

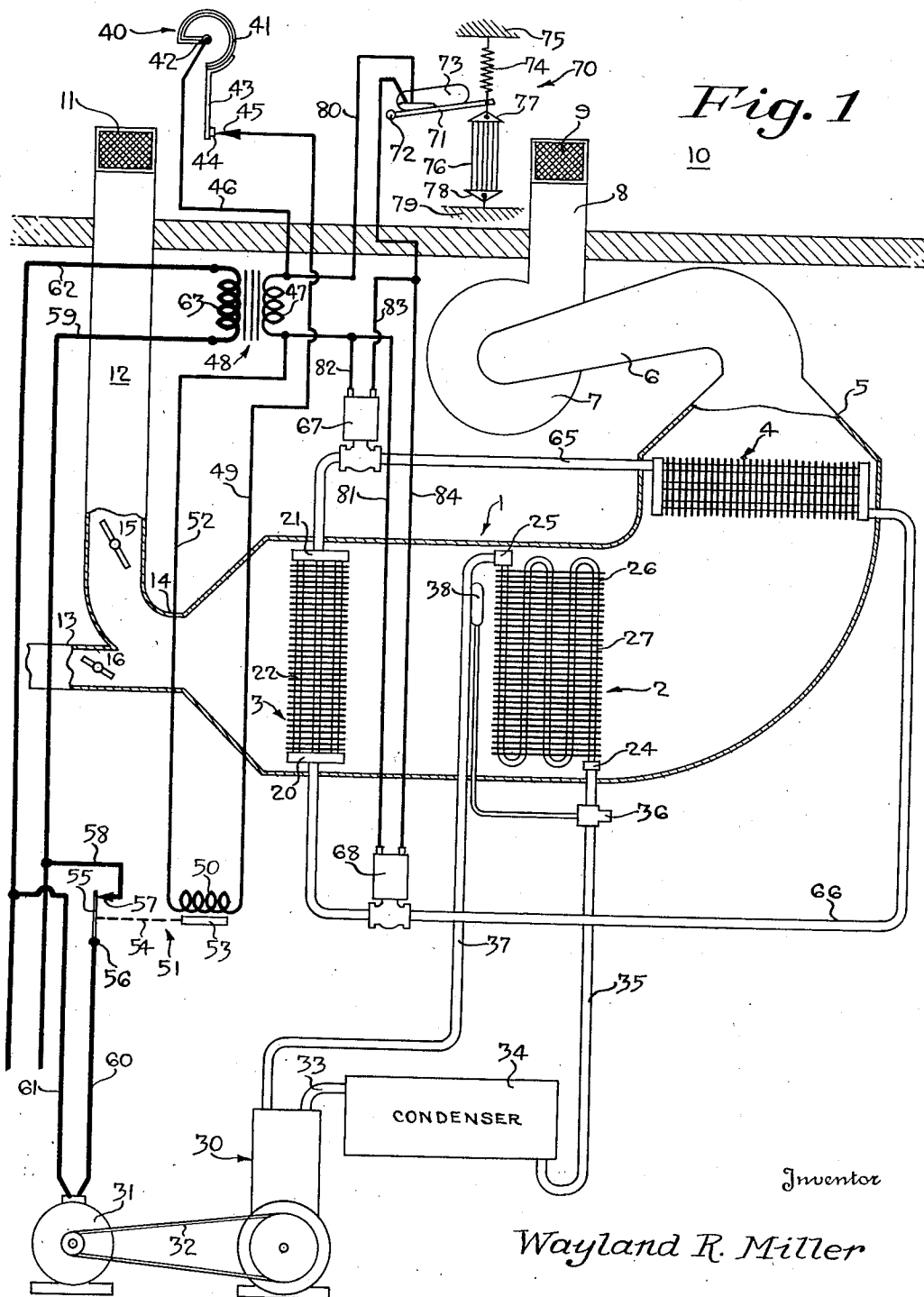
May 7, 1940.

