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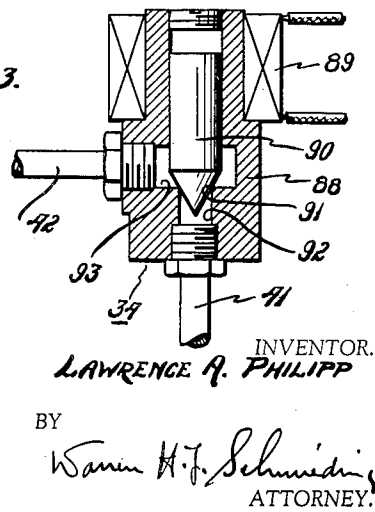
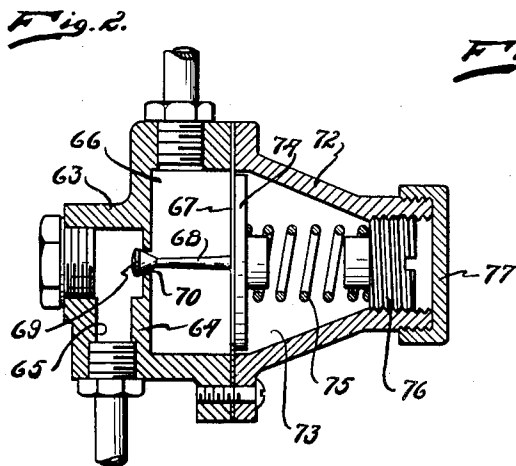
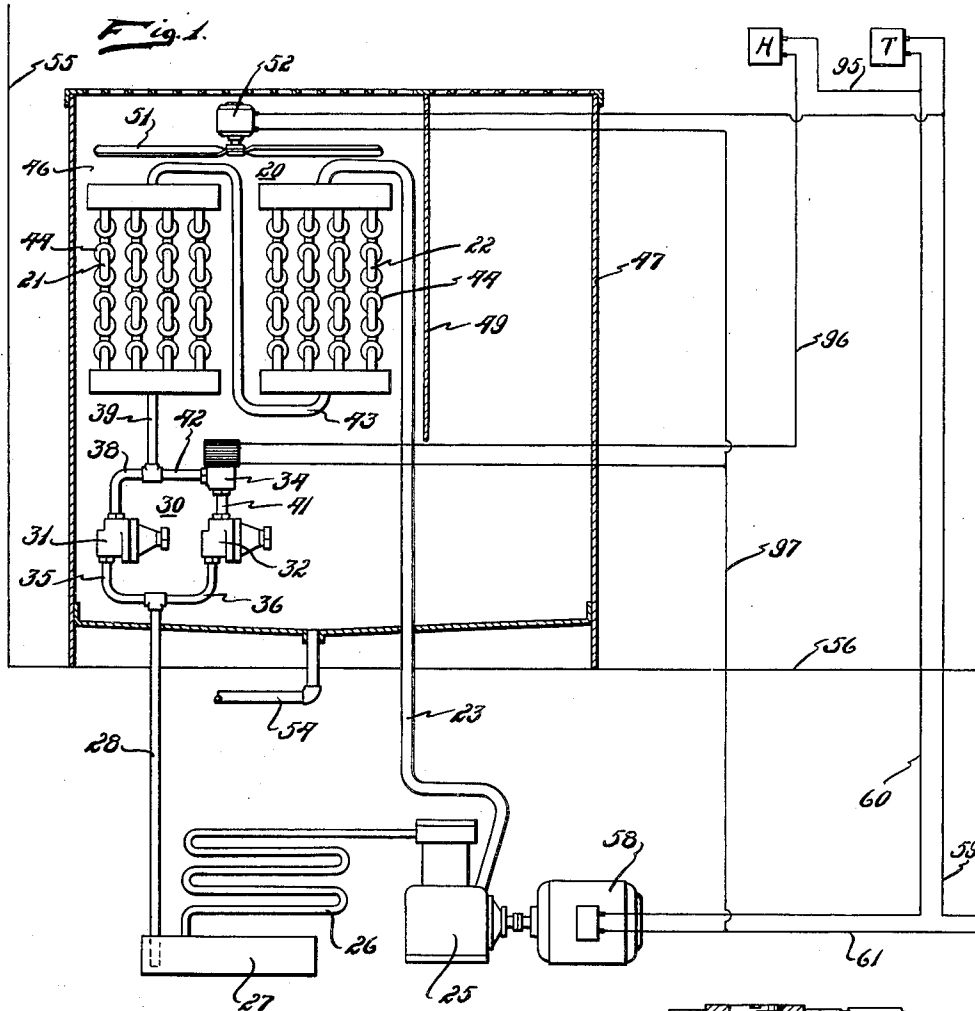
L. A. PHILIPP

