July 4, 1933. S. M. ANDERSON 1,917,006

AIR CONDITIONING METHOD AND APPARATUS

Filed July 18, 1931

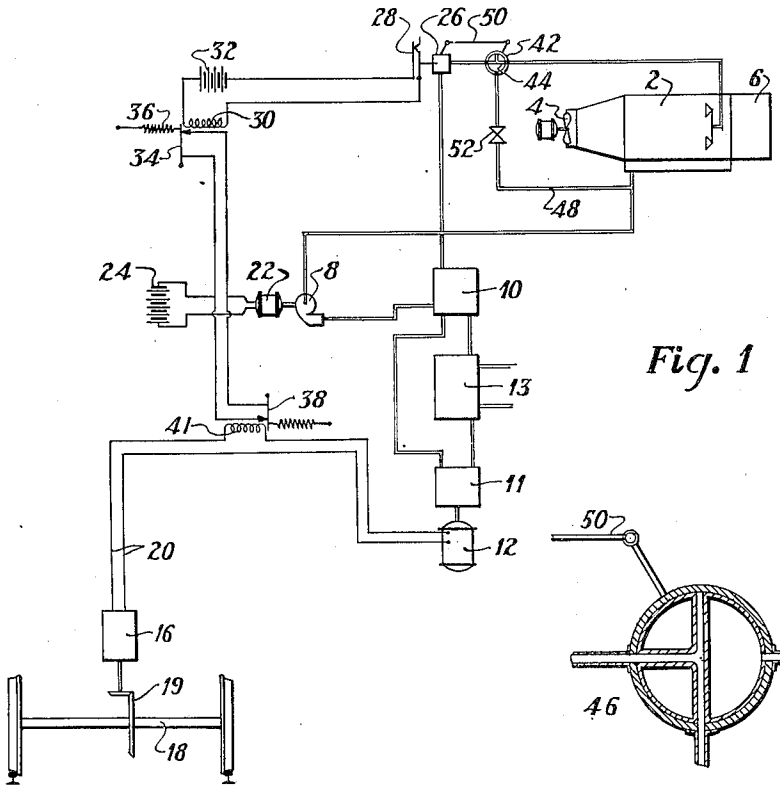

Fig. 1

Fig. 2

Witness
Ernest A. Myers

Inventor
Samuel M. Anderson
by his attorneys
Van Everen, Fish, Hildreth & Cary

Patented July 4, 1933 1,917,006

UNITED STATES PATENT OFFICE

SAMUEL M. ANDERSON, OF SHARON, MASSACHUSETTS, ASSIGNOR TO B. F. STURTEVANT COMPANY, OF HYDE PARK, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

AIR CONDITIONING METHOD AND APPARATUS

Application filed July 18, 1931. Serial No. 551,630.

The present invention relates to air conditioning methods and apparatus and more particularly to air conditioning methods and apparatus for supplying cooled and dehumidified air to rooms, auditoriums, vehicles, and the like.

In the operation of a cooling and dehumidifying system, it is undesirable to permit continued operation if for any reason the sprayed water rises above a predetermined temperature, in fact, from the standpoint of comfort, the operation of the system with water at too high a temperature is more of a detriment than an advantage. Conditions of operation with too elevated a water temperature are most frequently met with in air conditioning systems for vehicles, wherein a refrigerating system driven directly or indirectly from the axle is shut down when the vehicle is stopped. The copending application of Davis and Anderson filed of even date herewith describes a system in which the water circulation is shut off when the vehicle is stopped and the water temperature becomes too high. When the vehicle is restarted, means are provided for resuming circulation of the water independently of the temperature control so that a period exists in which water of too high a temperature is passed through the dehumidifier. Moreover, the system described in the Davis and Anderson application permits circulating of the warm water in the event of breakdown of the refrigerating apparatus.

One object of the present invention is to provide an air conditioning apparatus in which the circulating water is prevented from passing through the dehumidifier under any conditions when its temperature becomes too high.

A further object of the invention is to provide improvements in air conditioning apparatus for vehicles of the type described in the above-mentioned application, whereby circulation of the water through the dehumidifier is prevented under all conditions when the temperature is above a predetermined value.

With these and other objects in view, as will hereinafter appear, one feature of the invention comprises a by-pass around the dehumidifier and controlled by the temperature of the water to prevent passage of the water through the dehumidifier when the temperature rises above a predetermined value. This feature of the invention may be utilized in connection with any air conditioning system, but is particularly adapted for use in combination with the system of the above-mentioned application. When so employed, the complete system permits circulation of water through the dehumidifier when its temperature is sufficiently low, even though the refrigerator may be temporarily shut down, due to stoppage of the vehicle or other reasons. Upon resumption of operation of the refrigerator, circulation of the water in the circulating system is restarted, but passage of the water through the dehumidifier is prevented until the temperature drops to the desired value.

