands and contracts and serves to vary the resistance in the motor control circuit 251 and 252 with respect to that in the circuit 251 and 253 to thus unbalance the circuit and actuate motor 84 to correspondingly position the damper 82. The damper 82 is controlled entirely by the humidity responsive element 87 and as the humidity increases this damper will be operated to admit a larger proportion of dehumidified and cooled air to the warm air duct. The reverse acting damper 83 is positioned by motor 85 and for summer operation this motor is also controlled primarily by the humidity responsive device 87 in keeping with the operation of the motor 84. The damper motor 84 operates a linkage 91 to position the slider arm 92 of the master potentiometer 90 for effecting the control of the damper motor 85. The slider arm 92 is positioned with respect to the center tapped resistance 93 and the resistance 94 of the potentiometer. The center tapped potentiometer resistance is connected by a wire 271 to the common wire 274 of the motor control circuit and the potentiometer resistance

94 is connected by wires 270 and 272 to the outer wires 275 and 276, respectively, of the motor control circuit. Power is supplied to motor 85 from the supply lines 278 and 279. Operation of the damper motor 84 to vary the position of the slider arm 92 results in varying the resistance in the motor control circuit including wires 270 and 271 with respect to the resistance in the motor control circuit including wires 271 and 272 and the motor 85 is operated to position the damper 83 an amount corresponding to the movement of the potentiometer slider arm 92. Movement of the slider arm 92 a distance X will operate the damper 83 between the fully open and fully closed positions. The damper 83 is in this manner operated in a closing direction upon movement of the damper 82 in an opening direction in response to an increase in humidity. The dampers 82 and 83 are positioned under the control of the humidity responsive means 87 to maintain a desired value of relative humidity of, for example, 55% in the summer.

The warm air damper regulating motor 85 is further controlled by the fresh air temperature responsive means 95, although this is so adjusted as to exert a controlling action primarily when the system is operating on the winter cycle for causing a throttling operation of the damper 83 as the outdoor temperature decreases below a predetermined temperature of, for example, 60° F.

During the winter operating cycle when dehumidification no longer is normally required, the humidity responsive means 87 will operate motor 84 to maintain the damper 82 in a closed position. The motor 84 in turn positions the slider arm 92 of potentiometer 90 to open the damper 83 so that substantially all of the air supplied to the warm air duct must pass through the damper 83. In order to derive a maximum of comfort from the air conditioning system as the outdoor temperature decreases to relatively low values provision is made for decreasing the flow of air in the system. For this purpose the outdoor temperature responsive means 95 operates through the bellows 96 to position the slider arm 97 with respect to the potentiometer resistance 98 for controlling the damper motor 85. The potentiometer slider arm 97 is connected to the common wire 274 of the motor control circuit and the ends of the potentiometer resistance are connected in the motor control circuit by the wires 275 and 276. When in response to decreasing outdoor temperatures the slider arm is moved to the left across the potentiometer resistance 98 the resistance in the circuit including wires 274 and 275 is decreased with respect to that in the circuit including the wires 274 and 276. This unbalancing of the motor control circuit results in operating the motor 85 for positioning the damper 83 in a closing direction. During operation on the winter cycle as the outdoor temperature decreases to relatively low values from a predetermined temperature of, for example, 60°, the damper 83 is throttled to decrease the total flow of air in the system.

The humidifying spray means 45 controlled by the solenoid valve 46 is operable under the control of the humidity responsive means 49 for humidifying the air when the system is operated on the winter cycle. The pivotally mounted mercury switch 50 is operated through a linkage 279 which is connected to the switch 51. The solenoid valve for regulating the humidifying spray is operated through a circuit including the lines

280 and 281, the mercury switch 50, and the pivotally mounted and biased mercury switch 48 which is actuated by the humidity responsive device 49. The humidity responsive device 49 is adjusted to maintain a desired relative humidity of, for example, 55% or 60%.

The conditioning of the several zones A, B, and C is accomplished by proportioning the air simultaneously admitted to the zones from the warm and cool air ducts. To regulate and proportion the flow of air to the zones, the reverse acting and proportioning dampers 20, 21 for zone A; 22, 23 for zone B; and 24, 25 for zone C may be actuated by the damper motors 26, 27 and 28, respectively. The damper operating motors may be controlled by the means responsive to temperature in each of the respective zones, each of which is indicated by the reference character T.