2,222,242

AIR CONDITIONING SYSTEM

Filed Feb. 15, 1934

3 Sheets-Sheet 1



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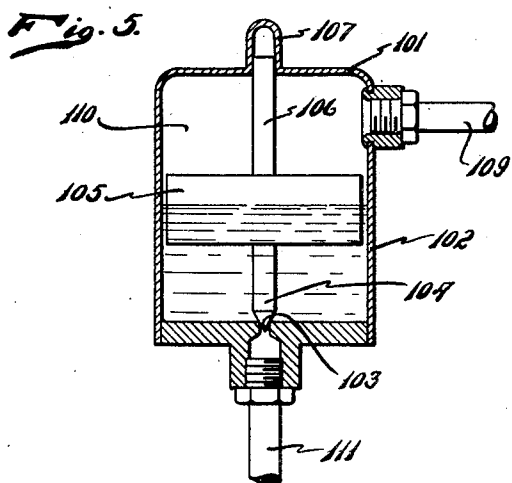
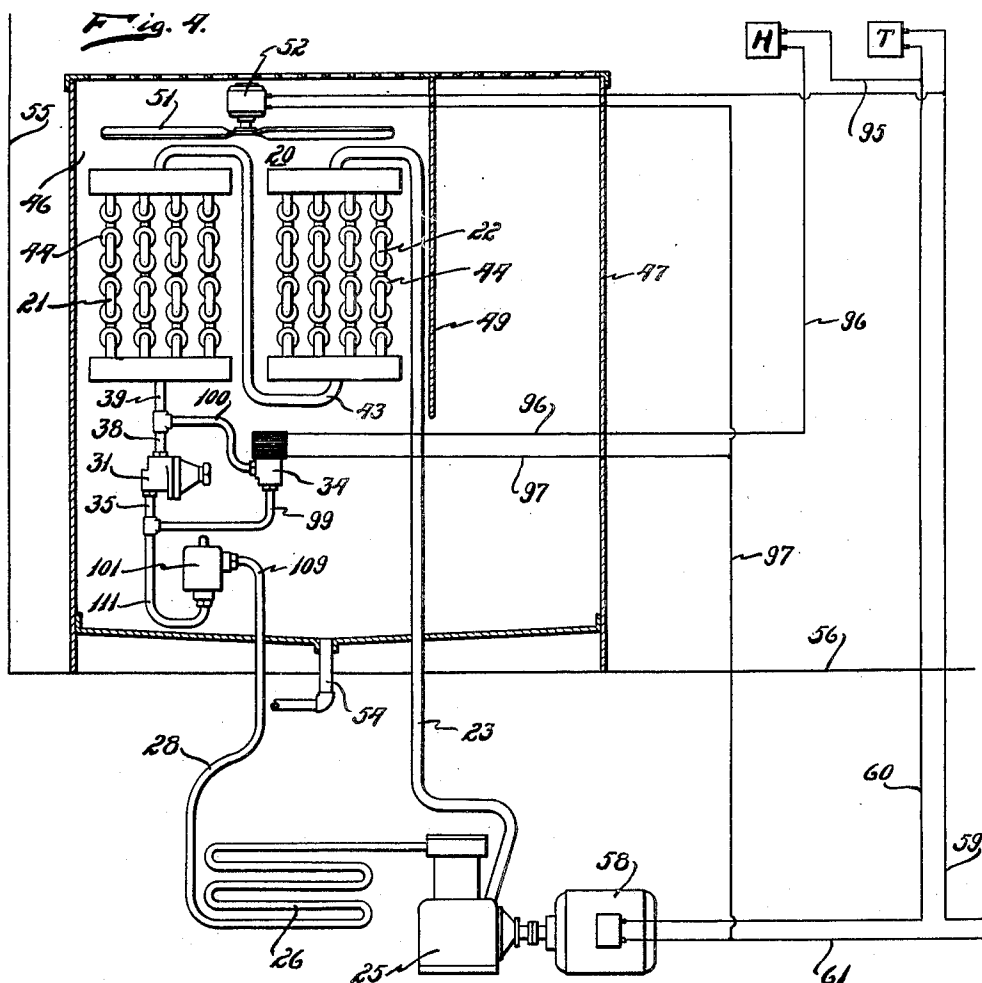
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AIR CONDITIONING SYSTEM

