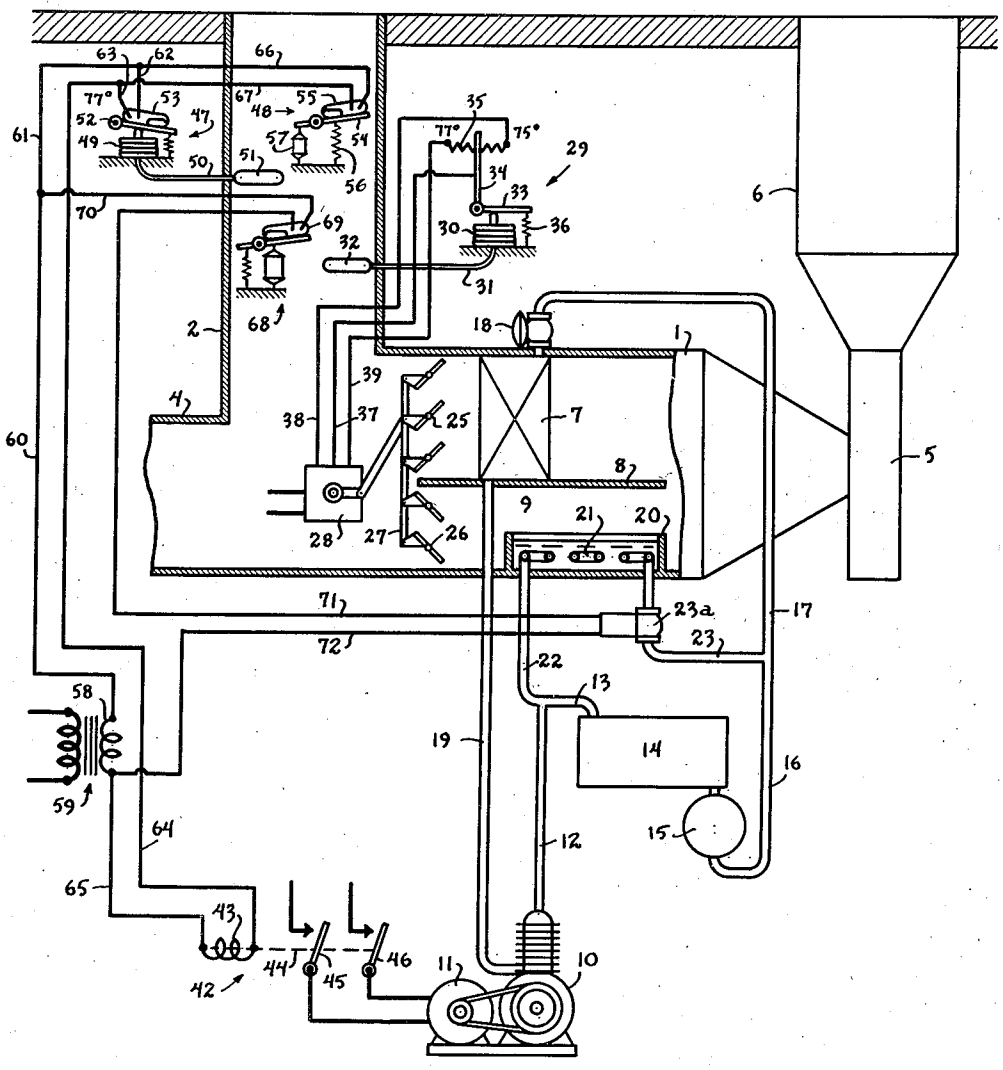
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AIR CONDITIONING SYSTEM

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AIR CONDITIONING SYSTEM

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This invention relates to air conditioning and is concerned with the provision of an automatic air conditioning system which maintains proper temperature and humidity conditions within a conditioned space at all times.

In the air conditioning art, it has been customary to provide for cooling a space by passing air over a cooling coil which may either be cooled by a cooling medium such as cold water or by direct expansion of refrigerant therein. Inasmuch as it is usually necessary to perform dehumidification as well as cooling and as it is desirable to reduce the necessary coil area to a minimum, such coils are usually sized so as to require operation at a temperature below the dew-point of the air which causes dehumidification of the air. This arrangement is satisfactory in many installations. However, in certain localities which are subject at times to relatively hot dry weather, this type of system is providing the necessary cooling inherently provides too much dehumidification thus causing the relative humidity in the space to fall too low. Heretofore it has been proposed to overcome this difficulty by providing a humidifier for rehumidifying the air after it has been cooled. However, such arrangements have not proven satisfactory as the air which must be humidified is quite cold and does not take up the moisture.