The temperature responsive means T for proportioning the air admitted to each of the zones from the warm and cool air ducts may be of a type that are compensated for relatively high outdoor temperatures during operation on the summer cycle. The temperature responsive means T through operation of the bellows 290 positions a pivotally mounted and biased potentiometer slider 291 of a master potentiometer with respect to the center tapped resistance 292 and the potentiometer resistance 293. The center tapped resistance is connected through wire 294 to the common wire 297 of the control circuit for damper motor 26. The ends of the potentiometer resistance 293 are connected through the wires 295 and 296 to the wires 299 and 298 of the motor control circuit. Movement of the slider arm 291 across the resistances 292 and 293 a distance X varies the resistance in the circuit including wires 294 and 295 with respect to that including the wires 294 and 296 to produce an unbalancing of the motor control circuit and result in the operation of the damper motor 26 to actuate the dampers 20 and 21 between fully open and fully closed positions. In this manner, the dampers 20 and 21 are positioned to control the flow of warm and cool air and maintain a selected temperature for which each zone thermostat is adjusted. The thermostat T for the zones B and C operate in a similar manner and are illustrated diagrammatically in the drawings.

Control of the conditioning by the zone thermostats T may be compensated for relatively high outdoor temperatures in a manner to increase the temperature maintained in each zone as the outdoor temperature increases above a predetermined value of, for example, 75° F. For this purpose the outdoor temperature responsive means 30 is employed to operate a series of zone compensating potentiometer controllers 31, 32 and 33. The outdoor temperature responsive means 30 operates the compensating potentiometer 31 of the zone A by actuating the slider arm 306 with respect to resistance 307. The slider arm is connected to the common wire 297 of the damper motor control circuit, the right-hand end of the potentiometer resistance is connected by wire 298 of the motor control circuit and the left-hand end of the conductor secured to the potentiometer resistance 307 is connected to the wire 299 of the motor control circuit. For temperatures lower than 75° F., the slider arm of the potentiometer controller 31 is positioned by the bellows 305 along a conductor connected to the potentiometer resistance 307 and no compensating action is produced by the potentiometer. However, as the temperature varies between 75° F. and 100° F. the

slider arm is positioned along the potentiometer resistance 397 to vary the resistance between wires 297 and 299 with respect to that inserted between wires 297 and 298 of the control circuit for motor 26. The damper motor 26 is accordingly actuated in response to the unbalancing of the compensating potentiometer control circuit in a manner to increase the temperature of the conditioned air admitted to the zone upon an increase in relatively high outdoor temperatures. In effect, the compensating controller 31 serves to vary the control point of the master potentiometer controller which is actuated by the zone temperature responsive means T.

The potentiometer slider arm 306 of the compensating controller 305 may be connected by a linkage 310 to simultaneously operate the potentiometer controllers 32 and 33 for the zones B and C, respectively, as shown diagrammatically in Figure 1 of the drawings.

The system illustrated in Figure 1 is obviously of a type wherein the air for a warm air duct and a cool air duct is treated and tempered in accordance with variously compensated controls and wherein the treatment of the air for one duct is aided by mixing therewith controlled portions of the air as treated for use in the other duct. The air as conditioned for use in the warm and cool air ducts is employed for conditioning each zone in accordance with the compensated requirements of the individual zones.

In Figure 2 of the drawings there is disclosed a modification of the system illustrated in Figure 1. In this modification the flow of air from the warm and cool air ducts is controllably proportioned for conditioning the plurality of zones A, B, and C in accordance with the individual zone requirements as shown in Figure 1.

The modification shown in Figure 2 discloses a system in which a substantially constant air flow is maintained and in which draft effects are eliminated during periods of relatively low outdoor temperatures. Referring to Figure 2, a fan 10 supplies air to a plenum chamber 11 from which it is fed to a warm air duct 400 and a cool air duct 401. A heat exchange means 415 is employed for heating the air supplied to the warm air duct and also a portion of the air supplied to the cool air duct. The heating medium supply is regulated by a motor operated valve 416 controlled by the temperature responsive means 417 located in the warm air duct. The temperature responsive means 417 through bellows 418 positions a pivotally mounted and biased potentiometer slider arm 419 with respect to the potentiometer resistance 420 for controlling the motor operated valve 416. The potentiometer slider arm 419 is connected to the common wire 423 of the motor control circuit and the ends of the potentiometer resistance 420 are connected to wires 421 and 422 of the motor control circuit. Movement of the potentiometer slider arm 419 by the temperature responsive means 417 varies the resistance in the circuit which includes the wires 421 and 423 with respect to the resistance in the circuit including the wires 421 and 422. This unbalancing of the motor control circuit results in operation of the motor actuated valve 416 in a graduating manner corresponding to the movement of the potentiometer slider arm. The temperature responsive device 417 is adjusted to maintain a desired temperature in the warm air duct of, for example, 140° F. In order to maintain a substantially constant air flow without the production of objectionable draft effects dur-