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3 Sheets-Sheet 2



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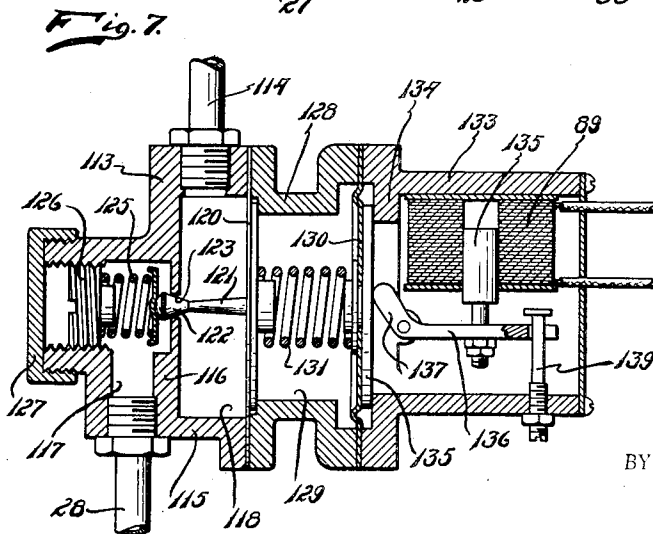
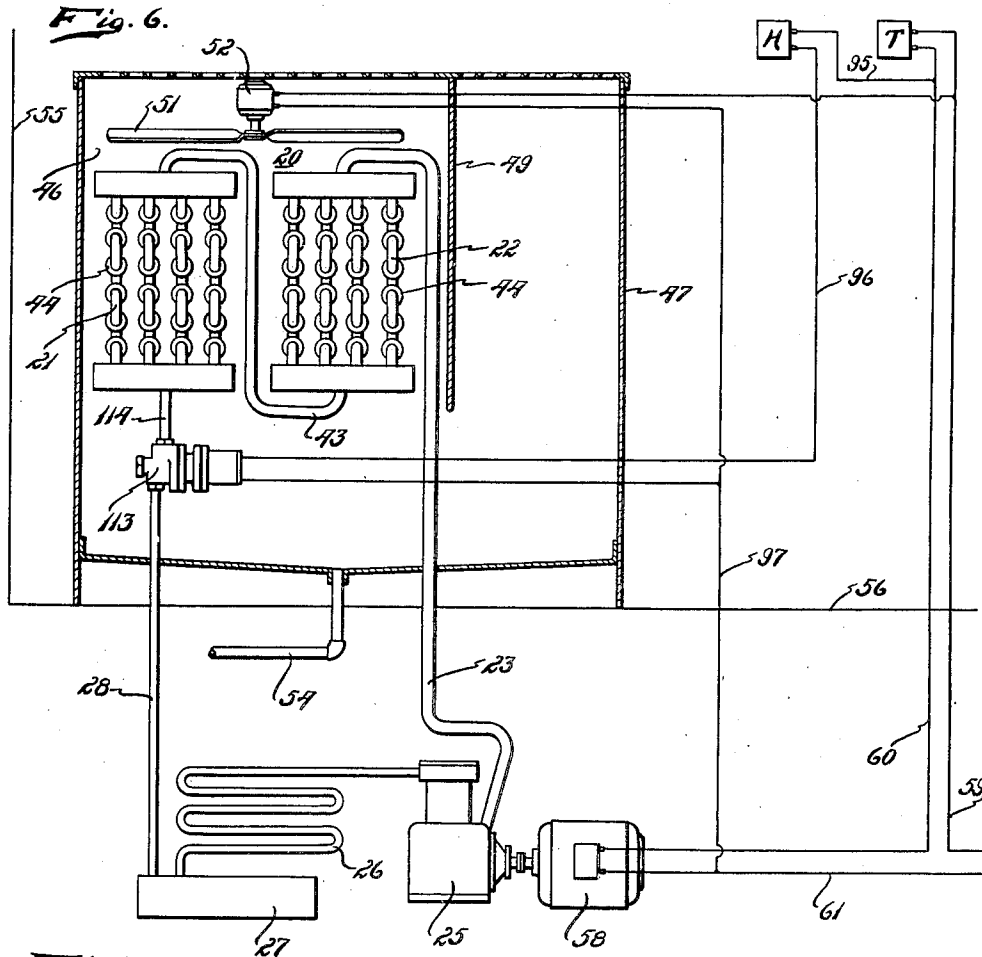
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AIR CONDITIONING SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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AIR CONDITIONING SYSTEM