W. R. MILLER
AIR CONDITIONING SYSTEM

2,200,118

Filed Oct. 15, 1936

2 Sheets-Sheet 1



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By

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Attorney

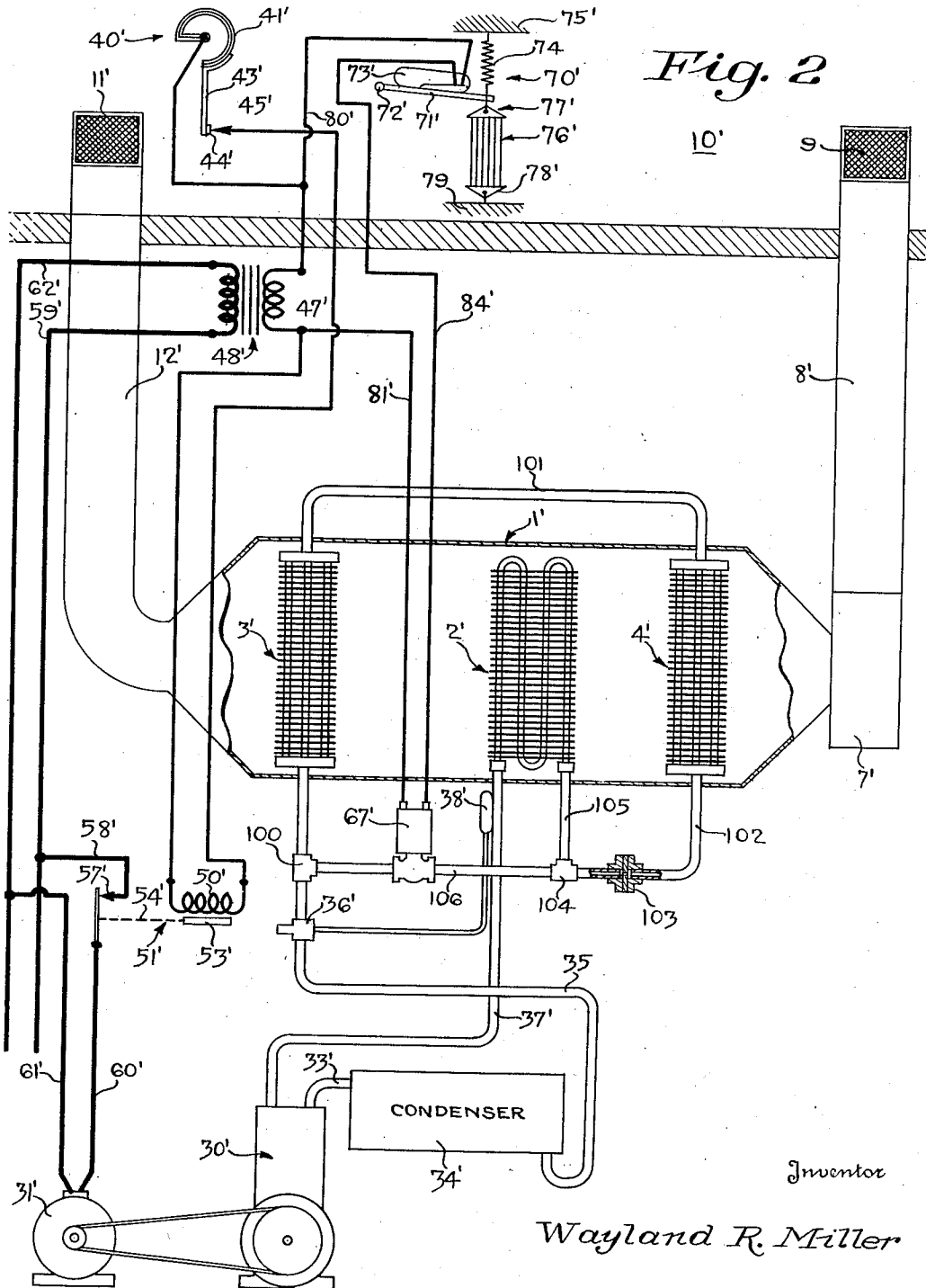
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UNITED STATES PATENT OFFICE

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AIR CONDITIONING SYSTEM

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Application October 15, 1936, Serial No. 105,840

12 Claims. (Cl. 62-6)

This invention relates to the art of air conditioning and is more particularly concerned with the cooling and dehumidification of air.

In order to reduce excessive temperature or humidity, removal of heat from the air is necessary. Removal of excessive humidity, however, requires a different type of cooling action than does the removal of excessive temperature. In order to reduce temperature it is necessary only to remove heat from the air and part of the super-heat of the water vapor contained therein. For reduction in humidity, however, it is necessary to condense a part of the water vapor contained in the air. This requires first that the temperature of the air be reduced to the dew-point. Upon abstraction of heat from the air after the dew-point temperature has been reached, condensation of the water vapor will take place.

When air is passed through a cooling coil or some other type of cooling device, both temperature and humidity may be reduced. The cooling device first acts to remove only sensible heat until the dew-point temperature has been reached, and then acts to remove the latent heat of evaporation of the water vapor in the air, thereby causing condensation of such water vapor, consequently resulting in dehumidification. Assuming that the heat removal capacity of the cooling device remains fairly constant and that the dew-point temperature of the air is likewise fairly constant, the amount of dehumidification caused by such cooling device will depend upon the temperature of the entering air. For instance, if the temperature of the entering air is at the dew-point, substantially all of the heat removal capacity of the cooling device will go towards removal of water vapor. If, however, the temperature of the entering air is substantially above the dew-point, the coil must first act to remove sensible heat until the dew-point temperature has been reached before condensation of water vapor will begin. The amount of condensation will therefore be reduced. It follows that by varying the temperature of the air entering the cooling device, the dehumidifying action of such device may be controlled.