In the accompanying drawing illustrating what is now considered the preferred form of the invention, Fig. 1 is a diagram of a complete air conditioning system for a vehicle such as a railway car and Fig. 2 is a detail view illustrating the operation of the by-pass valve to prevent passage of water through the dehumidifier.

The illustrated embodiment of the invention comprises a fluid circulating air conditioning system including a spray device or a dehumidifier 2 of any usual or preferred form through which air to be conditioned is continuously forced by a fan 4. The conditioned air leaving the dehumidifier is distributed through a duct 6 in any suitable manner to different parts of the vehicle. The operation of the dehumidifier and the flow of air therethrough may be controlled by any suitable instruments sensitive to temperature and humidity conditions in the vehicle. Water, which constitutes the air conditioning medium, is continuously circulated through the spray device by a pump 8. The outlet of the pump connects through a cooler 10 with the spray device and the outlet of the spray device leads to the inlet of the pump.

The water circulated through the spray device is cooled in the cooler 10 by a refriger-

ation apparatus indicated diagrammatically by the compressor 11 driven by the motor 12 and the condenser 13. The refrigerant is circulated through the pipe lines 14 through the compressor, the condenser and the cooler. The refrigerator motor 12 is supplied with electric current by a generator 16 driven from the axle 18 of the vehicle through suitable gearing 19 and connected with the motor by leads 20.

The pump 8 for circulating the water is driven by an electric motor 22 which is energized by a battery 24. The battery may be continuously charged when the vehicle is in motion by an axle generator, not shown. The drive for the pump 8 being independent of the refrigerator drive, the pump will continue to operate when the vehicle is stationary. Therefore, for a short stop, even though the refrigerator is inactive, the temperature of the circulating water may be maintained sufficiently low for a considerable period and will be circulated to the spray nozzles to cool and dehumidify the air.

However, if the stop is an extended one, the temperature of the circulating water increases so that eventually it becomes ineffective for proper conditioning of the air, and if continued to be sprayed into the air, will increase the temperature and humidity. In order to stop the water spray under these conditions, there is placed in the circulating line a thermostat, indicated generally at 26, controlling a switch 28. This switch is maintained closed below a predetermined temperature of the spray water, but is caused to open by the action of the thermostat when the water temperature rises to a predetermined value. The switch 28 is included in a relay circuit which also includes a relay coil 30 and a battery 32. If desired, a single battery may be used in place of the two batteries 24 and 32. The coil 30 normally maintains closed the stopping relay switch 34, which is connected in a lead between the battery 24 and the pump motor 22. A spring 36 tends to open the switch 34 when the coil 30 is deenergized. Upon an extended stop, therefore, when the refrigerator is inactive, the pump 8 continues to operate until the water temperature rises above the predetermined value for which the thermostat 26 is set, whereupon the switch 34 is opened and the pump is stopped.

In order to provide for the automatic restarting of the circulating system, regardless of the water temperature, a second or starting relay switch 38 is connected in parallel to the switch 34. The switch 38 is adapted to be held open by a spring 40 but is normally held closed when the vehicle is in motion by a relay magnet 41 connected in one of the leads 20 between the axle generator 16 and the refrigerator motor 12. Although the starting switch 38 is open when the car is stationary, it is closed immediately upon restarting of the car. The closure of the switch 38 completes the circuit of the motor 22, thereby starting the pump 8 even though the stopping switch 34 remains open because of the elevated temperature of the water. After a short time, however, the water becomes sufficiently cooled by the action of the refrigerator to effect closing of the switch 34, thereby again placing the system in readiness for operation on the reserve of cooled water at a subsequent stop.

The parts thus far described are identical with those of the Davis and Anderson application.

Included in the water circulating system is a thermostatically controlled two-way valve 42. The valve has a passage 44 permitting direct flow of water through the dehumidifier, as shown in Fig. 1, and a passage 46 which, when the valve is in the position of Fig. 2, cuts off the dehumidifier and directs the fluid through a by-pass pipe 48 connected around the dehumidifier. The valve, which is preferably snap acting, is connected by links 50 with the thermostat 26, by which its movement from one position to the other is determined. Preferably the thermostat is set to open the by-pass connection at the same temperature that the switch 28 is opened. The by-pass includes a reduced orifice, indicated by the valve 52, to offer approximately the same resistance as that afforded by the dehumidifier, so that the load on the pump is not materially changed when the by-pass is cut in.