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Application February 15, 1934, Serial No. 711,297

9 Claims. (Cl. 62—6)

The present invention relates to refrigerating systems and air conditioning systems.

One of the objects of the present invention is to provide an improved method of and apparatus for refrigeration, utilizing an evaporator for cooling and valve mechanism which is adapted to maintain vaporizable refrigerant throughout a large portion of the evaporator at times and at other times limits the flow of refrigerant to the evaporator so that a lesser portion only of the evaporator contains vaporizable refrigerant. In carrying out this object, it is a further object of the invention to control the valve mechanism in accordance with the relative humidity of the air to be conditioned.

Further objects and advantages of the present invention will be apparent from the following description reference being had to the accompanying drawings wherein preferred forms of the embodiment are clearly shown.

In the drawings:

Fig. 1 is a diagrammatic view of my improved refrigerating apparatus employed in an air conditioning system;

Fig. 2 is a longitudinal sectional view of an expansion valve used in the apparatus;

Fig. 3 is a sectional view of a shut off valve employed in the apparatus.

Fig. 4 is a diagrammatic view similar to Fig. 1 but showing a different form of expansion mechanism.

Fig. 5 is a sectional view of one of the valves used in the system shown in Fig. 4;

Fig. 6 is a diagrammatic view similar to Fig. 1 but showing another form of expansion mechanism and

Fig. 7 is a sectional view of the expansion mechanism employed in Fig. 6.

My invention is particularly applicable to air conditioning and includes an evaporator of any suitable type over which air to be conditioned is circulated. Part of the air to be conditioned is circulated over one portion or section of the evaporator for the purpose of removing principally sensible heat from the air and part of the air to be conditioned is circulated over another portion or section of the evaporator, which latter portion is utilized at times to remove principally latent heat from the air and is utilized, particularly when the air to be conditioned is high in relative humidity, for cooling the air to considerably below its dew point in order to cause precipitation and thereby removal of a large part of the moisture from the air.

In the present embodiment the evaporator 20

of a mechanical refrigerator is formed into two portions or sections 21 and 22. Gaseous refrigerant is withdrawn from the evaporator 20 through a pipe 23 which is connected to the low pressure side of a compressor 25. When the compressor operates, it withdraws gaseous refrigerant from the evaporator 20, compresses the refrigerant and forces the same into a heat dissipator or condenser 26 wherein it is cooled and then flows to a receiver 27. From the receiver 27 the liquid refrigerant is conducted by a pipe 28 to expansion mechanism generally designated as 30. In the illustration shown in Fig. 1, the expansion mechanism includes two expansion valves 31 and 32 and a shut off valve 34. Liquid refrigerant from the pipe 28 is fed to expansion valves 31 and 32 by branch pipes 35 and 36 respectively. From the expansion valve 31 the refrigerant is led to the evaporator section 21 by a branch pipe 38 and pipe 39 to the lower header of section 21. From the expansion valve 32, the refrigerant is conducted also to the lower header of section 21 through a pipe 41, valve 34, a branch pipe 42 and pipe 39. Thus it will be seen that pipe 35, valve 31 and branch pipe 38 parallel branch pipe 36, valve 32, pipe 41, valve 34 and pipe 42. Refrigerant conducted to the lower header of section 21 flows upwardly through the parallel tubes of the section to the upper header and from the upper header of section 21 by a pipe 43 to the lower header of section 22. The refrigerant then flows upwardly through the parallel tubes of section 22 to the upper header whence it is conducted to pipe 23. Fins 44 are intimately attached to the parallel tubes of the sections to increase the heat absorbing surfaces of the evaporator.