In accordance with my invention, I effect pre-cooling, cooling and reheating by a single refrigeration system. In this form an auxiliary evaporator is placed in the conditioning chamber in advance of the main cooling coil, while a condenser is placed on the down-stream side of such main cooling coil. A liquid refrigerant is passed through an expansion valve first into

the auxiliary evaporator wherein part of it is evaporated, causing pre-cooling of the air. The mixture of liquid and gaseous refrigerant is then passed into the reheater wherein the vaporized refrigerant is condensed. The liquid refrigerant from this reheater is then passed into the main cooling coil wherein it is evaporated, thereby causing cooling of the air.

It is therefore an object of my invention to provide a single refrigeration system for an air conditioning apparatus which acts to pre-cool, cool and reheat the air.

A further object of my invention is to provide a control means for such a system for controlling the pre-cooling and reheating to maintain a desired condition of the air.

Another object of my invention is the provision of a novel multiple type refrigeration system and control system for controlling the action thereof.

Another object is the provision of an air conditioning system utilizing a primary and secondary cooling system wherein the secondary system includes an evaporator and a condenser located relatively to each other in a manner for providing a positive circulation of refrigerant between the condenser and evaporator.

Other objects will appear from the following detailed description and the appended claims. For a complete disclosure of my invention, reference is made to the following description and to the accompanying drawings, in which:

Figure 1 indicates diagrammatically an air conditioning system utilizing primary and secondary cooling systems wherein the secondary system operates by thermosiphonic action; and

Figure 2 is a diagrammatic showing of an air conditioning system wherein the primary and secondary cooling systems are integral parts of a single refrigeration system.

Referring to Figure 1, reference character 1 indicates generally an air conditioning chamber. Conditioning chamber 1 is L-shaped and houses a main cooling coil 2, a pre-cooler 3, and a reheater 4, reheater 4 being located above the pre-cooler 3. The upper end of conditioning chamber 1 is reduced as at 5 and connects with an elbow 6 leading to a fan 7. A discharge duct 8 from fan 7 leads to a register 9 in the air conditioned space 10. The return air register 11 is disposed in the space 10 and is connected to a return duct 12 which joins a fresh air duct 13 and an inlet duct 14 which leads to the inlet of the conditioning chamber 1. Suitable dampers 15 and 16 may be provided in the return and

fresh air ducts respectively to control the proportions of the return and fresh air admitted to the conditioning chamber in accordance with usual practice.

5 The pre-cooler 3 is illustrated as formed of inlet and outlet headers 20 and 21 connected by a series of fin tubes 22. The condenser 4 is formed in a similar manner. It is to be understood, however, that the form shown is merely
10 illustrative and that these devices may take any other desired form. The main cooling coil 2 is illustrated as comprising inlet and outlet headers 24 and 25 connected together by a series of sinuous tubes 26 having thereon a series of fins 27.
15 This again is merely an illustrative form, and my invention is not limited thereto.

For supplying liquid refrigerant to the main cooling coil 2 and for withdrawing the evaporated refrigerant therefrom, I have shown the usual
20 form of compression refrigeration system. This system comprises a compressor 30 driven by an electric motor 31 through a belt drive 32. A discharge pipe 33 leads from the discharge side of the compressor to a condenser 34 which may be
25 of any known form. To the outlet of the condenser 34 is secured a supply pipe 35 for conducting the liquid refrigerant to the main cooling coil 2. Interposed in the pipe 35 is an expansion valve 36 which is in this case shown as a thermostatic expansion valve of known form. A suction line 37 is connected to the discharge header
30 25 of the main cooling coil 2 and leads to the suction side of the compressor 30.

The operation of this form of refrigeration
35 system is well understood. The compressor 30 acts to remove vaporized refrigerant from the cooling coil and to increase the pressure of such refrigerant. This compressed refrigerant then passes into the condenser where heat is removed
40 therefrom, causing liquification of the compressed refrigerant. This liquified refrigerant is then passed through the expansion valve wherein its pressure is reduced. Upon entry of this liquid refrigerant into the main cooling coil it absorbs
45 heat and changes its state from a liquid to a vapor, this action causing lowering in temperature of the cooling coil. This vaporized refrigerant is then drawn into the suction side of the compressor and the cycle is repeated. The thermostatic expansion valve 36 is indicated as having
50 its thermostatic bulb 38 located at the outlet of the evaporating coil. This arrangement acts to admit sufficient refrigerant into the cooling coil to keep such coil substantially full of liquid refrigerant.