ing periods of relatively low outdoor temperatures, the air admitted to the cold air duct is maintained at a predetermined temperature of, for example, 65° F. In order to maintain the temperature of the air in the cool air duct at a temperature of 65° F. this volume of air is made up of a mixture of air from the fan plenum chamber 11 and air diverted to the cool air duct from the volume which is conditioned in the warm air duct. The reverse operating dampers 404 and 405 are operated by the motor 406 under the control of the temperature responsive means 425 located in the cool air duct for maintaining the temperature of the air supplied to the cool air duct at 65° F. The temperature responsive means 425 through bellows 426 actuates the potentiometer slider arm 427 with respect to the potentiometer resistance 428 for controlling the damper operating motor 406. The potentiometer slider arm 427 is connected by the common wire 409 of the motor control circuit, and the ends of the potentiometer resistance 428 are connected to the wires 410 and 411 of the motor control circuit. Movement of the potentiometer slider arm with respect to the resistance 428 causes an unbalancing of the motor control circuit which results in the operation of the motor for adjusting the position of the reverse acting dampers. Power for operating the motor 406 is obtained from the supply lines 407 and 408.

Reverse acting fresh and return air dampers 456 and 457 for proportioning the flow of fresh and return air are positioned by a motor 458 and their operation may be controlled by the temperature responsive device 425 located in the cool air duct for operation of the dampers 404 and 405. The potentiometer controller for the damper motor is actuated by the bellows 426 through a linkage 492 that cooperates with the slider arm 427 to position the slider arm with respect to the potentiometer resistance 431. The potentiometer slider arm 430 is connected to the common wire 434 of the damper motor control circuit and the ends of the potentiometer resistance 431 are connected to wires 435 and 436 of the motor control circuit. Power for operating the motor 458 is supplied from the lines 437 and 438 which are connected to a suitable source, not shown. Movement of the potentiometer slider arm to the left across the full length of the potentiometer resistance 431 in response to an increased demand for heated air in the cool air duct results in unbalancing the motor control circuit and operation of the fresh air damper from a fully open to a fully closed position.

A minimum open position for the fresh air damper may be required for ventilation purposes regardless of the existence of low outdoor temperatures. A resistance 432 is inserted in the wire 436 of the motor control circuit to prevent operation of the damper motor beyond a minimum open position for the fresh air damper. The resistance 432 may be adjusted by the contact 433 to maintain any desired minimum opening position of the fresh air damper.

The fresh and return air dampers 456 and 457 are so regulated as to maintain the desired predetermined open position for the fresh air damper during periods of relatively low winter temperatures. The controller 425 for maintaining the temperature in the cool air duct operates on rising temperatures to open the fresh air damper above the minimum position in order to provide additional outdoor air for the cool air duct in the event of a relatively low internal heat load.

The system described in Figure 2 provides for advantageous operation of a double duct type of conditioning system during the winter. The temperature of the air in the cool air duct is controlled by diverting and mixing therewith a portion of the treated air supply from the warm air duct. A single temperature responsive means located in the cool air duct is employed to control the temperature of the air admitted thereto for the prevention of drafts in the zones being conditioned during low outdoor temperatures. The cool air temperature responsive control means is also employed to operate a damper motor for positioning the fresh and return air dampers and manually adjustable means are incorporated in the control circuit to prevent the proportioning operation of the fresh and return air dampers beyond a minimum open position for the fresh air damper upon increased demands for heating of the air supplied to the cool air duct which normally accompanies decreasing outdoor temperatures. As referred to above, the cool and warm air ducts shown in Figure 2 may be employed to condition a zone or zones under the control of zone mixing dampers of the type illustrated in Figure 1.

The preferred form of my invention as illustrated in Figure 3 embodies features in addition to certain of those incorporated in the forms of my invention illustrated in Figures 1 and 2 as will become apparent from the following description.

In this embodiment of my invention a dual plenum type of conditioning system is employed to provide summer and winter individual zone control. The conditioning for both temperature and humidity is partly regulated by a controlled diversion of various quantities of air between the warm and cold air plenums and means are provided for controlling the mixture of air from the plenums in accordance with the individual zone requirements.

A double cage type of fan 500 is employed to circulate air to the cool air duct 501 and the warm air duct 502. Fresh air is supplied through the duct 503 to that side of the dual fan which is connected to the cool air duct 501 and return air is supplied through the duct 504 to that side of the dual fan which is connected to the warm air duct 502. In this manner the fresh air admitted to the system will for the most part be supplied to the cool air duct. In the summer the fresh air will accordingly be subjected to cooling and dehumidification in the cool air duct. In winter operation the fresh air will most effectively serve to maintain the temperature of the cool air duct at the desired value, and during this time the return air which is for the most part admitted to the warm air duct will require a minimum of heating.