The evaporator 20 is disposed within a compartment 46 of a cabinet 47. This compartment 46 is formed by the front, back and one side wall of the cabinet 47 and by a partition 49 which depends from the top wall of the cabinet and extends from the front to the rear thereof. Air is circulated through the cabinet 47 by a fan 51 which is driven by a motor 52, the air being drawn into the compartment 46 and forced over the evaporator downwardly and then upwardly on the right side of the partition 49 and out through the top of the cabinet. The air passing over the evaporator 20 will be cooled and if any condensation takes place on the evaporator 20, the water will drip to the bottom of the cabinet 47 and from there drain through the drain pipe 54.

In the present illustration, the temperature

of the air in the room, which room is shown diagrammatically by a side wall 55 and a floor 56, is controlled by varying the heat exchange between the evaporator 20 and the air circulating thereover and in the present embodiment, this heat exchange is controlled by intermittently operating the compressor 25. The compressor is driven by a motor 58 and the starting and stopping thereof is controlled by a thermostat T disposed in the room. The circuit for the motor includes wire 59, thermostat T, wire 60, motor 58 and wire 61. When the temperature of the room rises to a predetermined maximum, the thermostat completes the motor circuit to cause the compressor 25 to be driven. This will cause refrigeration by the evaporator 20 and a consequent lowering of the air passing thereover. When the temperature of the air is decreased to a predetermined desired minimum, the thermostat T will open the motor circuit and the compressor will stop. In this manner the desired temperature will be maintained in the room.

In addition to controlling the temperature of the air in the room, it is also desirable to control the relative humidity of the air and to accomplish this there is provided the particular type of expansion mechanism 30 and a humidostat H for controlling the same. The expansion valve mechanism 30, humidostat H and the evaporator cooperate at times to maintain both sections of the evaporator at substantially the same temperature when it is desirable to remove principally sensible heat from the air and cooperate at times to cause the section 21 to decrease in temperature so as to remove latent heat from the air.

The expansion valves 31 and 32 are the usual type well known in the art and are identical in structure and the valve 31 will now be described. It comprises a casing 63 having a dividing wall 64 to form a high pressure chamber 65 which is connected with pipe 35 and a low pressure chamber 66 which is connected to pipe 38. One wall of the chamber 66 comprises a flexible diaphragm 67 to which is attached a valve stem 68 carrying a valve 69 which controls the port 70 in the partition wall 64. The back side of the diaphragm 67 is closed by a casing 72 forming a chamber 73. The back side of the diaphragm 67 carries a plate 74 and a spring 75 abuts this plate. The opposite end of the spring 75 abuts an adjusting nut 76 which is utilized for varying the tension on the back side of the diaphragm. A fluid tight cap 77 closes the end of the casing 72. As the pressure within evaporator 20 decreases, due to the action of the compressor 25, the pressure within chamber 66 is correspondingly decreased so as to open and close the valve 69. Thus the flow of refrigerant to the evaporator 20 through the valve 31 is controlled by the degree of tension of the spring 75.

When the valve 34 is closed, all of the refrigerant flows through the expansion valve 31 to the evaporator 20 and the tension of spring 75 is such that a relatively low pressure be maintained in order to pass refrigerant therethrough. The size of the compressor is such that under this condition vaporizable refrigerant will extend through only the first portion of the evaporator 20 and preferably throughout section 21 thereof and therefore substantially only gaseous refrigerant will be present in section 22. The adjustment of the valve 31 is such that the temperature of section 21 at this time will be considerably below the dew point of the air passing thereover, where-

by the moisture from the air will condense thereon and drip to the bottom of the cabinet 47 and will be drained through the drain pipe 54.

