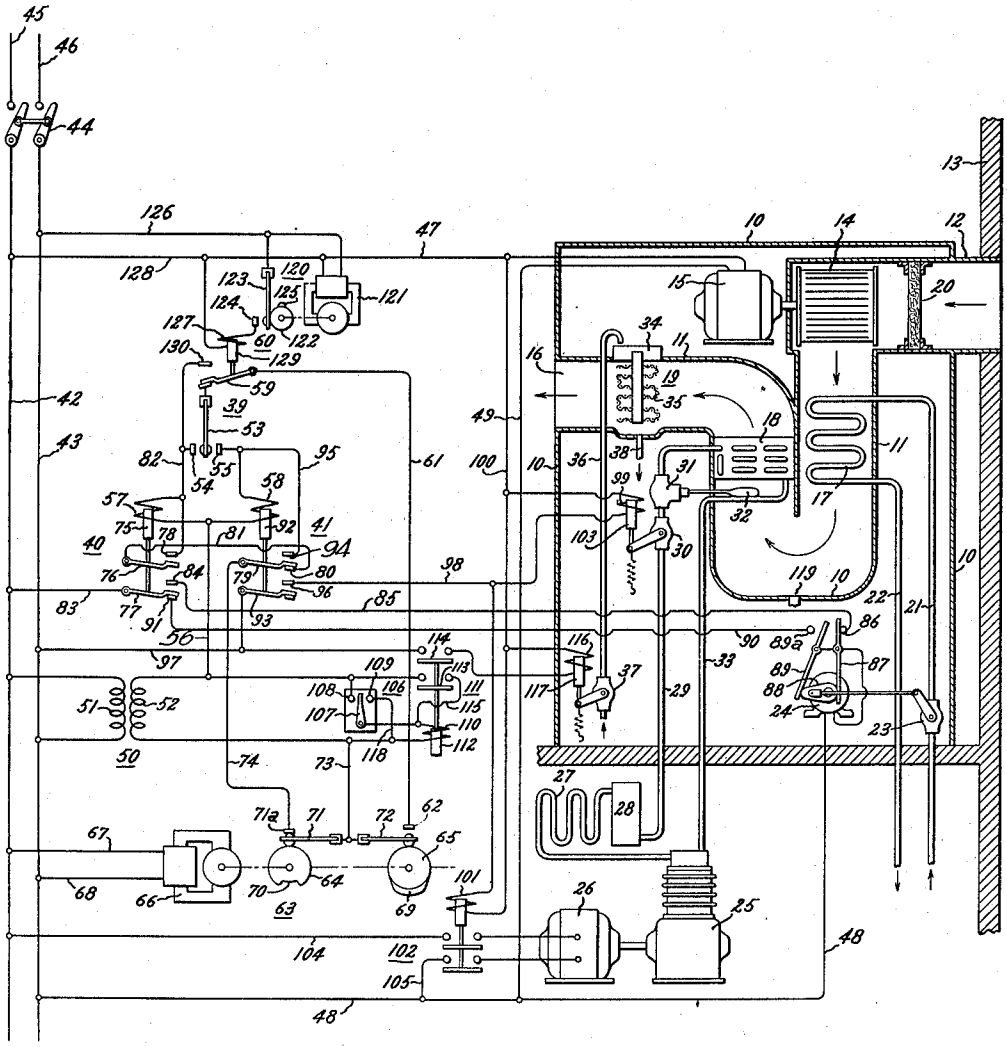
March 8, 1938. E. A. BAILEY 2,110,693

AIR CONDITIONING SYSTEM

Filed May 26, 1937



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Patented Mar. 8, 1938 2,110,693

UNITED STATES PATENT OFFICE

2,110,693

AIR CONDITIONING SYSTEM

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Application May 26, 1937, Serial No. 144,917

5 Claims. (Cl. 257—3)

My invention relates to systems for conditioning the air within rooms or other enclosures and particularly to such systems provided with both heating and cooling coils.