Reverse acting dampers 505 and 506 positioned by the motors 507 and 508, respectively, are employed to control in a proportioning manner the fresh and return air admitted to the system.

The cooler 510 located in the cool air duct is regulated by the joint action of an expansion valve 511 and the solenoid valve 512 for the purpose of satisfying the cooling and dehumidifying requirements for the system. A spray humidifying means 513 is located in the warm air duct 502 and connected to a suitable source of water supply is actuated by a valve 514 for the purpose of providing humidification for the system. The heater 516 located in the warm air duct 502 may be of any suitable type and as illustrated is regu-

lated by a valve 517 to maintain a desired air temperature at the outlet of the warm air duct. The reverse acting and proportioning dampers 520 and 521 are actuated by a motor 522 and serve to divert cooled and dehumidified air from the cool air duct for mixture with the supply of air that is to be heated in the warm air duct. The reverse acting dampers 523 and 524 are actuated by a motor 525 and serve to divert heated air from the warm air duct to the cool air duct for mixture with the cool air in order to maintain the desired temperature of the cool air duct outlet supply. A back pressure regulating valve or other known means for regulating the capacity control of the refrigeration compressor, not shown, may preferably also be employed to prevent freezing of the coil upon variation in the quantity of air passing thereover.

The cool air plenum chamber 501 is provided with an outlet 530 and the warm air plenum chamber 502 is provided with an outlet 531. Similar outlets are provided from the ducts for each zone to be conditioned. The flow of conditioned air to the zone is regulated in a proportioning manner by the reverse acting dampers 532 and 533 located in the cool and warm air duct outlets, respectively, and these dampers are actuated by the motor 534. The flow of conditioned air to each zone is regulated in a similar manner.

The system is schematically illustrated in Figure 3 as being controlled pneumatically and various well known forms of pneumatic control means might be employed. It will be apparent that the system may be operated by electrical control means or by a combination of electric and pneumatic controllers.

In the form illustrated the solenoid valve 512 for the cooler is controlled by a switch and relay device 538 which is actuated pneumatically by varying the pressure from the air supply line 539. The motor is connected by the line 539 to a suitable source of air supply, not shown, such as a compressor. The pressure in the line 539 is varied to operate the motor and switch 538 by operation of the thermostat 540 which includes the bellows or motor actuated flapper which is positioned with respect to a nozzle in the supply line 539 to vary the pressure therein. The thermostat 540 is actuated by a temperature responsive capsule 541 located in the fresh air plenum. The switch 538 serves to control a circuit which includes any suitable source of power, not shown, for operation of the solenoid valve 512 to in turn control the cooling medium supply for the cooler. The valve 512 is actuated in conjunction with the valve 511 to control the cooler 510 in a known manner in order to maintain a desired temperature of the air subjected thereto and this temperature may be of a value that is sufficiently low as to produce dehumidification.

The heater 516 is operated by the motor actuated valve 517 which is connected to an air line 543 that is supplied from any suitable source. The master thermostat 540, operated by the capsule 541 in response to outdoor or fresh air plenum chamber temperature, serves in conjunction with the submaster thermostat 544, which is actuated by the capsule 545 located near the outlet of the warm air duct, to control the operation of the heater. For this purpose the motor and flapper of the thermostat 544 serve to vary the bleed of air from the line 543 for actuating

the heater valve 517. Also, the master thermostat 540 is connected through the lines 539 and 548 to a pressure motor 550 which serves to position the nozzle of the line 543 with respect to that of the flapper of the submaster thermostat 544 to vary the pressure in line 543 and to thus modify the control of the heater by the thermostat 544. The pressure motor 550 is illustrated as being of a type that operates through a flexible connection 551 in the line 543 to position the nozzle of the line 543 with reference to the flapper of the submaster thermostat 544 through the operation of a biased bellows operated member or motor connected to the line 548. Accordingly as the master thermostat varies the pressure in line 548 the nozzle of the line 543 is varied in position with respect to the flapper of the submaster thermostat 544 to decrease the control point of said submaster thermostat 544 upon rise in outdoor temperature. The heater is thus operated to maintain a warm air outlet duct temperature within a range of from 75° F. to 100° F. as the fresh air temperature decreases from a value of 70° F. to 0° F. and a predetermined temperature is maintained in the warm air duct for a given temperature in the fresh air plenum.

The motorized valve 514 in control of the spray humidifying means is operated by a line 555 which is connected to a suitable source of air supply, not shown, and controlled by the humidity responsive means H1. The humidity responsive means located in the return air plenum serves to position the pivoted and biased flapper for varying the pressure in the line 555 to operate the spray to maintain a desired value of humidity of the air in the system.