The tension of spring 75 of expansion valve 32 is set, relative to the tension of the like spring in valve 31, so that the valve 32 will maintain a higher pressure within the evaporator when valve 32 is in control. When it is desirable to remove only or principally sensible heat from the air, the valve 34 is open and the refrigerating apparatus will then function under the control of valve 32. In this event vaporizable refrigerant will be maintained throughout the greater portion of the evaporator 20, substantially through section 22, at a higher pressure and consequent higher temperature in section 21. Thus under this condition sections 21 and the major portion of section 22 will be maintained at substantially the same temperature. The port 70 in the expansion valve 32 supplies sufficient refrigerant to the evaporator 20 so that, when valve 34 is open, the pressure within the evaporator 20 will not be decreased to such low degree as to cause the opening of the expansion valve 31.

The valve 34 comprises a casing 80 which carries a magnetic coil 89, which when energized raises a solenoid valve 90. When the solenoid valve 90 is raised from its seat 91, refrigerant can pass from the pipe 41 through the port 92 and chamber 93 of casing 80 to the pipe 42. Magnetic coil 89 is controlled by a humidostat H and the circuit therefore includes wire 59, thermostat T, wire 95, humidostat H, wire 96, magnetic coil 89 of valve 34, and wires 97 and 61. When the percentage of relative humidity of the air in the room is above a predetermined desired maximum, the humidostat H in the room, is in a position in which the flow of current to the valve 34 is interrupted whereby valve 34 will be closed and the expansion valve 32 ineffective. At this time, the flow of refrigerant to the evaporator 20 is controlled solely by the expansion valve 31. As previously explained, under this condition, the section 21 will be decreased in temperature sufficient to remove a large portion of moisture from the air circulating thereover. The system will continue to operate in this manner until the relative humidity of the air in the room is lowered to the desired minimum, at which time, the humidostat H will operate to energize coil 89 of valve 34 and thereby render valve 32 effective. Under this latter condition, only or principally sensible heat will be removed from the air flowing over the evaporator 20.

In Figs. 4 and 6, other types of expansion mechanism are shown. In Fig. 4 the expansion valve 31 is adjusted substantially the same as expansion valve 31 of Fig. 1; namely, that it maintains the section 21 of evaporator 20 at a considerably lower temperature than section 22. In the embodiment shown in Fig. 4, there is provided a by-pass for expansion valve 31, which by-pass includes pipe 99, valve 34 and pipe 100. When it is desirable to remove only or principally sensible heat from the air, the valve 34 is opened by the humidostat, as explained with respect to Fig. 1 and in that event, the flow of refrigerant to the evaporator 20 is controlled by an expansion valve 101.

In this illustration, the expansion valve 101 is the high-side-float-type shown in Fig. 5, including a casing 102 having an outlet port 103 which is controlled by a needle valve 104. The needle valve is carried by a float 105 which is guided by a rod 106 extending into an extension 75

107. Liquid refrigerant is conducted from the condenser 26 by a pipe 109 to the chamber 110 of casing 102 and when a predetermined quantity of liquid refrigerant accumulates within chamber 110, the float 105 will lift the valve 104 off of its seat and permit liquid refrigerant to pass into pipe 111. From the pipe 111 refrigerant flows either through the pipe 35 to expansion valve 31, pipe 38 and pipe 39 or through pipe 39, through valve 34 and pipe 100 to pipe 39.

When the valve 34 is open, the valve 101 functions as the expansion valve for the refrigerating system and the quantity of liquid refrigerant contained in the system is sufficient to insure vaporizable refrigerant substantially throughout the evaporator 20 and an adequate quantity of liquid refrigerant within the chamber 110 of valve 101, to lift the valve 104 from its seat. When the valve 34 is closed, at which time section 21 will be operating at a relatively low temperature, less refrigerant will be contained within the low pressure side of the refrigerating system and consequently a larger quantity of refrigerant will be maintained on the high pressure side of the system. In this latter event sufficient liquid will be maintained in chamber 110 of valve 101 to continuously hold the valve 104 off of its seat whereby there is a free flow of refrigerant between the condenser 26 and the expansion valve 31 and consequently the valve 101 will not function as an expansion valve and the flow of refrigerant to the evaporator 20 is controlled entirely by valve 31.