It is an object of this invention to provide an air conditioning system which acts to maintain the temperature in the conditioned space at the desired value and which effectively humidifies the air simultaneously with cooling when necessary for maintaining the space relative humidity at the desired value.

A further object is the provision of a system of the type mentioned in which the humidifier is provided with a heating means consisting of an auxiliary condenser in the system which provides refrigeration, thereby utilizing heat which would ordinarily be wasted and also aiding in the condensing of the compressed refrigerant.

Other objects will appear from the following description and the appended claims.

For a full disclosure of this invention reference is made to the following detailed description and to the accompanying drawing, the single figure of which illustrates diagrammatically a preferred form of the invention.

Referring to the drawing, reference character 1 indicates generally a conditioning chamber, this chamber being connected by a return duct 2 to a space 3 which is conditioned by the system. This conditioning chamber may also be provided with a fresh air duct 4 and a suitable fresh air damper controlling arrangement (not shown). The outlet of the chamber 1 is connected to a fan 5 which is connected by a discharge duct 6 to the space 3.

Located within the chamber is a direct expansion cooling coil 7. A partition 8 is provided for forming a by-pass passage 9 beneath the coil 7. The coil 7 forms part of a refrigeration system which includes a compressor 10 driven by an electric motor 11. This compressor is connected by pipes 12 and 13 to a condenser 14 which in turn is connected to a receiver 15. This receiver is connected by pipes 16 and 17 to an expansion valve 18 located at the inlet of the cooling coil 7. The outlet of this cooling coil is connected by a suitable line 19 to the inlet of the compressor 10.

Located in the by-pass passage 9 is a pan type humidifier 20 which contains water for humidifying the air flowing through this passage. This humidifier may be provided with a suitable float type valve (not shown) for maintaining a constant water level therein. Located in the humidifier 20 is a heating coil 21 for heating the water and thereby increasing the effectiveness of the humidifier. This coil 21 in accordance with the present invention is connected to an inlet pipe 22 which is in turn connected to the discharge pipe 12 leading from the compressor. Therefore compressed regriferant from the compressor is delivered to the coil 21. Inasmuch as this compressed refrigerant is hot the coil 21 is caused to heat the water in the humidifier. The refrigerant also condenses within the coil 21 and passes through the outlet pipe 23 and solenoid valve 23a to the pipe 17 leading to the expansion valve 18. The coil 21 therefore acts to utilize heat from the refrigeration system itself for providing the necessary heat for humidification and in addition utilizes the humidifier as an auxiliary condenser for aiding in condensing the compressed refrigerant. By locating the valve 23a in the outlet line 23, this valve handles only condensed refrigerant and consequently a very small solenoid valve may be used. When this valve is closed the coil 21 will become flooded with condensed refrigerant thereby rendering it inactive.

Located within the conditioning chamber 1 is a set of dampers including a face damper 25 and a by-pass damper 26, these dampers being formed of rotatable blades as usual in the art and being cross-connected by a member 27 so that the dampers are actuated in opposite directions with

