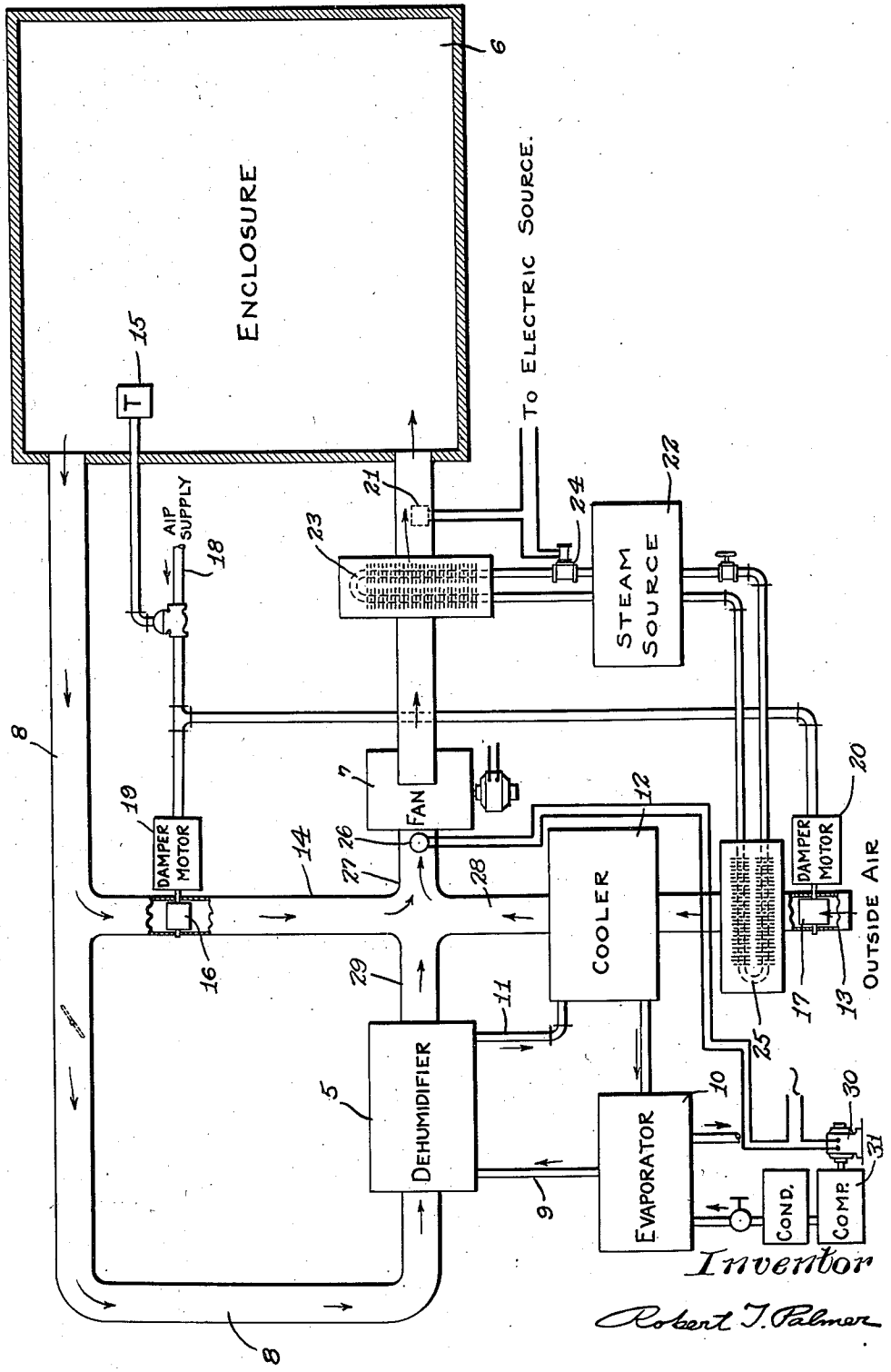
July 21, 1936. R. T. PALMER 2,048,137

REFRIGERATION METHOD AND APPARATUS FOR THE CONDITIONING OF AIR

Filed July 16, 1935



Inventor

Robert T. Palmer

Patented July 21, 1936

2,048,137

UNITED STATES PATENT OFFICE

2,048,137

REFRIGERATION METHOD AND APPARATUS FOR THE CONDITIONING OF AIR

Robert T. Palmer, Sharon, Mass., assignor to B. F. Sturtevant Company, Inc., Hyde Park, Boston, Mass.