The operation of the compressor motor 31 is indicated as being controlled by means of a room thermostat 40 located in the air conditioned space
55 10. The thermostat 40 may take any known form and is in this case illustrated as comprising a bimetallic element 41 having one end fixed at 42 and its other end connected to a contact blade 43. The contact blade 43 carries a contact 44 cooperating with a stationary contact 45. Upon
60 an increase in temperature bimetallic element 41 will act to swing the contact blade 43 to bring the contact 44 into engagement with the contact 45. Upon a decrease in temperature from that at which the thermostat is set, the bimetallic element
65 41 will cause the contact 44 to become disengaged from contact 45. The bimetallic element 41 is connected by a wire 46 to the secondary 47 of a step-down transformer 48. The stationary contact 45 is connected by a wire 49 to one end
70 of the coil 50 of a relay 51, the other end of said

relay coil being connected by a wire 52 to the other side of the transformer secondary 47.

Relay 51 includes an armature or plunger 53 located in the magnetic field of the coil 50. Armature 53 is connected to a link 54 which has
5 55. Switch arm 55 is pivoted at one end at 56 and at its other end cooperates with a contact 57. The contact 57 is connected by a wire 58 to a line wire 59. The switch arm 55 is connected to one terminal of motor 31 by means of a wire
10 60. The other terminal of motor 31 is connected by a wire 61 to the line wire 62. Line wires 59 and 62 are illustrated also as energizing the primary 63 of the step-down transformer 48.
15

When the temperature in the conditioned space 10 is above a predetermined value the movable contact 44 of the thermostat 40 will engage the contact 43. This will close an energizing circuit
20 for the relay coil 50 as follows: transformer secondary 47, wire 46, bimetallic element 41, contact 44, contact 45, wire 49, relay coil 50 and wire 52 back to transformer secondary 47. Energization of the relay coil 50 will cause the armature 53 to move to the right, thereby bringing the switch arm
25 55 into engagement with the contact 57. This will close the operating circuit for the compressor motor and place the compressor into operation.

If the temperature in the space 10 falls below the value for which the thermostat 40 is set, the
30 bimetallic element 41 will cause disengagement of contact 44 from the contact 45. This will break the energizing circuit for the relay coil 50, this permitting the armature 53 to be moved towards the left under the action of a spring (not shown)
35 resulting in the switch arm 55 disengaging the contact 57. This will break the compressor motor operating the circuit and place the compressor out of operation.

From the foregoing it should be apparent that
40 the cooling coil 2 will be placed in operation so long as the temperature in the space 10 is above a predetermined value and that when the temperature in such space becomes sufficiently low the cooling coil 2 will be placed out of operation.

The upper or outlet header 21 of the pre-cooler 3 is connected by means of a pipe 65 to the inlet header of the reheater 4. A pipe 66 is connected to the outlet header of the reheater 4, this pipe
45 leading to the inlet header 20 of the pre-cooler 3. A solenoid valve 67 is interposed in the pipe 65 while a similar valve 68 is interposed in the pipe 66. It will thus be apparent that the pre-cooler and reheater are connected together to form a closed system which is entirely separate
50 from the system for actuating the main cooling coil 2. This system may be charged with any suitable secondary refrigerant, such for instance as Freon, menthol chloride, ammonia, etc.

The solenoid valves 67 and 68 may be of any known form and are herein shown as comprising
55 a type which opens when energized and which closes when deenergized. These valves are controlled by means of a humidostat generally indicated at 70, this humidostat being located in the conditioned space 10. Humidostat 70 is formed of a mercury switch supporting arm 71 which is pivoted at one end at 72 and which carries a mercury switch 73 of known form. The other end of the arm 71 is connected to one end
60 of a spring 74. Spring 74 at its other end is secured to a suitable fixed support 75. Also connected to the free end of the arm 71 and opposing the action of spring 74 is a humidity responsive member. This humidity responsive member comprises a plurality of strands of hair
65 75

76 or other moisture responsive elements, these elements being secured at their ends to suitable clamping members 77 and 78, the clamping member 77 being connected to the free end of arm 5 71 while the clamping member 78 is secured to a suitable stationary member 79. Upon an increase in humidity, the moisture responsive elements 76 will expand, thereby permitting the spring 74 to raise the free end of the arm 71 thus tilting the mercury switch to circuit closing position. Conversely, a decrease in humidity will cause the moisture responsive elements 76 to contract, this action causing tilting of the arm 71 and the mercury switch 73 to circuit opening position. The mercury switch 73 is connected to control the solenoid valves 67 and 68.