In normal operation, when the vehicle is in motion, water is continuously circulated through the dehumidifier and the cooler, the latter being cooled by operation of the refrigerator. When the vehicle stops, the switch 38 opens, but the circulation of water is maintained by operation of the pump motor through the switch 34. The system then operates on the reserve of cooled water and refrigerant until the water temperature becomes high enough to operate the thermostat, whereupon the pump is shut down, and the by-pass connection is established. This action occurs only on an extended stop; for a normal stop, the body of water will not rise to a sufficiently high temperature to shut off the circulation.

When the vehicle starts after an extended stop, the pump having been shut down and the by-pass established, the circuit of the pump motor is established through the relay switch 38. Water now circulates through the by-pass, but is not permitted to pass through the dehumidifier until it is cooled to a temperature sufficiently low to operate the thermostat. Upon operation of the thermostat, the switch 34 is again closed, and the valve 42 is operated to direct the water through the dehumidifier.

It will be seen that water circulation is maintained whenever either of the relay switches is closed and stopped only when both of the switches are open; that is to say, circulation is maintained either when the vehicle is running or when the water temperature is low, but is cut off only under the dual condition of high water temperature and stoppage of the vehicle.

However, regardless of the operation of the switches, water above the predetermined temperature is not permitted to pass through the dehumidifier, because of the action of the thermostatic valve. This by-pass action is particularly advantageous upon resumption of motion of the vehicle after an extended stop, in that it prevents improper air conditioning until the circulated water drops to the necessary low temperature.

Furthermore, the by-pass control is of advantage in preventing passage of water through the dehumidifier in the event of mechanical breakdown of the refrigerator, a contingency which is not taken care of by the operation of the switches alone.

Although the invention has been described as embodied in an air conditioning system for vehicles, it is understood that the invention is not limited to such a system, but may be employed for supplying conditioned air to rooms, auditoriums, and the like. In other respects, also, the illustrated embodiment may be modified without departing from the present invention.

Having thus described the invention, what is claimed is:

1. Air conditioning apparatus having, in combination, a dehumidifier, liquid circulating means, a by-pass around the dehumidifier, and means controlled by the temperature of the circulated liquid for determining the flow thereof either through the dehumidifier or the by-pass.

2. Air conditioning apparatus having, in combination, a dehumidifier, liquid circulating means, and means controlled by a rise in temperature of the liquid above a predetermined value for by-passing the liquid around the spray device.

3. Air conditioning apparatus having, in combination, a dehumidifier, a cooler, means for circulating liquid through the cooler and the dehumidifier, a by-pass around the dehumidifier, a thermostat responsive to the liquid temperature, and means operated by the thermostat for determining flow either through the dehumidifier or the by-pass.

4. Air conditioning apparatus having, in combination, a refrigerator, a liquid circulating system including a cooler cooled by the refrigerator and a dehumidifier, means for circulating liquid through the system, and temperature controlled means for shutting off circulation of the liquid and for establishing a by-pass around the dehumidifier upon rise of temperature of the liquid to a predetermined value.

5. Air conditioning apparatus for vehicles having, in combination, a refrigerator, means for driving the refrigerator, an independently driven liquid circulating system to permit continued operation thereof after cessation of operation of the refrigerator, the liquid circulating system including a dehumidifier and a cooler, a connection between the refrigerator and the cooler, temperature controlled means for shutting off circulation of the liquid when the temperature thereof rises to a predetermined value, a by-pass around the dehumidifier, a thermostatically controlled valve for establishing liquid circulation through the by-pass upon rise of temperature above a predetermined value, and means for restarting operation of the liquid circulating system on resumption of operation of the refrigerator.

6. Air conditioning apparatus for vehicles having, in combination, a refrigerator, means for driving the refrigerator from the motion of the vehicle, an independently driven liquid circulating system to permit continued operation thereof after cessation of operation of the refrigerator by stopping of the vehicle, the liquid circulating system including a dehumidifier and a cooler, a connection between the refrigerator and the cooler, temperature controlled means for shutting off circulation of the liquid when the temperature thereof rises to a predetermined value, a by-pass around the dehumidifier, a thermostatically controlled valve for establishing liquid circulation through the by-pass upon rise of temperature above a predetermined value, and means for restarting operation of the liquid circulating system on resumption of operation of the refrigerator.