Application July 16, 1935, Serial No. 31,597

9 Claims. (Cl. 62—176)

This invention relates to refrigeration methods and apparatus for the conditioning of air.

In those air conditioning systems such as are installed in motion picture theatres, where in summer the air is chilled to a low temperature, in order that the necessary dehumidification may take place, it is customary to mix recirculated air from the space being served with fresh outside air; to chill the mixture in a dehumidifier to a temperature lower than the dew point of the air within the space and to mix variable quantities of "by-pass" recirculated air with the dehumidified fresh and recirculated air for the purpose of adding the necessary sensible heat to the too cold dehumidified air.

According to this invention, recirculated air only, passes through the dehumidifier and the necessary outside make up air passes through a cooler which does not cool the outside air to a temperature below the dew point of the recirculated air but merely cools the outside air to a condition approximately equal to that of the recirculated air. This cooled outside air mixes with the by-pass air at the output side of the dehumidifier and serves with the by-pass air to raise the sensible heat of the too cold dehumidified recirculated air.

According to a feature of this invention, the refrigerant used in the dehumidifier for dehumidifying the recirculated air is circulated through the cooler for cooling the outside make up air before being recooled in the refrigeration apparatus. The refrigerant in a single circuit thus serves, efficiently to dehumidify the recirculated air and to cool the outside air to a condition approaching that of the recirculated air.

The outside air is not dehumidified by being cooled to a temperature below the dew point of the indoor air since the refrigerant which is used to cool the outside air was previously heated in the dehumidifier to a temperature above the dew point temperature of the recirculated air.

An object of the invention is to dehumidify recirculated air from the space to be served and to mix with the dehumidified air, outside air cooled to a temperature approximating that of the air within the space to be served.

Another object of the invention is to dehumidify recirculated air from the space to be served, and to mix with the dehumidified recirculated air, by-pass recirculated air and outside air cooled to a condition approximately that of the by-pass air.

Another object of the invention is to dehumidify with refrigeration, recirculated air from the space to be served, to cool outside air with the refrigeration used in dehumidifying the recirculated air and to add the cooled outside air to the dehumidified recirculated air.

Other objects of the invention will be apparent from the following description taken together with the drawing.

The drawing illustrates diagrammatically one embodiment of the invention for the dehumidification of recirculated air and the cooling of outside air.

The dehumidifier 5 is preferably of the well known spray type although coils may be used. Recirculated air from the space 6 is drawn by the suction of the fan 7 through the duct 8 and through the dehumidifier 5. The dehumidifier is supplied with chilled water through the pipe 9 from the evaporator 10 which chills the spray water to a sufficiently low temperature so that the recirculated air passing through the dehumidifier has its temperature reduced to the required dew point. The dehumidifier is preferably operated under the well known dew point control, for the adjustment of the spray water temperature.

The dehumidifier 5 is so constructed and arranged that the spray water leaving it through the pipe 11, takes on in the dehumidifier, a temperature above the dew point temperature of the recirculated air.

The spray water on leaving the dehumidifier 5 passes through the pipe 11 into the spray type outside air cooler 12 and acts to cool the outside air which enters through the duct 13 to a temperature above the dew point of the recirculated air which passes as by-pass air through the duct 14 to be mixed at the output side of the dehumidifier 5 with the air leaving the dehumidifier.