In air conditioning systems provided with cooling coils, it is sometimes necessary to operate the coils at temperatures below freezing. Consequently, moisture condensed from the air passing over the coils accumulates on the coils as frost. If allowed to accumulate, the frost will reduce the cooling capacity of the coil and it is therefore necessary to provide some arrangement for removing the frost in order to obtain maximum economy of operation. Accordingly, it is an object of my invention to provide a system for conditioning the air within an enclosure having a cooling element and an improved arrangement for removing frost collected on the cooling coil.

Another object of my invention is to provide an improved system for heating or cooling the air within an enclosure and an arrangement whereby the heating unit may be utilized to defrost the cooling unit.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawing, the single figure of which shows diagrammatically an air conditioning system embodying my invention.

Referring now to the drawing, I have shown an air conditioning system including a casing 10 within which is arranged a duct 11 provided with an inlet 12 passing through a wall 13 of the enclosure for receiving air from outside the enclosure. A fan 14 driven by a motor 15 is provided for circulating air through the duct 11 and into the enclosure through a discharge outlet 16. Within the duct 11 are arranged a heating coil or element 17, a cooling coil or element 18 and a humidifier 19. The air circulating through the duct 11 passes over the elements 17 and 18 and the humidifier 19 in the order named. A filter 20 is provided between the inlet 12 and the fan 14 to remove dust particles or other foreign matter from the air entering the duct. Heating medium is supplied to the coil 17 through conduit 21 and is discharged therefrom through conduit 22. The flow of heating medium is controlled by a valve 23 operated by a motor 24. Cooling medium is supplied to the cooling coil 18 from a mechanical refrigerating machine comprising a compressor 25 driven by a motor 26, a condenser 27 and a liquid receiver 28. Gaseous refrigerant is compressed by the compressor 25 and is discharged into the condenser 27 where it is cooled and liquefied, the liquid refrigerant flowing into and collecting in the receiver 28. Liquid refrigerant flows from the receiver 28 through a conduit 29 to the cooling coil 18. A normally closed solenoid valve 30 is provided in the conduit 29. When the valve 30 is opened, refrigerant flows to the coil 18 and the flow is controlled by a thermostatic expansion valve 31. The valve 31 is provided with a bulb 32 filled with a volatile liquid and secured in contact with the outlet conduit of the coil as is well known in the art to control the degree of superheat of the gaseous refrigerant discharged from the coil. The refrigerant vaporized within the coil 18 is returned to the compressor through a suction conduit 33.

The humidifier 19 comprises a pan 34 below which and within the duct 11 is suspended a zig-zag wire screen 35. Water is supplied to the pan 34 through a pipe 36, the flow of water being controlled by a solenoid valve 37. When water is admitted to the pan 34 it flows from the pan onto the screen 35 through a plurality of orifices in the bottom of the pan. The air flowing through the duct 11 passes through the screen 35 and absorbs a portion of the water flowing thereover. The remaining water falls to the bottom of the duct and is drained therefrom through a pipe 38.

When there is a demand for heating of the air within the enclosure, heating medium is supplied to the coil 17 to heat the air passing through the duct 11 and into the room. Should there be a demand for increasing the relative humidity of the air within the room, water will be admitted to the pan 34 of the humidifier. When there is a demand for cooling of the air within the room a solenoid valve 30 and a motor 26 are operated to supply refrigerant to the coil 18 and thereby cool the air passing through the duct and into the room.

In order to initiate the heating and cooling operations of the air conditioning system a thermostat 39 is provided in the enclosure to be conditioned and is arranged to operate heating and cooling relays 40 and 41 respectively depending on whether there is a demand for heating or for cooling. Power for energizing the motor and control circuits is supplied from lines 42 and 43 which may be connected by a manual switch 44 to supply mains 45 and 46 respectively. The fan motor 15 is connected to line 42 through a line