One electrode of mercury switch 73 is connected by a wire 80 to one end of the transformer secondary 47. The other end of the transformer secondary 47 is connected by wires 81 and 82 to one terminal each of the solenoid valves 67 and 68. The remaining terminals of valves 67 and 68 are connected together by wires 83 and 84, wire 84 also acting to connect these terminals to the other electrode of the mercury switch 73.

It should be apparent, therefore, that upon an increase in humidity the mercury switch 73 will be tilted to circuit closing position, this action causing opening of solenoid valves 67 and 68. Conversely, when the humidity decreases below a predetermined value mercury switch 73 will be tilted to circuit opening position, thereby causing the valves 67 and 68 to close.

While I have shown the secondary system as being controlled by solenoid valves 67 and 68, it is to be understood, that other types of valves may be used, and that if desired, only one valve may be employed.

40 Operation

Whenever the space temperature is above a predetermined minimum value, such for instance as 75° F., the room thermostat 40 will cause operation of the compressor motor and hence chilling of the cooling coil 2. Due to the operation of the fan 1, air will be drawn through the return register and duct 12 into the conditioning chamber, across the cooling coil 2, where- in its temperature will be reduced. The cooled air will then be discharged through the discharge duct 8 and register 9 back into the conditioned space 10. The air in passing through the cooling coil 2 will be first reduced in temperature until the dew-point is reached. After this point is reached the air will further be reduced in temperature and the latent heat of evaporation of the water vapor contained in such air will be removed, thereby causing a dehumidifying action as well as a cooling action. This cooling and dehumidifying action will continue until the space temperature is lowered to the predetermined minimum, when the thermostat 40 will act to place the compressor 30 out of operation, thereby stopping the cooling action of cooling coil 2 and preventing further reduction in temperature within the space 10. However, as long as the space temperature is above the predetermined minimum the compressor will remain in operation and the cooling coil 2 will thus remain chilled.

Should the humidity within the space 10 be above a predetermined value, the mercury switch 73 will be tilted to circuit closing position as illustrated. This will cause the solenoid valves 67 and 68 to be energized, thereby assuming an

open position. With valves 67 and 68 open the pre-cooler 3 and the reheater 4 are placed in communication with each other. As the pre-cooler 3 is in the path of the air passing to the cooling coil 2 it is exposed to air of relatively high temperature. The reheater 4, on the other hand, is located in the path of the air which has been cooled by the main cooling coil 2 and is therefore exposed to air of substantially lower temperature than that contacting the pre-cooler 3. Due to the relatively high temperature to which the pre-cooler 3 is subjected, the liquid refrigerant therein will be evaporated and absorb heat from the air. The vapor will then pass through the pipe 65, through solenoid valve 67 into the reheater 4. As the reheater 4 is subjected to air of lower temperature than caused evaporation of the refrigerant, heat will be removed from the vaporized refrigerant, thereby causing it to condense and thus give up to the cooled air the same amount of heat that it absorbed from the incoming air. This liquid refrigerant will then flow through the pipe 66 back to the pre-cooler 3, where it will be re-evaporated and this cycle will be repeated continuously. It will be observed that the reheater 4 is located on a level above that of the pre-cooler 3. As the pipe 65 will contain the evaporated refrigerant while the pipe 66 will contain refrigerant in a liquid state, a thermo-syphonic circulation of refrigerant through the secondary refrigerating system formed of pre-cooler 3 and reheater 4 will take place. It should be apparent, therefore, that the secondary refrigeration system will act to remove heat from the air passing to the main cooling coil 2 and will act to give up the heat which has been removed to the air after it has been cooled by the cooling coil 2, this action occurring without the application of any external force.

The effect of the operation of the secondary refrigerating system is to reduce the temperature of the air passing to the main cooling coil and to reheat the air after it has been cooled by said main cooling coil. This action causes the cooling coil 2 to expend its efforts towards dehumidification of the air to a greater extent than would occur without operation of the secondary refrigerating system. In other words, the action of the secondary system is to remove sensible heat from the air before its contacts with the cooling coil 2, thereby decreasing the amount of sensible heat which must be removed by the coil 2 before dehumidification starts. In this manner operation of the secondary system increases the dehumidifying effect of the cooling coil 2. Inasmuch as all the heat which is absorbed by the pre-cooler 3 is delivered back to the air by the reheater 4, the operation of the secondary system has substantially no effect upon the total quantity of heat removed from the air. Such system merely increases the dehumidifying action of coil 2.