The cooled outside air leaving the cooler 12 mixes with the air leaving the dehumidifier and with the by-pass air and having substantially the temperature of the by-pass air, acts with the by-pass air to raise the sensible heat of the air leaving the dehumidifier.

The by-pass and partially cooled outside air acts to increase the sensible heat of the air leaving the dehumidifier 5, under control of the thermostat, exposed to conditions within the enclosure 6. The thermostat 15 also acts to control the volume of air passing through the dehumidifier as when the load within the enclosure 6 changes.

When the enclosure 6 is empty, minimum cooling and dehumidification is required due to the absence of occupants who would add both moisture and sensible heat to the air. The thermo-

stat 15 which may be responsive to wet or dry bulb temperature or both, then acts to open the damper 16 in the by-pass air duct 14 and to close the damper 17 in the outside air duct 13. This is accomplished by the control of compressed air in the supply line 18 to the damper motors 19 and 20.

With the damper 16 moved towards open position and the damper 17 moved simultaneously towards closed position, the volume of air through the by-pass duct 14 increases towards a maximum and the volume of recirculated air through the dehumidifier 5 and the volume of outside air through the outside air duct 13 and the cooler 12 decreases towards a minimum with the result that minimum refrigeration is required.

When on the other hand, the load within the enclosure 6 increases, the thermostat 15 causes the damper 16 to be adjusted towards closed position and the damper 17 to be adjusted towards open position. This results in increased flow of recirculated air through the dehumidifier 5 and of outside air through the duct 13 and cooler 12 and decreased flow of air through the by-pass duct 14.

Upon decrease of by-pass air there is an increase of outside air for adding sensible heat to the air leaving the dehumidifier. The thermostat 15 thus acts to automatically vary the proportion of dehumidified air, by-pass air and outside air as the air conditions within the enclosure 6, change, due to the varying number of occupants.

The refrigeration load varys accordingly due to the characteristics of the dew point control in maintaining a constant dew point in the air passing through the dehumidifier.

Changes in the wet bulb temperature of the outside air passing through the cooler 12 will cause a change in the dew point of the air entering the enclosure 6. While this may not be objectionable where the system is used for the comfort conditioning of air, it perhaps might be objectionable for the industrial conditioning of air in certain plants where conditioned air at a constant dew point is required. To ensure such a constant dew point, the dew point control 26 is mounted in the duct 27 on the delivery side of the ducts 14, 28, and 29, and acts for example, to control the supply of electrical energy to the motor 30 driving the compressor 31.

When under unusual conditions, the necessary reheating of the chilled air is not accomplished by the mixture therewith of the by-pass and outside air, the thermostat 21 acts to permit the flow of steam from the steam source 22 into the reheater coils 23 by adjustment of the electrically controlled valve 24.

The steam coils 23 and the similar steam coils 25 in contact with the outside air may be used in cold weather for heating the air supplied to the enclosure 6 at which time the cooler 12 and dehumidifier 5 or both may be used for adding the necessary moisture to the air.

The apparatus is illustrated diagrammatically by the drawing and there has been no attempt to illustrate all of the equipment obviously required. For example, means for forcing water flow between the evaporator, dehumidifier and cooler is obviously required.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention should not be limited to the exact arrangement described, as many departures may be made by those skilled in the art after having had access to this disclosure.

What is claimed is:

1. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, a dehumidifier, means for withdrawing air from said enclosure and for passing a portion thereof through said dehumidifier and for passing another portion thereof as by-pass air to the output side of said dehumidifier, a cooler, means for passing outside air through said cooler, means for mixing the air passing from said dehumidifier, the by-pass air and the outside air leaving said cooler and for supplying the mixture within said enclosure, means for circulating a refrigerating fluid through said dehumidifier, and means for circulating the refrigerating fluid leaving said dehumidifier through said cooler.

2. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, a dehumidifier, means for withdrawing air from said enclosure and for passing same through said dehumidifier, a cooler, means for passing outside air through said cooler, means for mixing the air passing from said dehumidifier, and the outside air leaving said cooler and for supplying the mixture within said enclosure, means for circulating a refrigerating fluid through said dehumidifier, and means for circulating the refrigerating fluid leaving said dehumidifier through said cooler.

3. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, means for withdrawing air from said enclosure, a dehumidifier for chilling a portion of said withdrawn air to a temperature lower than the dew point of the air within said enclosure, means for passing another portion of said withdrawn air as by-pass air to be mixed with said other portion after it has been chilled, means for cooling outside air to a condition nearer to that of said by-pass air than to that of said chilled air, and means for mixing said chilled air, said by-pass air and said cooled outside air at the output side of said dehumidifier and for supplying the mixture into said enclosure.

4. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, a dehumidifier, means for withdrawing air from said enclosure and for passing a portion thereof through said dehumidifier and for passing another portion thereof as by-pass air to the output side of said dehumidifier, a cooler, means for passing outside air through said cooler, means for mixing the air passing from said dehumidifier, the by-pass air and the outside air leaving said cooler and for supplying the mixture within said enclosure, means for circulating a refrigerating fluid through said dehumidifier, means for circulating the refrigerating fluid leaving said dehumidifier through said cooler, and means for varying the proportion of by-pass air to outside air and dehumidified air as the load within said enclosure varies.

5. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, a dehumidifier, means for withdrawing air from said enclosure and for passing same through said de-

humidifier, a cooler, means for passing outside air through said cooler, means for mixing the air passing from said dehumidifier, and the outside air leaving said cooler and for supplying the mixture within said enclosure, means for circulating a refrigerating fluid through said dehumidifier, means for circulating the refrigerating fluid leaving said dehumidifier through said cooler, and means for varying the proportion of outside air to dehumidified air as the load within said enclosure varies.

6. Refrigeration apparatus for the conditioning of air comprising in combination, an enclosure, the air of which is to be conditioned, a dehumidifier, means for withdrawing air from said enclosure, means for chilling a portion of said withdrawn air in said dehumidifier to a temperature lower than the dew point of the air within said enclosure, means for passing another portion of said withdrawn air as by-pass air to be mixed at the output side of said dehumidifier with said other portion after it has been chilled, means for cooling outside air to a condition nearer to that of said by-pass air than to that of said chilled air, means for passing said cooled outside air to the output side of said dehumidifier to be mixed with said chilled air and said by-pass air and for supplying the mixture into said enclosure, and means for varying the volumes of by-pass air, of outside air and of dehumidified air as the load within said enclosure varies.

7. Heat exchange apparatus for the conditioning of air, comprising in combination, an enclosure, the air of which is to be conditioned, means for withdrawing air from said enclosure and for chilling it to a temperature lower than the dew point of the air within said enclosure, means for cooling outside air to a condition nearer to that of the air within said enclosure than to that of said chilled withdrawn air, means for mixing said chilled withdrawn air and said cooled outside air and for supplying the mixture into said enclosure, and means for varying the volumes of outside air and of dehumidified air as the load within said enclosure varies.

8. The method of conditioning the air supplied to an enclosure which comprises recirculating air from the enclosure, chilling the recirculated air to a temperature below the dew point, of the air within said enclosure, cooling outside air to a condition nearer that of the air within said enclosure than to that of the dehumdified air, mixing the cooled outside air and dehumidified air and supplying the mixture into said enclosure, and varying the volumes of the recirculated air and of the outside air as the load within said enclosure changes.

9. The method of conditioning the air supplied to an enclosure which comprises recirculating air from the enclosure, dividing the recirculated air into two streams, chilling the air in one stream to a temperature below the dew point of the air within said enclosure, cooling outside air to a condition nearer to that of the air in said enclosure than to that of the chilled air, mixing the chilled air, the air in said other stream and the cooled outside air and supplying the mixture within said enclosure, and varying the volumes of untreated recirculated air and that of the chilled recirculated air and of the outside air as the load within said enclosure changes.

ROBERT T. PALMER.