47 and to line 43 through lines 48 and 49, so that it is energized whenever the switch 44 is closed. The operating circuit for the thermostat 39 is energized through a transformer 50 having a primary 51 connected across the lines 42 and 43 and a secondary 52. The thermostat comprises a bimetallic member 53 which moves to the left and engages a contact 54 on a demand for heating and moves to the right to engage a contact 55 on a demand for cooling. When the relays 40 and 41 are in the positions shown and the member 53 engages one of the contacts 54 and 55, a circuit is prepared from one side of the secondary 52 through a connection 56 and one of the coils 57 and 58 of the relays 40 and 41 respectively through the member 53, a bridging member 59 of a relay 60 and a line 61 to a contact 62. A time controlled mechanism 63 is provided to test the thermostat circuit periodically and if there is a demand for heating or cooling to energize the circuit and operate one of the relays 40 and 41 as selected by the thermostat 39. The time controlled device 63 comprises two cams 64 and 65 mounted upon a shaft driven by a synchronous motor 66 connected across the lines 42 and 43 by lines 67 and 68 respectively. The motor 66 may be selected, for example, to rotate the cams 64 and 65 at a speed of one revolution per minute so that the thermostat circuit is tested once in every minute to determine whether one of the relays 40 and 41 should be operated or released. The cam 65 is provided with a raised portion 69 and the cam 64 is provided with a recessed portion 70 corresponding in position to the raised portion 69. Cam 64 operates a movable contact member 71 and the cam 65 operates a movable contact member 72. The raised portion 69 lifts the contact member 72 to engage the contact 62 and connect the line 61 through a connection 73 to the secondary 52 of a transformer. If the thermostat member 53 is in engagement with either of the contacts 54 and 55 at this time a circuit will be completed through one of the coils 57 and 58 and one of the relays 40 and 41 will be operated. The recessed portion 70 is somewhat shorter than the raised portion 69. For example, the raised portion 69 may correspond to a time of five seconds and the recessed portion 70 to a time of two seconds. The purpose of the cam 64 and the contact member 71 is to provide a holding circuit for the relay coils 57 and 58. This holding circuit is broken while the recessed portion 70 is engaging the movable member 71. It will be seen that the members 71 and 72 will both be in engagement with their contacts 71*a* and 62 respectively for a period of one and one-half seconds at either end of the time during which the cam surface 69 engages the member 72. If the relay coils are energized during this time they will be maintained energized throughout the remainder of the period of rotation of the cams since the holding circuit will be maintained closed from connection 73 through member 71 and a line 74.

During the operation of the air conditioning system, should the member 53 of thermostat 39 be in engagement with the contact 54 when the cam 65 moves the member 72 against the contact 62 the coil 57 of relay 40 will be energized to raise an armature 75 and relay arms 76 and 77. Arm 76 engages a contact 78 and closes the holding circuit for coil 57 from line 74 through an arm 79 and a contact 80 of relay 41 and a connection 81 to the coil 57 through a line 82 which connects coil 57 and contact 54. A lower arm 77 of the relay closes a circuit from line 42 through a connection 83, a contact 84 and a line 85 and a contact 86 through a cam operated switch member 87 to the motor 24, the motor being connected to the line 43 through line 48. Motor 24 is thereby energized and operates to open valve 23 for supplying heating medium to the coil 17. A cam 88 driven by the motor rotates and moves the member 87 away from the contact 86 to open the motor circuit when the valve 23 has been opened, and allows a movable switch member 89 to engage a contact 89*a* and prepare a motor circuit through the movable member 89 and a line 90 to a contact 91 of the relay 40. At a subsequent rotation of the cams 64 and 65 into position to move the arms 71 and 72 should member 53 not be in engagement with contact 54 the relay circuit will be broken and the relay coil 57 deenergized allowing the armature 75 to drop out. In the drop-out position the arm 76 opens the holding circuit of the coil 57 and the arm 77 closes a circuit to the motor 24 upon engagement with the contact 91. The motor 24 thereupon rotates to close the valve 23 and the cam 88 restores the movable members 87 and 89 to the positions shown in the drawing.