respect to air flow. These dampers are actuated by means of a proportioning motor 28 which is preferably of the type shown and described in the Taylor Patent 2,028,110. This motor is controlled by means of a potentiometer type return air thermostat generally indicated as 29. This thermostat 29 is of usual form and comprises a bellows 30 which is connected by a capillary tube 31 to a control bulb 32. The bellows 30 actuates a bell-crank member including an arm 33 and a slider 34 which cooperates with a resistance 35 to form a control potentiometer. Upon increase in temperature within the return air duct 2, the bellows 30 will expand against the action of a spring 36 thus causing the slider 34 to move to the left across resistance 35. Conversely, upon fall in temperature the pressure within bellows 30 decreases for causing travel of slider 34 in the opposite direction. This instrument may be designed and adjusted in a manner to cause the slider 34 to engage the right-hand end of resistance 35 when the return air temperature is at 75° F. or below while engaging the left-hand end of resistance 35 when the space temperature rises to 77° F. The slider 34 and the resistance 35 are connected to the proportioning motor 28 by wires 37, 38, and 39. The operating lever of the proportioning motor 28 is caused by the motor mechanism to follow movements of the slider 34 on the resistance 35. Thus when the space temperature is at or above 77° F., which causes the slider 34 to engage the left-hand end of resistance 35, the operating lever of motor 28 will assume its counterclockwise limit of rotation wherein the face damper 25 is wide open and the by-pass damper 26 closed to its minimum position. This by-pass damper 26 is adjusted so that it is never completely closed for always permitting a certain flow of air across the humidifier 20. As the space temperature decreases below 77° F., the motor 28 will graduatingly close the face damper 25 and open the by-pass damper 26 and when the space temperature falls to 75° F. the by-pass damper 26 will be wide open while the face damper 25 will be closed to its minimum position. This face damper 25 is adjusted so that it never closes completely thereby permitting a certain minimum flow of air across the cooling coil 7 at all times.

The compressor motor 11 is provided with a motor starter 42 of usual form. This starter is diagrammatically illustrated as comprising a coil 43 which actuates an armature 44 connected to switch arms 45 and 46, the switch arms being connected into the power circuit for the motor. When the coil 43 is energized the switch arms 45 and 46 engage their respective contacts for causing operation of motor 11, while when the coil 43 is deenergized the power circuit to the motor 11 will be broken.

The motor starter 42 is controlled by means of a return air thermostat 47 and a return air humidity controller 48. Referring to the controller 47, this controller may be of usual form consisting of a bellows 49 connected by capillary tube 50 to a control bulb 51. The bellows 49 actuates a pivoted switch carrier 52 which carries a mercury switch 53. When the return air temperature rises to a value such as 77° F., the bellows 49 will expand against the action of its biasing spring for causing closure of the mercury switch 53. However, when the return air temperature falls below this value, the switch 53 will be opened.

The humidity controller 48 is of usual type and is diagrammatically illustrated as comprising a lever 54 carrying a mercury switch 55, this lever being urged in one direction by a spring 56 and in the opposite direction by a moisture responsive device 57 which may consist of hair or other suitable material. When the relative humidity rises to a value such as 60%, the device 57 will expand sufficiently for permitting rotation of the lever 54 by spring 56 to close the mercury switch 55. However, when the relative humidity is below this value, the mercury switch 55 will be opened.

In the event that the space temperature should rise sufficiently to cause closure of the mercury switch 55 of thermostat 47, a circuit will be completed from the secondary 58 of the transformer 59 through wires 60, 61, and 62 to the mercury switch 53, through wires 63 and 64, coil 43, and wire 65 to secondary 58. This will energize the starter 42 for placing the compressor into operation. It will be noted that the mercury switch 55 of the humidity controller is connected in parallel with mercury switch 53 by wires 66 and 67. Therefore if the relative humidity rises to the control point of the humidity controller 48, the compressor starter 42 will be energized for placing the compressor in operation.

The solenoid valve 23 is controlled by means of a humidity controller 68 which is located in the return air duct 2. This humidity controller may be the same as the humidity controller 48 and includes the mercury switch 69. This controller may be set so that when the relative humidity falls below a predetermined value such as 40%, the mercury switch 69 will close. Upon closure of this switch a circuit will be completed from the transformer secondary 58 through wire 60, wire 70, mercury switch 69, wire 71, solenoid valve 23, and wire 72 to the secondary 59. Therefore the valve 23 is opened when the relative humidity falls to a predetermined low value for permitting operation of the humidifier. However, when the humidity is above this value, the valve 23 is closed for placing the humidifier 20 out of operation.

Operation

With the parts in the positions shown, the return air temperature is 76° F., as indicated by the slider 34 engaging the center of resistance 35. As the thermostat 47 is set to close at 77° F., the mercury switch 53 of this thermostat is now open. Also, the relative humidity within the space is between 40 and 60% as indicated by the mercury switches 55 and 69 of controllers 48 and 68 being opened. Therefore at this time the compressor 10 is out of operation and the solenoid valve 23*a* is closed.