The motor 522 in control of the reverse acting dampers 520 and 521 is operated by air supplied through the line 557 from a suitable source, not shown. The humidity responsive control device H2 is illustrated as being located in the return air duct, but might, if desired, be located in the discharge of the warm air duct, and this device serves to position a flapper element for varying the pressure in the line 557 for operation of the motor of the mixing dampers. On a rise in relative humidity the dampers 520 and 521 will be positioned in a manner to divert an increased amount of cold, dehumidified air from the cool air duct for mixture with the supply for the warm air duct. The cool, dehumidified air will if necessary be reheated in the warm air duct. The humidity responsive means H2 thus serves to vary the volume of air subjected to cooling and dehumidification and to maintain the desired conditions of humidity for the system.

A thermostat 560 operated by a temperature responsive capsule 561 located in the cool air duct and the reverse acting thermostat 562 operated by a temperature responsive capsule 563 which is responsive to outdoor, or fresh air plenum chamber temperatures, serve jointly to control the motors 525, 507 and 508 for the reverse acting warm to cool air duct mixing dampers 523 and 524 and the fresh and return air dampers 505 and 506. Each of the motors are connected for operation to a line 566 which is supplied with air from any suitable source. The duct diverting dampers and the fresh and return air dampers are preferably operated in the sequential manner hereinafter described. The thermostat 560 actuates a flapper element for controlling the pressure in the line 566 for actuating the mixing damper motor to normally maintain a cool air duct outlet temperature of 60° F. The mixing damper motor 525 is

adjusted, in a known manner, for operation between the closed and open damper positions upon a variation of pressure in the line 566 of, for example, between 3 and 8 pounds. Upon a decrease in temperature in the cool air duct the thermostat 560 accordingly actuates motor 525 and the mixing dampers to increase the flow of air diverted from the warm air duct and to correspondingly decrease the flow of cooled air. The motor 507 normally maintains the fresh air damper in a closed or in a predetermined minimum opened position. The reverse acting fresh and return air damper motors are adjusted for operation between their full open and fully closed positions as the pressure in the line 566 varies between, for example, 8 pounds and 13 pounds. Upon a sufficient rise in temperature in the cool air duct the thermostat 560 operates to increase the pressure in line 566 to within the range of 8 pounds and 13 pounds for actuation of the motors 507 and 508 to increase the supply of fresh air to the system and to correspondingly decrease the supply of return air. Upon a temperature drop in the cool air duct the thermostat 560 will actuate the fresh and return air dampers to decrease the flow of fresh air and subsequently actuate the mixing dampers 523 and 524 to increase the amount of heated air diverted from the warm air duct. The reverse acting thermostat 562 is adjusted for operation as the outdoor temperature rises above 75° F. to modify the pressure in the line 566 for operating the fresh air damper in a closing direction and the return air damper in an opening direction in order to prevent the use of large quantities of outside air when the outside temperature is relatively high. This thermostat 562 will have no effect upon the damper motors as the temperature decreases below a value of 75° F.

The thermostat 570 is located in the zone, or in other desired position by virtue of which it is capable of controlling both the humidity and temperature which it is desired to maintain in the zone to be conditioned. This thermostat serves to control the reverse acting warm and cool air duct dampers 532 and 533 for varying in a graduated manner the flow of conditioned air from the warm and cool air ducts to the particular zone being served thereby. The damper operating motor 534 is connected with the line 571 which is supplied from any suitable air supply source, not shown, and the temperature responsive bellows of the thermostat 570 positions the flapper valve to regulate the pressure maintained in the air supply line for actuating the damper motor.

Upon an increase in the zone temperature the thermostat 570 positions the flapper in a manner to decrease the flow of air permitted to escape from line 571 and to accordingly increase the pressure in the line for actuating the damper motor 534 to move the cool air duct damper 532 in an opening direction and to correspondingly move the warm air duct damper 533 in a closing direction.

Control elements similar to the thermostat 570 may be employed in association with each individual zone of the system for operation of the warm and cool air duct outlet dampers in accordance with the individual zone requirements.

My invention as illustrated in Figure 3 provides a system that is relatively inexpensive to install and both economical and efficient in operation. In the operation of the system the fresh and return air dampers and the warm and cool air duct diverting dampers cooperate with a single heating

means and a single cooling means to economically condition the air in the warm and cool air ducts with respect to both humidity and temperature for the year around. In the winter the humidity of the system is maintained at a desired value by the humidifying means in the warm air duct and since the humidity and temperature requirements are generally proportional at this time, the zone thermostats proportion the warm and humidified air to the zones in accordance with individual requirements. In the winter the fresh air admitted to the system largely maintains the temperature desired for the cool air duct and the fresh air inlet is adjacent to the cool air duct inlet for this purpose while the return air which at this time forms the largest portion of the volume circulated is supplied adjacent to the warm air duct inlet to reduce the heater operation requirements to a minimum. This heated and humidified air is also diverted to the cool air duct if necessary in order to maintain the desired cool air duct outlet temperature.