Upon a demand for cooling of the air within the room to be conditioned the movable member 53 of thermostat 39 engages contact 55 and the cams 64 and 65 close the operating and holding circuits of the coil 58 in the same manner as that described above in connection with the coil 57. When energized, the coil 58 raises an armature 92 of relay 41 and relay arms 79 and 93. The arm 79 in its raised position engages a contact 94 to close the holding circuit from the line 74 through the arm and a connection 95 to the coil 58. The lower arm 93 engages a contact 96 to complete a circuit from the line 43 through a line 97, arm 93, contact 96 and a line 98 to energize a coil 99 of solenoid valve 30, the circuit being completed from coil 99 through a line 100 and line 47. Connected in parallel with the coil 99 across the lines 98 and 100 is a coil 101 of a switch 102 controlling the motor 26. Energization of the coil 99 raises an armature 103 and opens the valve 30. Energization of coil 101 closes the switch 102 to connect motor 26 to lines 42 and 48 through connections 104 and 105 respectively. The refrigerating machine is thereby set in operation to supply liquid refrigerant to the cooling coil 18 through the thermostatic expansion valve 31, and the air passing through the duct 11 is thereby cooled. On a subsequent rotation of the cams 64 and 65 should the thermostat member 53 be out of engagement with the contact 55 the coil 58 will be deenergized thereby deenergizing the coils 99 and 101 and stopping the operation of the refrigerating machine.

When it is desired to increase the relative humidity of the air within the room to be conditioned the humidistat 106 is operated to open the valve 37 and admit water to the pan 34. The humidistat 106 comprises a movable member 107 which engages a contact 108 upon a demand for humidity increase and the contact 109 when the humidity has increased to the desired value. When the member 107 engages the contact 108 a circuit is completed from the secondary 52 of the transformer 50 through the contact 108 and member 107 to a coil 110 of a switch 111. Energization of the coil 110 raises an armature 112 and switch arms 113 and 114 are raised to engage their contacts. The arm 113 closes a holding circuit for the coil 110 through a connection 115.

The arm 114 closes a circuit from line 97 through arm 114 to a coil 116 of solenoid valve 37 and thence through lines 100 and 47 to supply line 42. Energization of the coil 116 raises an armature 117 and actuates the solenoid valve 37 to open the valve and permit a flow of water through the pipe 36 into the pan 34 and thence over the screen 35 of the humidifier. When the humidity has been increased to the desired value, the movable member 107 engages the contact 109 and shorts out the coil 110 through a connection 118. Armature 112 then drops out and opens the circuit to coil 116 to stop the flow of water to the pan 35.

During the operation of the cooling coil 18, moisture is condensed from the air circulating through the duct 11 and when the cooling coil is operated at temperatures below freezing the moisture forms a coating of frost on the coil. In order periodically to remove the accumulation of frost, I provide an arrangement whereby the supply of cooling medium to the coil 18 is interrupted for a predetermined length of time while heating medium is supplied to the coil 17. The air passing through the duct 11 is then heated by the coil 17 and in passing over the coil 18 melts the accumulation of frost which flows to the bottom of the duct and is drained out through a pipe 119.

In order to effect this periodic defrosting of the coil 18, I provide a time controlled mechanism 120 comprising a synchronous motor 121 arranged to drive a cam 122 which periodically moves a contact member 123 into engagement with a stationary contact 124, the cam 122 being provided with a raised portion 125 which moves the member 123 against the contact 124. The cam 122 may, for example, be designed to operate the movable switch member 123 so that it holds the switch member in engagement with the contact 124 for a period of about two minutes every four hours to defrost the coil 18 and maintain a minimum accumulation of frost. When the member 123 engages the contact 124 a circuit is closed from a line 126 through the member 123 and the contact 124 to a coil 127 of the relay 60 and back to the supply line through a line 128. Energization of the coil 127 raises an armature 129 and lifts switch member 59 to engage a stationary contact 130. Raising of the switch member 59 breaks the connection between the line 61 and the thermostatic member 53, and establishes a connection between the line 61 and the line 82, so that the coil 57 of the heating relay 40 is placed in the relay operating circuit and is actuated upon rotation of the cams 64 and 65, in the same manner as previously disclosed, with reference to the moving of the thermostatic member 53 into engagement with the contact 54 in response to a demand for heating of the air within the enclosure. Since the connection to the thermostatic member 53 has been broken, the cooling relay 41 cannot be energized and the refrigerating machine is stopped so that no refrigerant is supplied to the coil 18. Since the fan 14 operates continuously air is circulated through the duct 11 over the coil 17 and is thereby heated before flowing over the coil 18. The heated air melts any accumulation of frost on the coil 18 and is cooled thereby before being discharged into the room. There is, therefore, no appreciable heating of the air in the room during the short period required for defrosting. As soon as the cam 122 rotates to move the raised portion 125 away from the member 123, the circuit of the coil 127 is broken and the armature 129 drops out to restore normal operation of the system under the control of the thermostat 38. The defrosting operation is thus effected with a minimum of additional control apparatus and no additional heating units are required in the air conditioning system.