As a specific example of the effect of operation of the secondary system, it may be assumed that the incoming air is at 90° F. and 70% relative humidity. Assuming that the pre-cooler is designed to remove 10° of sensible heat from the air for the given air flow, the air after passing through the pre-cooler will be 80° F. and 94% relative humidity. In passing through the cooling coil 2 sufficient heat may be removed from the air to reduce its condition from 80° F.—94% relative humidity, 130 grains of moisture per pound, to 55° F.—100% relative humidity, 65 75

grains of moisture per pound. In passing through the reheater 4 the same amount of heat will be returned to the air as was absorbed from it in the pre-cooling coil 3. Hence the final temperature of the air leaving the conditioning chamber will be approximately 65° F.—75% relative humidity, 65 grains of moisture per pound.

If the secondary refrigeration system is placed out of operation, as by closing valves 67 and 68, no heat will be absorbed by the pre-cooler and no heat will be given up to the air by the reheater 4. Assuming the same initial conditions of the entering air, that is 90° F.—70% relative humidity, and the same cooling effect of cooling coil 2, the air leaving such cooling coil will be reduced to 58° F.—100% relative humidity, 74 grains of moisture per pound. Summarizing for the condition stated, when the secondary system is in operation the final air condition will be 65° F.—75% relative humidity, 65 grains of moisture per pound, while with the secondary system out of operation, the final air condition will be 58° F.—100% relative humidity, 74 grains of moisture per pound. It should be apparent, therefore, that the effect of the secondary system is to increase the amount of dehumidification and to decrease the amount of reduction in sensible heat by the cooling coil 2.

As long as the temperature within the space 10 is above a predetermined minimum value and the humidity is above a desired value, operation of both the main cooling coil 2 and the secondary refrigeration system will continue. Due to the increased dehumidifying effect of coil 2 caused by the operation of the secondary system, the excessive humidity conditions within the space 10 will eventually be overcome. At this point the humidostat 70 will act to cause closing of the solenoid valves 67 and 68. This will prevent circulation of refrigerant from the pre-cooler 3 to the reheater 4, thereby placing the secondary refrigeration system out of operation thereby decreasing the dehumidifying effect of the cooling coil 2 and increasing the portion of the cooling effect of said coil which goes towards reduction in sensible heat of the air. This operation will continue until the temperature in the space is lowered to the desired value, when the thermostat 40 will act to place the entire system out of operation.

From the foregoing it will be seen that the thermostat 40 assumes dominating control over the entire system and prevents any cooling whatsoever after the space temperature is below a desired value, and it will further be apparent that when the system is in operation due to the temperature within the space being above the predetermined minimum, the cooling effect of the main cooling coil will be shifted from either temperature reduction or humidity reduction in accordance with the humidity within the conditioned space. In this manner both the temperature and humidity may be maintained within the desired limits.

Figure 2

In Figure 2 I have shown a system which obtains the same results and which operates in a manner similar to that of Figure 1. With this system, however, no secondary refrigerating system is required, the pre-cooler and the reheater forming part of the main refrigerating system. In this figure corresponding parts are indicated by the same reference characters as in Figure 1, these reference characters, however, being primed. As in the case of Figure 1, the condi-

tioning chamber 1' is provided with a main cooling coil 2', a pre-cooler 3', and a reheater 4'. The conditioning chamber 1' is connected at one end to a fan 7' which discharges into a duct 8' leading to a register 9' in the conditioned space 10'. A return air register 11' is connected to a return duct 12' which discharges into the inlet of the conditioning chamber 1'. The compressor motor 31' and the compressor 30' is controlled by means of a room thermostat 40', the control arrangement being identical with that illustrated in Figure 1. Hence no further description thereof is made at this point.

The compressor 30' is connected at its discharge side to a discharge line 33' leading to the condenser 34'. The outlet of the condenser 34' is connected by means of a pipe 35' to an expansion valve 36'. The outlet of the expansion valve 36' is connected to a T connection 100. One branch of the T connection 100 leads to the inlet of the pre-cooler 3'. The outlet of the pre-cooler 3' is connected by a pipe 101 to the inlet of the reheater 4'. The lower or outlet header of the preheater 4' is connected to a pipe 102 having interposed therein a flow restricting orifice plate 103. Pipe 102 is connected to a T connection 104, one branch of which is connected by the pipe 105 with the inlet of the main evaporating coil 2'. A pipe 106 connects the other branches of the T connections 100 and 104 together. This pipe has interposed therein a solenoid or other electrically actuated valve 67'. The outlet of the main cooling coil 2' is connected by the suction line 37' to the suction side of the compressor 30'.