In the summer operation of the system the fresh air admitted to the system forms the largest portion of the volume circulated and most of this air will be admitted to the cooling coil. A portion of this cooled and dehumidified air is subsequently diverted into the warm air duct as required. If the cooling and dehumidifying requirements are relatively high the dehumidified air diverted to the warm air duct will be heated and a portion of air from the warm air duct is subsequently diverted to the cool air duct to maintain the desired conditions therein. The zone thermostats will in the summer control air flow from the two volumes of air to the individual zones to maintain the desired zone temperature, and by reason of the particular dehumidification treatment of the two volumes of air the humidity requirements of the zones are simultaneously satisfied.

It will be noted that the system of my invention is operative to provide year around air conditioning for a single zone or for a plurality of zones in accordance with the individual zone requirements and although certain of the zones require heating at a time when other zones demand cooling.

In each of the above described systems of my invention, provision may readily be made for shutting off the conditioning of one or more zones of the system. In order to insure a constant pressure flow of air to each zone, volume dampers controlled by static pressure in the system might be employed in a manner well known in the art and the cross-sectional area of the warm and cool air ducts leading to each zone outlet may be so designed as to insure a proper distribution of the conditioned air to the duct outlet for each zone.

It is obvious that the systems illustrated may be modified in various forms within the scope of my invention and that the systems are capable of application in various fields, accordingly the embodiments disclosed are merely illustrative and the invention is to be limited only as determined by the appended claims.

I claim as my invention:

1. In an air conditioning system for a plurality of zones, the combination comprising, a first duct and a second duct, means for circulating air through said ducts, heat exchange means in said first duct, regulating means for diverting a portion of the air which has passed in heat exchange relation with said heat ex-

change means in said first duct to said second duct for mixture with the air directly circulated thereto, humidity responsive means for controlling the said regulating means for diverting air to said second duct, zone damper means in said first and second ducts for proportioning the flow of air issuing simultaneously from said ducts for conditioning each of said zones, and temperature responsive means in each of said plurality of zones for individually regulating the zone conditioning air flow proportioning means.

2. In an air conditioning system for a plurality of zones, the combination comprising, a conditioning unit including a plurality of separate ducts, heat exchange means in each of said ducts, means for forcing air through the ducts, means for regulating the heat exchange means in one of said ducts for dehumidifying and cooling the air, means for regulating a flow of the said dehumidified and cooled air from the said one duct to a second duct for mixture with the flow of air therein and prior to treatment by the heat exchange means in the said second duct, humidity responsive means for controlling the air flow regulating means, means for regulating the proportions of air admitted to each of the plurality of zones from said plurality of ducts, and temperature responsive means for controlling the means for regulating the proportions of air admitted to each of the zones.

3. An air conditioning system for a plurality of zones, in combination comprising, a conditioning chamber containing a first volume of air and a second separate volume of air and means to supply air therefor, heat exchange means for cooling and dehumidifying said first volume of air, regulating means for diverting a portion of said first volume of cool and dehumidified air to said second volume of air for admixture therewith, heat exchange means for said second volume of air including the portion diverted from the first volume and means including temperature responsive means for maintaining the second volume at a predetermined temperature, means for proportioning the flow of air from said first volume and from said second volume for admission to each of said zones to be conditioned, humidity responsive means for controlling the said regulating means for diverting a portion of said first volume of air to said second volume, and temperature responsive means for regulating the said means for proportioning the flow of air for admission to each zone of the plurality of zones to be conditioned.

4. An air conditioning system in combination comprising, a conditioning chamber containing a first volume of air, a second volume of air, and means to supply air therefor, heat exchange means for each of said volumes of air and means for regulating the heat exchange means, damper means for diverting a portion of said first volume of air after contact with said heat exchange means to said second volume of air for admixture therewith, zone damper means operated by motor means for proportioning the flow of air from said first volume and from said second volume for admission to a zone to be conditioned, humidity responsive means for controlling the said damper means in a graduating manner for diverting a portion of said first volume of air to said second volume and temperature responsive means for controlling the regulating means proportioning the flow of air admitted to a zone to be conditioned.