In the embodiment illustrated in Fig. 6 the expansion valve mechanism includes a single expansion valve having a high pressure adjustment and a low pressure adjustment. The refrigerant flows from the receiver 27 through pipe 28, expansion mechanism 113 and pipe 114, to the lower header of section 21. The valve mechanism includes a casing 115 having a dividing wall 116 to form a high pressure chamber 117 and a low pressure chamber 118. Pipe 28 is connected with chamber 117 and pipe 114 is connected with chamber 118. One wall of chamber 118 comprises a flexible diaphragm 120 to which is attached a valve stem 121 carrying a valve 122 which controls the flow of refrigerant from chamber 117 to chamber 118 through the port 123. A reduction of pressure within chamber 118, caused by the operation of the compressor 25 tends to cause movement of the diaphragm 120 to the left. A spring 125 normally urges the valve 122 towards its seat and the tension of this spring must be overcome before the valve 122 opens the port 123. The tension of this spring can be adjusted by a nut 126. The end of the casing 115 is closed by a fluidtight cap 127.

The back side of the diaphragm 120 is closed by a casing 128 having a fluidtight chamber 129. The casing 128 includes a flexible diaphragm 130 and a spring 131 is interposed between the flexible diaphragm 130 and the flexible diaphragm 120 and normally urges the diaphragm 120 to the left and partially counteracts the tension of spring 125. The back side of diaphragm 130 is closed by a casing 133 having an abutment 134 which is engaged by a disk 135 carried by the diaphragm 130 to limit the right hand movement of diaphragm 130. In this illustration, the magnetic coil 89 is contained within casing 133 and operates a solenoid 135. Solenoid 135 actuates a bell crank lever 136 and when energized, tends to rotate the lever 136 in a counterclockwise direction. An arm 137 of the

lever 136 engages the disk 135 on diaphragm 130 when the magnet coil 89 is energized to cause the diaphragm 130 to move to the left and thereby increase the tension of spring 131. This in effect permits the valve 102 to open the port 123 at a higher pressure. In other words, the valve 122 will open at a higher pressure in the evaporator when the magnet coil 89 is energized. The extent of depression of the spring 131 by the magnet coil 89 is controlled by the extent of movement of lever 136 and this can be adjusted by the screw 139 which limits the upward movement of the solenoid 135. This screw 139 is threaded in the casing 133 and is adjustably held in position by a lock nut 140.

When the relative humidity of the air in the room is too high, the circuit to the magnetic coil 89 will be interrupted and a relatively low pressure must be maintained in the evaporator 20 and chamber 118 in order to supply refrigerant to the port 123. This pressure value and consequently the temperature within the evaporator 20 can be regulated by adjusting the tension of spring 125 by the nut 126. At this time the diaphragm 130 will be held stationary due to the engagement of the disc 135 with the abutment 134. This adjustment may be such, as explained with regard to Fig. 1, that substantially only section 21 contains a vaporizable refrigerant and the temperature thereof is considerably below the dew point of the air flowing thereover.

When the relative humidity of the air in the room has been decreased to the desired minimum, the humidostat H completes the circuit to magnet coil 89 whereby the arm 137 will force the diaphragm 130 to the left. This will cause an increase in tension of the spring 131 providing a greater force tending to open the valve port 123 which will have the effect of permitting the valve 122 to open its port 123 at a higher pressure. In this manner, a higher pressure will be maintained in the evaporator, and the entire evaporator will then be maintained at substantially the same temperature. The screw 139 can be adjusted so that the pressure in the evaporator is such that the temperature thereof is sufficient to remove only or principally specific heat from the air flowing thereover.

From the foregoing it will be apparent that I have provided air conditioning systems in which the temperature of the air will be maintained between predetermined high and low temperature limits. The room thermostat T controls the starting and stopping of the compressor 25 to provide the proper temperature of the air and this is accomplished regardless of whether the evaporator sections are functioning to remove both latent and sensible heat or functioning to remove principally sensible heat. It is also apparent that I have provided for maintaining a comfortable humidity condition of the air. The humidostat H controls the expansion mechanism so that the evaporator operates either as a means for removing principally sensible heat or as a means for removing both sensible and latent heat.