The solenoid valve 67' is preferably designed so as to open when energized and to close when deenergized. This valve is controlled by means of the humidostat 70' which is located in the conditioned space 10'. This humidostat is formed similarly to the humidostat 70 of Figure 1 except for the fact that the position of the mercury switch 73 is reversed. That is, when the humidity is excessive, the mercury switch will be tilted toward circuit opening position, while when the humidity is below a predetermined value, the mercury switch will be tilted toward circuit closing position, thereby energizing the valve 67' and causing opening thereof. In other words, when the humidity within the space 10' is low, the solenoid valve 67' will be open while when the humidity in said space is excessive, the solenoid valve 67' will be closed.

When the valve 67' is closed due to excessive humidity conditions in the space 10', refrigerant from the condenser will pass through the expansion valve into the pre-cooler 3'. As its pressure has been reduced by the expansion valve, evaporation thereof will take place, thereby causing the pre-cooler 3' to absorb heat from the air entering the conditioning chamber 1'. Due to the relatively small size of the pre-cooler 3' only partial evaporation will take place. Therefore a mixture of gaseous and liquid refrigerant leaves the evaporator 3' through the pipe 101 and passes into the reheater 4'. Due to the effect of the cooling coil 2' the temperature of the air at the reheater 4' will be lower than the temperature at the pre-cooler 3', which caused partial evaporation of the refrigerant. This lower temperature will cause heat to be absorbed from the vaporized refrigerant, thereby causing condensation thereof and its return to the liquid state. The liquid refrigerant then passes from the evaporating coil 4' through the pipe 102 and the

restricting orifice 103 into the inlet of the evaporating coil 2'. As the outlet of the evaporating coil 2' is connected to the suction side of the compressor the pressure within the evaporating coil 2' will be considerably reduced, thereby causing evaporation of all the refrigerant within the cooling coil 2' and the passage of refrigerant in a vaporized state to the compressor. The purpose of the restricting orifice 103 is to restrict the flow of refrigerant from the reheater 4' into the evaporating coil 2', thereby preventing the flow of anything but liquid refrigerant from the reheater 4'.

From the foregoing it should be apparent that when the humidity is excessive in the conditioned space 10' the solenoid valve 67' will be closed, thereby forcing the refrigerant through the pre-cooler and reheater before entry into the main cooling coil 2', thereby causing operation of the pre-cooler 3' and the reheater 4'. This will lower the temperature of the air entering cooling coil 2' and thus increase the dehumidification effect of the cooling coil 2'.

When the humidity within the conditioned space 10' falls below the predetermined value, the mercury switch 73' will be tilted to cause opening of the solenoid valve 67'. With this valve opened the refrigerant will by-pass the pre-cooler and reheater and enter directly into the main cooling coil 2' due to the latter path having less resistance than the path through the pre-cooler, reheater, and orifice 103. The dehumidifying effect of the coil 2' will therefore be reduced.

It should thus be apparent that I have provided an air conditioning system in which both temperature and humidity are controlled and in which the humidity is controlled by varying the cooling effect of a cooling coil, this variation in cooling effect being obtained by controlling the amount of heat which is removed from the air entering the cooling coil and which is returned to the air after passing through said coil. It will be further apparent that the differential in temperature caused by the cooling coil is employed for causing the flow of heat from the air on the inlet side thereof to the cooled air.

While I have shown the pre-cooler and reheating system as being controlled by humidity and the main refrigerating system as controlled by temperature, it will be apparent that this arrangement may be varied considerably and still obtain satisfactory results. Also, while I have shown controllers of the two-position variety, it is to be understood that other controllers such as a modulating type may be substituted therefor. Inasmuch as many other modifications will suggest themselves to those skilled in the art, I desire to be limited only by the scope of the appended claims and the prior art.

I claim as my invention:

1. In an air conditioning system, in combination, a conditioning chamber through which air is adapted to be passed, a refrigeration system for varying the temperature and humidity of the air flowing through said conditioning chamber, said refrigeration system including a main evaporator, an auxiliary evaporator in advance of said main evaporator with respect to air flow, and a condenser downstream of said main evaporator, means for supplying refrigerant first to the auxiliary evaporator, means for conveying said refrigerant from the auxiliary evaporator to the condenser, and means for discharging the refrigerant from the condenser into the main evaporator.

2. In an air conditioning system, in combination, a conditioning chamber through which air is adapted to be passed, a refrigeration system for varying the temperature and humidity of the air flowing through said conditioning chamber, said refrigeration system including a main evaporator, an auxiliary evaporator in advance of said main evaporator with respect to air flow, and a condenser downstream of said main evaporator, means for supplying refrigerant first to the auxiliary evaporator, means for conveying said refrigerant from the auxiliary evaporator to the condenser, means for discharging the refrigerant from the condenser into the main evaporator, means for by-passing refrigerant around said auxiliary evaporator and condenser, and condition responsive means in control of said by-pass means.