5. In an air conditioning system for a plural-

ity of zones, the combination comprising, a first duct and a second duct, means for circulating air through said ducts, outside and return air damper means and means for operating the damper means in a proportioning manner, means operable below a predetermined temperature and means operable below a predetermined relative humidity point for placing a temperature responsive means in control of said damper operating means and for otherwise operating its fresh air damper in a closing direction, heat exchange means in said first duct, regulating means for diverting a portion of the air which has passed in heat exchange relation with said heat exchange means in said first duct to said second duct for mixture with the air directly circulated thereto, heat exchange means for said second duct for treating said mixture of air therein, humidity responsive means for controlling the said regulating means for diverting air to said second duct, zone damper means in said first and second ducts for proportioning the flow of air issuing simultaneously from said ducts for conditioning each of said zones, and temperature responsive means in each of said plurality of zones for individually regulating the zone conditioning air flow proportioning means.

6. In an air conditioning system, the combination comprising, a first duct and a second duct, means for circulating air through said ducts; heat exchange means in said first duct and in said second duct, regulating means for controlling the flow of air to said second duct in a graduating manner including damper means for the control of air admitted directly thereto and damper means for diverting treated air from said first duct, humidity responsive means for controlling the said regulating means to increase the proportion of air diverted to said second duct upon increase in humidity above a predetermined value while maintaining the volume of air circulated thereto substantially constant, and means responsive to temperature for additionally controlling the said regulating means for decreasing the total flow of air to said duct upon decreasing temperature from a predetermined temperature.

7. A system in combination comprising, a conditioning unit including a first outlet and a second outlet, means for circulating a medium through said unit and for separating the flow to each of said outlets, means in said unit for conditioning the flow of medium to the said first outlet including temperature responsive means and heating means for maintaining a predetermined temperature of the medium flow to the first of said outlets, damper means for diverting a flow of the medium at said predetermined temperature for said first outlet to the flow of medium for said second outlet, damper means for regulating a flow of fresh and recirculated medium to the inlet of said unit, and condition responsive means subject to the flow of medium for said second outlet for controlling both the said means for regulating the flow of fresh and recirculated medium and the said flow diverting means.

8. A system in combination comprising, a conditioning unit including a first outlet and a second outlet means for circulating a medium through said unit and for separating the flow to each of said outlets, means in said unit for conditioning the flow of medium to the said first outlet including temperature responsive means and a heat exchanger for maintaining a predetermined temperature of the medium flow to the

first of said outlets, damper means for diverting a flow of the medium at said predetermined temperature for said first outlet to the flow of medium for said second outlet, damper means for regulating a flow of fresh and recirculated medium to the inlet of said unit, temperature responsive means subject to the flow of medium for said second outlet for controlling both the said means for regulating the flow of fresh and recirculated medium and the said flow diverting means, damper means for proportioning the flow of air issuing simultaneously from each of said outlets, and zone condition responsive means for controlling the positioning of said flow proportioning outlet damper means.

9. An air conditioning system in combination comprising, regulating means for admitting fresh and return air to a conditioner and for circulating the air therethrough, partition means for separating the air flow to maintain a first and a second volume of untreated air in the conditioner, cooling means for the said first volume of air, damper means for mixing air from the second volume with the cooled air of the first volume, and temperature responsive means for controlling said mixing damper means and said fresh and return air regulating means in such manner that the proportion of fresh air to return air is a maximum within a predetermined temperature range and is a minimum at a temperature above said range.

10. A conditioning system in combination comprising, a first and a second medium conditioner, means for circulating a medium through said conditioners, a first heat exchange means for cooling and dehumidifying the medium flow to the said first conditioner, temperature responsive means for controlling the first heat exchange means to maintain the medium subjected thereto at a first predetermined temperature, means for regulating a flow of medium to the second conditioner including means for admitting medium thereto at said first predetermined temperature from said first conditioner, humidifying means in said second conditioner, heat exchange and temperature responsive means in said second conditioner for maintaining the flow of medium to the outlet thereof at a second predetermined temperature, means for regulating a supply of medium to the outlet of the first conditioner including means for regulating and mixing a flow of medium at said first predetermined temperature with a flow of medium from said second conditioner at said second predetermined temperature, temperature responsive means for controlling said mixing and regulating means to maintain a predetermined temperature of the medium flow to the outlet of said first conditioner, and humidity responsive means for controlling the said humidifying means and the said means for regulating the flow of medium at the first predetermined temperature for admission to the second conditioner.