From the foregoing, it is apparent that I have provided an improved air conditioning system for heating and cooling the air within an enclosure, which includes a simple and effective arrangement for periodically defrosting the cooling coil.

Although I have described my invention in connection with a particular air conditioning system, other arrangements will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the construction shown and described and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A system for conditioning the air within an enclosure including a duct, a heating element associated with said duct, a cooling element associated with said duct, means for circulating air continuously through said duct and for discharging a portion of said air into said enclosure to cool the air within said enclosure, means for supplying heating medium to said heating element, means for supplying cooling medium to said cooling element whereby moisture may be condensed from said circulating air and frost may be formed on said cooling element, means responsive to the temperature of the air within said enclosure for controlling said cooling medium supplying means, and means for periodically stopping automatically the supply of cooling medium to said cooling element and for starting the supply of heating medium to said heating element to melt the frost on said cooling element.

2. A system for conditioning the air within an enclosure including a duct, a heating element in said duct, a cooling element in said duct, means for circulating air continuously through said duct first over said heating element and then over said cooling element and for discharging a portion of said air into said enclosure to cool the air within said enclosure, means for supplying heating medium to said heating element, means for supplying cooling medium to said cooling element whereby moisture may be condensed from said circulating air and frost may be formed on said cooling element, means responsive to the temperature of the air within said enclosure for controlling said cooling medium supplying means, and means for periodically stopping automatically the supply of cooling medium to said cooling element and for starting the supply of heating medium to said heating element to heat the air passing through said duct and to melt the frost on said cooling element.

3. A system for conditioning the air within an enclosure including a duct, a heating element in said duct, a cooling element in said duct, means for circulating air continuously through said duct first over said heating element and then over said cooling element and for discharging a portion of said air into said enclosure, means for supplying heating medium to said heating element, means for supplying cooling medium to said cooling element whereby moisture may be condensed from said circulating air and frost may be formed on said cooling element, means dependent upon a demand for heating of the

air within said enclosure for controlling said heating medium supplying means, means dependent upon a demand for cooling of the air within said enclosure for controlling said cooling medium supplying means, and means operable automatically for periodically preventing the supplying of cooling medium to said cooling element and for actuating said heating medium supply means to heat the air passing through said duct and to melt the frost on said cooling element.

4. A system for conditioning the air within an enclosure including a duct, a heating element in said duct, a cooling element in said duct, means for circulating air continuously through said duct first over said heating element and then over said cooling element and for discharging a portion of said air into said enclosure, means for supplying heating medium to said heating element, means for supplying cooling medium to said cooling element whereby moisture may be condensed from said circulating air and frost may be formed on said cooling element, means responsive to the temperature of the air within said enclosure for selectively actuating said cooling medium supplying means and said heating medium supplying means to heat and to cool the air circulating through said duct, and means cooperating with said temperature responsive means for periodically stopping automatically the supply of cooling medium to said cooling element and for starting the supply of heating medium to said heating element to heat the air passing through said duct and to melt the frost on said cooling element.

5. A system for conditioning the air within an enclosure including a duct, a heating coil in said duct, a cooling coil in said duct, means including a fan for circulating air continuously through said duct first over said heating coil and then over said cooling coil and for discharging a portion of said air into said enclosure, means for supplying heating medium to said heating coil, means for supplying cooling medium to said cooling coil, means for maintaining said cooling coil at temperatures below freezing whereby frost may be formed on said cooling coil, means including a thermostat responsive to the temperature of the air within said enclosure for selectively actuating said cooling medium supplying means and said heating medium supplying means dependent upon demands for heating and for cooling of the air within said enclosure, and time controlled means cooperating with said temperature responsive means for periodically preventing the supplying of cooling medium to said cooling coil and for actuating said heating medium supplying means to heat the air passing through said duct and to melt the frost on said cooling element.

EDWARD A. BAILEY.