If the relative humidity should rise to 60%, the mercury switch 55 of the humidity controller 48 will close. This in the manner previously described will energize the compressor starter 42 for placing the compressor in operation. At this time the solenoid valve 23*a* will be closed and thus the coil 21 within the humidifier 20 will be ineffective to heat the water. With the compressor now operating under the command of the humidity controller 48, the dampers 25 and 26 will be positioned by the return air thermostat 29. Thus if the return air temperature rises, this thermostat will cause the face damper 25 to open slightly wider and the by-pass damper 26 to close slightly further. This will increase the flow of air through the cooling coil 7 and thereby increase the amount of cooling performed which will tend to counteract the rising temperature. This action, however, will not proportionately increase the dehumidifying

action of the coil. This is due to the fact that the increased load upon the cooling coil 7 will cause its temperature to rise which lowers the proportion of the effort of coil 7 which performs dehumidification. Thus the rise in temperature of coil 7 counteracts the effect of increased air flow and the total amount of dehumidification performed by the coil 7 may remain substantially constant. If the return air temperature lowers, the thermostat 29 will cause positioning of the dampers for decreasing the flow of air through the cooling coil 7. This will decrease the amount of sensible cooling performed but will not materially vary the amount of dehumidification performed by the coil.

From the foregoing it will be apparent that during relatively cool and damp weather the compressor will be stopped and started by the humidity controller 48 and the dampers 25 and 26 will be positioned in accordance with return air temperature in a manner to maintain the temperature within the space substantially constant.

During relatively hot dry weather, the space temperature will rise to 77° F. for causing the compressor to be placed into operation by the return air thermostat 47. When this occurs, the thermostat 29 will have positioned the dampers 25 and 26 so that the flow of air through coil 7 is at a maximum. Therefore, at this time the cooling coil 7 performs a large amount of sensible cooling as compared with dehumidification. At times this dehumidification which accompanies the cooling action of the coil 7 will cause the relative humidity within the space to fall below 40% which will cause the humidity controller 68 to open the solenoid valve 23*a*. This will permit the condensed refrigerant to flow from the coil 21 and thus compressed gaseous refrigerant from the compressor will enter the coil 21 thereby causing the water within the humidifier pan to become heated. As pointed out before, the by-pass damper 26 will never completely close so that air continually passes through the by-pass 9 and over the humidifier 20. This air is quite warm and consequently takes up moisture from the humidifier readily. This warm humidified air passing through the by-pass joins the cool air which is discharged from the coil 7 and the two portions of air will intimately mix in passing through the fan 5.

From the foregoing description, it will be apparent that this invention provides an air conditioning system which acts to maintain proper temperature and humidity conditions within the space being conditioned and provides for effective rehumidification of the air in the event that the space relative humidity falls to a low value due to the dehumidifying action which accompanies the cooling action of the cooling coil. While for purposes of description specific values of temperature and humidity have been mentioned, it will be understood that the invention is not limited to these values as other values may be used in different installations and applications of the invention. While I have shown and described a preferred form of the invention, it will be apparent that various modifications may be made without departing from the scope of the invention. I therefore desire to be limited only by the scope of the appended claims.

I claim as my invention:

1. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to said space is passed, a cooling and dehumidifying device in said chamber for cooling and dehumidifying said air, a by-pass passage around said cooling and dehumidifying device, damper means for varying the proportions of air flowing through said cooling and dehumidifying device and through said by-pass, a humidifier located in said by-pass, a first condition responsive means influenced by space temperature, a second condition responsive means influenced by space humidity, one of said condition responsive means controlling said damper means and the other of said condition responsive means controlling said humidifier.

2. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to said space is passed, a cooling and dehumidifying device in said chamber for cooling and dehumidifying said air, a by-pass passage around said cooling and dehumidifying device, damper means for varying the proportions of air flowing through said cooling and dehumidifying device and through said by-pass, a humidifier located in said by-pass, means responsive to space temperature for controlling said damper means and means influenced by space humidity for controlling said humidifier.

3. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to said space is passed, a cooling and dehumidifying device in said chamber for cooling and dehumidifying said air, a by-pass passage around said cooling and dehumidifying device, damper means for varying the proportions of air flowing through said cooling and dehumidifying device and through said by-pass, a humidifier located in said by-pass, means responsive to space temperature for controlling said cooling and dehumidifying device and said damper means in a manner to place said cooling and dehumidifying device into operation and to cause movement of said damper means for increasing the flow of air through said cooling and dehumidifying device upon rise in temperature, and means influenced by humidity in said space for placing said humidifier into operation when the humidity falls to a predetermined value.

4. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to said space is passed, a cooling and dehumidifying device in said chamber for cooling and dehumidifying said air, a by-pass passage around said cooling and dehumidifying device, damper means for varying the proportions of air flowing through said cooling and dehumidifying device and through said by-pass, a humidifier located in said by-pass, means influenced by space humidity for placing said cooling and dehumidifying device into operation when the humidity rises to a value indicating that dehumidification is desirable, means responsive to space temperature for controlling said cooling and dehumidifying device and said damper means in a manner to place said cooling and dehumidifying device into operation and to cause movement of said damper means for increasing the flow of air through said cooling and dehumidifying device upon rise in temperature, and means influenced by humidity in said space for placing said humidifier into operation when the humidity falls to a predetermined value.

5. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to a space is passed, a direct expansion cooling coil in said chamber, said direct expansion cooling coil forming part of a re-

frigeration system having a compressor and a condenser, a by-pass for the air around said cooling coil, damper means for controlling the portions of the air flowing through said cooling coil and said by-pass, a humidifier in said by-pass for humidifying the uncooled portion of the air flowing through said by-pass, means influenced by space temperature for controlling said damper means, and means influenced by space humidity for controlling said humidifier.

6. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to a space is passed, a direct expansion cooling coil in said chamber, said direct expansion cooling coil forming part of a refrigeration system having a compressor and a condenser, a by-pass for the air around said cooling coil, damper means for controlling the portions of the air flowing through said cooling coil and said by-pass, a humidifier in said by-pass for humidifying the uncooled portion of the air flowing through said by-pass, means influenced by space temperature for controlling said compressor and damper means in a manner to place said compressor into operation and to increase the flow of air over said cooling coil upon rise in space temperature, and means influenced by space humidity for controlling said humidifier.

7. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to a space is passed, a direct expansion cooling coil in said chamber, said direct expansion cooling coil forming part of a refrigeration system having a compressor and a condenser, a by-pass for the air around said cooling coil, damper means for controlling the portions of the air flowing through said cooling coil and said by-pass, a humidifier in said by-pass for humidifying the uncooled portion of the air flowing through said by-pass, means influenced by space relative humidity for controlling said compressor in a manner to place said compressor into operation upon rise in space humidity to a value requiring dehumidification, means influenced by space temperature for controlling said compressor and damper means in a manner to place said compressor into operation and to increase the flow of air over said cooling coil upon rise in space temperature, and means influenced by space humidity for controlling said humidifier.

8. In an air conditioning system for a space, in combination, a conditioning chamber through which air flowing to a space is passed, a direct expansion cooling coil in said chamber, said direct expansion cooling coil forming part of a refrigeration system having a compressor and a condenser, a by-pass for the air around said cooling coil, damper means for controlling the portions of the air flowing through said cooling coil and said by-pass, a humidifier in said by-pass for humidifying the uncooled portion of the air flowing through said by-pass, said humidifier having a heating element therefor, said heating element consisting of a heat exchange device receiving compressed refrigerant from the compressor and delivering condensed refrigerant to said cooling coil, a condition responsive device influenced by space temperature, a condition responsive device influenced by space humidity, one of said condition responsive devices controlling said damper means and the other of said condition responsive devices controlling said humidifier.

9. In an air conditioning system, in combination, means for providing a stream of relatively warm air for supply to a conditioned space, air cooling means for simultaneously providing a stream of relatively cool air for supply to said space, thermostatic means influenced by the demand for heating or cooling in said space for graduatingly varying the proportions of the warm air stream and the cool air stream supplied to said space for maintaining a predetermined temperature in said space, means for increasing the moisture content of the air in said first stream, and means responsive to the humidity of the air in said space for controlling said last mentioned means.

10. In an air conditioning system, in combination, means for providing a stream of relatively warm air for supply to a conditioned space, air cooling means for simultaneously providing a stream of relatively cool air for supply to said space, thermostatic means influenced by the demand for heating or cooling in said space for graduatingly varying the proportions of the warm air stream and the cool air stream supplied to said space for maintaining a predetermined temperature in said space, a humidifier for humidifying only said warm air stream, and means responsive to the humidity of the air in said space for controlling said humidifier.

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