11. A year around conditioning system for a plurality of zones in combination comprising, a first and a second medium conditioner, means for circulating a medium through said conditioners, a first heat exchange means for cooling and dehumidifying the medium flow to the said first conditioner, temperature responsive means for controlling the said first heat exchange means to maintain the medium subjected thereto at a first predetermined temperature, means for regulating a flow of medium to the second conditioner including means for admitting medium directly

thereto and for admitting medium thereto at said first predetermined temperature from said first conditioner, humidifying means in said second conditioner, heating means and temperature responsive means in said second conditioner for maintaining the flow of medium to the outlet thereof at a second predetermined temperature, means for regulating a supply of medium to the outlet of the first conditioner including means for regulating and mixing a flow of medium at said first predetermined temperature with a flow of medium from said second conditioner at said second predetermined temperature, temperature responsive means for controlling said mixing and regulating means to maintain a predetermined temperature of the medium flow to the outlet of said first conditioner, humidity responsive means for controlling the said humidifying means and the said means for regulating the flow of medium at the first predetermined temperature for admission to the second conditioner, damper means for regulating the air supply from each of said conditioners for each of said zones, and condition responsive means for controlling the said zone damper means.

12. In an air conditioning system for a plurality of zones, in combination, a warm air duct, a cool air duct, each duct having an outlet for each zone, heat exchange means including heating means in said warm air duct and cooling and dehumidifying means in said cool air duct, means causing a flow of air across said heat exchange means and through said ducts into said zones, means for varying the percentage of air flowing across each heat exchange means while maintaining the total flow of air substantially constant by diverting a portion of the air flowing through one duct after it has passed over its heat exchange means and causing it to flow into said other duct, means influenced by a psychrometric condition of the air in one of said ducts for controlling said last mentioned means in a manner tending to maintain said psychrometric condition substantially constant, and temperature responsive means in each zone for regulating the proportion of air from each outlet flowing into said zone for maintaining the temperature therein constant.

13. In an air conditioning system for a plurality of zones, in combination, warm and cool air ducts, each of said ducts having an outlet connected to each of said zones for regulating the temperature and humidity therein, means causing a flow of air through said ducts and into said zones, cooling means in said cool air duct for cooling and dehumidifying the air flowing there-through, and means including means responsive to an increase in the relative humidity in said zones for causing an increase in the percentage of air flowing across said cooling means by causing some of said cooled and dehumidified air to flow into said warm air duct, and means responsive to the temperature in said zones for regulating the air flowing from the outlets of said ducts.

14. In an air conditioning system for a plurality of zones, in combination, a warm air duct, a cool air duct, each duct having an outlet for each zone, heating means in said warm air duct, means causing a flow of fresh and return air through said ducts and into said zones, means controlling the proportions of said fresh and return air in response to the air temperature in said cool air duct, means responsive to the tem-

perature of the air in said cool air duct for causing some of the heated air from said warm air duct to flow into said cool air duct in order to prevent the temperature of the air in said cool air duct from dropping below a predetermined value, and temperature responsive means in each zone for regulating the proportion of air from each outlet flowing into said zone for maintaining the temperature therein constant.

15. In an air conditioning system, the combination including a plurality of separate ducts, heat exchange means in each of said ducts, means for forcing air through the ducts, means for regulating the heat exchange means in one of said ducts for dehumidifying and cooling the air, means for regulating a flow of said dehumidified and cooled air from the said one duct to a second duct for mixture with the flow of air therein and prior to treatment by the heat exchange means in the said second duct, humidity responsive means for controlling the air flow regulating means, and means for regulating the flow of air from said ducts.

16. In an air conditioning system, the combination comprising, a first duct and a second duct, an air supply, means for circulating air through said ducts, heating means in said first duct and cooling means in said second duct, means for diverting air from said second duct into said first duct, humidity responsive means for controlling said diverting means, other means for controlling the flow of air into said first duct, means responsive to the temperature of the air supply and influenced by said humidity responsive means to regulate said other means, and means to control the flow of air from said ducts.

17. In an air conditioning system, in combination, a warm air duct, a cool air duct, each duct having an outlet, heating means in said warm air duct, means causing a flow of fresh and return air through said ducts and said outlets, means responsive to the temperature of the air in said cool air duct for causing some of the heated air from said warm air duct to flow into said cool air duct to prevent the temperature of the air in said cool air duct from dropping below a predetermined value, and means for regulating the proportion of fresh air to return air in response to said means responsive to the temperature of air in said cool air duct.

18. A system in combination comprising, a conditioning unit including a first outlet and a second outlet, means for circulating a medium through said outlets, means in said unit including a heat exchanger for maintaining a predetermined temperature of the medium flow to the first of said outlets, means for diverting a flow of the medium at said predetermined temperature for the first outlet to the flow of medium for said second outlet to maintain a predetermined temperature of the medium flow to said second outlet, means for regulating a flow of fresh and recirculated medium to the inlet of said unit, and means responsive to the temperature of the air flowing to said second outlet for sequentially controlling both the said means for regulating the flow of fresh and recirculated medium and the said flow diverting means in such manner that the fresh air flow is first minimized and then air is diverted in increasing amounts as the temperature of the air flowing to the second outlet drops below a predetermined value.

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