Under certain conditions, it will be desirable to cause some precipitation of moisture at the sections 21 and 22 when these sections are operating at substantially the same temperature, and it is to be understood that when said section 22 is referred to as functioning to remove principally sensible heat, such term is used merely to define the main functional purpose of said section as distinguished from the main functional purpose of section 21 when section 21 is operat-

ing at a relatively lower temperature than section 22.

While the forms of embodiment of the present invention as herein described constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain vaporizable refrigerant throughout a large portion of the evaporator, means associated with the valve mechanism for limiting the flow of refrigerant to the evaporator so that a lesser portion only of the evaporator contains vaporizable refrigerant, and means cooperating with the associated means and responsive to decreasing and increasing of the relative humidity of the air for respectively increasing and decreasing the extent of vaporizable refrigerant within the evaporator.

2. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism at the inlet of the evaporator for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain at times a certain pressure in the evaporator, means associated with the valve mechanism for maintaining a lower pressure in the evaporator and means responsive to the relative humidity of the air for controlling the associated means.

3. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism at the inlet of the evaporator for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain at times a large portion of the evaporator at substantially the same temperature, means associated with the valve mechanism to maintain at times a smaller portion of the evaporator at a lower temperature, and means responsive to the relative humidity of the air for controlling the associated means.

4. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain a relatively large quantity of vaporizable refrigerant in the evaporator, means associated with the valve mechanism for maintaining a lesser quantity of vaporizable refrigerant in the evaporator, and means cooperating with the associated means and responsive to decreasing and increasing of the relative humidity of the air for respectively increasing and decreasing the quantity of vaporizable refrigerant within the evaporator.

5. The method of conditioning air which comprises causing air which is to be conditioned to

flow about an evaporator, withdrawing gaseous refrigerant from the evaporator, condensing the refrigerant and delivering the same through expansion mechanism to the inlet of the evaporator, and decreasing and increasing the quantity of vaporizable refrigerant within the evaporator in accordance with increase and decrease respectively of the relative humidity of the air by controlling the flow of refrigerant through the expansion mechanism.

6. The method of conditioning air which comprises causing air which is to be conditioned to flow about an evaporator, withdrawing gaseous refrigerant from the evaporator, condensing the refrigerant and delivering the same through expansion mechanism to the inlet of evaporator, and varying the extent of active refrigerating surface of the evaporator by controlling the flow of refrigerant through the expansion mechanism in accordance with the relative humidity of the air to be conditioned.

7. A refrigerating system for conditioning air comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, an expansion valve for controlling the flow of refrigerant to the evaporator and adapted when effective to maintain a vaporizable refrigerant throughout a large portion of the evaporator, a second expansion valve for controlling the flow of refrigerant to the evaporator and adapted to limit the flow of refrigerant to the evaporator so that a lesser portion only of the evaporator contains vaporizable refrigerant when the first mentioned expansion valve is ineffective, and means operative in response to the relative humidity of the air for rendering the first mentioned expansion valve ineffective.

8. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain vaporizable refrigerant throughout a large portion of the evaporator, and means directly associated with the inlet valve mechanism and responsive to decrease and increase of the relative humidity of the air for causing said valve mechanism to respectively increase and decrease the extent of vaporizable refrigerant within the evaporator.

9. An air conditioning system comprising in combination, an evaporator, means for withdrawing gaseous refrigerant from the evaporator and for condensing the same and for delivering the condensed refrigerant to the evaporator, valve mechanism for controlling the flow of refrigerant to the inlet of the evaporator, said valve mechanism being adapted to maintain vaporizable refrigerant throughout a large portion of the evaporator, means responsive to the temperature of the air for varying the heat exchange between the air and the evaporator, and means directly associated with the inlet valve mechanism and responsive to decrease and increase of the relative humidity of the air for causing said valve mechanism to respectively increase and decrease the extent of vaporizable refrigerant within the evaporator.

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