3. In an air conditioning system, in combination, a conditioning chamber through which air is adapted to be passed, a refrigeration system for varying the temperature and humidity of the air flowing through said conditioning chamber, said refrigeration system including a main evaporator, an auxiliary evaporator in advance of said main evaporator with respect to air flow, and a condenser downstream of said main evaporator, means for supplying refrigerant first to the auxiliary evaporator, means for conveying said refrigerant from the auxiliary evaporator to the condenser, means for discharging the refrigerant from the condenser into the main evaporator, by-pass means for by-passing refrigerant around said auxiliary evaporator, temperature responsive means for controlling the supply of liquid refrigerant to said evaporators, and means influenced by humidity for controlling said by-pass means.

4. In an air conditioning system for a space, in combination, a conditioning chamber, means for causing air to flow through said conditioning chamber, a refrigeration system for cooling and dehumidifying the air flowing through said chamber, said refrigeration system including a first evaporator, a second evaporator, and a condenser located in said conditioning chamber, means for passing refrigerant from said first evaporator to said condenser, and means for passing refrigerant from said condenser to said second evaporator.

5. In an air conditioning system for a space, in combination, a conditioning chamber, means for causing air to flow through said conditioning chamber, a refrigeration system for cooling and dehumidifying the air flowing through said chamber, said refrigeration system including a first evaporator, a second evaporator, a condenser located in said conditioning chamber, said first evaporator being connected to said second evaporator and said condenser, control means for controlling the flow of refrigerant into one of said evaporators, and condition responsive means influenced by a condition in said space in control of said control means.

6. In an air conditioning system, in combination, a conditioning chamber, means for causing air to flow through said conditioning chamber, a cooling coil in said chamber for cooling and dehumidifying the air flowing therethrough, means for supplying liquid refrigerant to said cooling coil, a reheater for reheating the air leaving said cooling coil, means for passing said liquid refrigerant through said reheater, means for by-passing the liquid refrigerant around said reheater, valve means for controlling the flow of

refrigerant through said reheater and by-pass, and condition responsive means for controlling said valve means.

7. In an air conditioning system, in combination, a cooling and dehumidifying device for cooling and dehumidifying a stream of air, a pre-cooling device in advance of said cooling and dehumidifying device with respect to air flow, a reheater device downstream of said cooling and dehumidifying device for reheating the air, and means for passing cooling medium through said precooling device, said reheater device and said cooling and dehumidifying device in the order named.

8. In an air conditioning system for a space, in combination, a cooling and dehumidifying device for cooling and dehumidifying a stream of air, means for passing liquid cooling medium to said cooling and dehumidifying device, a reheater device downstream of said cooling and dehumidifying device for reheating the air, means for passing said liquid cooling medium through said reheater in series relationship with said cooling and dehumidifying device, a by-pass for said medium around said reheater, and means including condition responsive means for controlling the flow of medium through said by-pass.

9. In a refrigeration system, in combination, refrigerant condensing and back pressure reducing means, a first evaporator in heat exchange relationship with medium to be cooled, means for conveying liquid refrigerant from said condensing means to said first evaporator and including an expansion valve, a condenser, means for conveying refrigerant from said first evaporator to said condenser, a second evaporator in heat exchange relationship with medium to be cooled, means for conveying refrigerant from said condenser to said second evaporator, and

means for connecting said second evaporator to said back pressure reducing means.

10. In a refrigeration system, in combination, refrigerant condensing and back pressure reducing means, a first evaporator in heat exchange relationship with medium to be cooled, means for conveying liquid refrigerant from said condensing means to said first evaporator, a condenser, means for conveying refrigerant from said first evaporator to said condenser, a second evaporator in heat exchange relationship with medium to be cooled, means for conveying refrigerant from said condenser to said second evaporator, and controllable means for passing refrigerant from said condensing means directly to said second evaporator.

11. In a refrigeration system, in combination, a first evaporator in heat exchange relationship with medium to be cooled, means including a first condenser for supplying refrigerant to said first evaporator, a second evaporator in heat exchange relationship with medium to be cooled, means for serially connecting said first and second evaporators in a manner to cause refrigerant to flow from said first evaporator to said second evaporator, and condensing means interposed between said first and second evaporators.

12. In a refrigeration system, in combination, a first evaporator in heat exchange relationship with medium to be cooled, means for supplying refrigerant to said first evaporator, a second evaporator in heat exchange relationship with medium to be cooled, means for serially connecting said first and second evaporators, condensing means interposed between said first and second evaporators, and controllable means for passing refrigerant to said second evaporator without passing through said first evaporator and condensing means.

WAYLAND R. MILLER.