7. Air conditioning apparatus for vehicles having, in combination, a refrigerator, means for driving the refrigerator, an independently driven liquid circulating system to permit continued operation thereof after cessation of operation of the refrigerator, the liquid circulating system including a dehumidifier and a cooler, a connection from the refrigerator to the cooler, a by-pass around the dehumidifier, a thermostatically controlled valve for establishing liquid circulation through the by-pass upon rise of temperature above a predetermined value, and means for stopping circulation of the liquid when the refrigerator is inactive and the temperature of the cooling liquid medium is above a predetermined value.

8. Air conditioning apparatus for vehicles having, in combination, a refrigerator, means for driving the refrigerator, an independently driven liquid circulating system to permit continued operation thereof after cessation of operation of the refrigerator, the liquid circulating system including a dehumid-

ifier and a cooler, a connection from the refrigerator to the cooler, thermostatic means in the circulating system, means for operating the circulating system either during the operation of the refrigerator or by the presence of liquid at lower than a predetermined temperature in the circulating system, a by-pass around the dehumidifier, and a thermostatically controlled valve for establishing liquid circulation through the by-pass upon rise of temperature above a predetermined value.

9. Air conditioning apparatus for vehicles having, in combination, a refrigerator, axle driven means for operating the refrigerator, a cooler cooled by the refrigerator, a dehumidifier, means for circulating liquid through the cooler, a drive for said circulating means independent of the axle driven means to permit continued circulation of the liquid after stopping of the vehicle, means for stopping circulation of the liquid upon rise of the temperature thereof to a predetermined value, a by-pass around the dehumidifier, a thermostatically controlled valve for establishing liquid circulation through the by-pass upon rise of temperature above a predetermined value, and means for restarting circulation of the liquid upon restarting of the vehicle.

10. Air conditioning apparatus for vehicles having, in combination, a refrigerator having an electric motor, an axle driven generator, electrical connections between the generator and the motor, a cooler cooled by the refrigerator, means for circulating liquid through the cooler, means for conditioning air with the circulated liquid, an electric motor drive for the circulating means, a motor circuit including a source of electrical energy for said electric motor drive independent of said axle driven generator, a thermostatically controlled switch to close the motor circuit upon the circulation of liquid below a predetermined temperature, a thermostatically controlled valve to by-pass the liquid around the air conditioning means, and a switch operated by the generator to close the motor circuit when the generator is running.

11. Air conditioning apparatus for vehicles having, in combination, a refrigerator having an electric motor, an axle driven generator, electrical connections between the generator and the motor, a cooler cooled by the refrigerator, means for circulating liquid through the cooler, means for conditioning air with the circulated liquid, an electric motor drive for the circulating means, a motor circuit including a source of electrical energy for said electric motor drive independent of said axle driven generator, two parallel switches in the motor circuit, means for opening one of said switches when the temperature of the circulated liquid rises to a predetermined value, means for opening the other of said switches upon stopping of the vehicle, and a thermostatically controlled valve to by-pass the liquid around the air conditioning means.

12. Air conditioning apparatus for vehicles having, in combination, a refrigerator having an electric motor, an axle driven generator, electrical connections between the generator and the motor, a cooler cooled by the refrigerator, means for circulating liquid through the cooler, means for conditioning air with the circulated liquid, an electric motor drive for the circulating means, a motor circuit including a source of electrical energy for said electric motor drive independent of said axle driven generator, a relay controlled by the temperature of the circulated liquid and having a switch in the motor circuit, a second relay controlled by the axle driven generator and having a switch in the motor circuit in parallel to said temperature controlled switch, and a thermostatically controlled valve to by-pass the liquid around the air conditioning means.

13. A method of conditioning air which consists in continuously circulating cooled liquid through sprays into the air to be conditioned, and by-passing the liquid around the sprays when the temperature of the liquid rises above a predetermined value.

14. A method of conditioning air for a vehicle having an axle driven refrigerator which consists in continuously circulating liquid, cooling the liquid by the refrigerator, passing the cooled liquid through sprays into the air to be conditioned, stopping the circulation of the liquid upon rise of the temperature thereof to a predetermined value, and by-passing the liquid around the sprays when the vehicle is stationary, and resuming circulation of the liquid through the by-pass upon restarting of the vehicle.

15. Air conditioning apparatus for vehicles having, in combination, an axle driven refrigerator, a cooler cooled by the refrigerator, a liquid circulating system including the cooler and a dehumidifier, means for shutting off circulation of the liquid upon rise of the temperature to a predetermined value, means for restarting circulation of the liquid on resumption of operation of the refrigerator, and means for by-passing the liquid around the dehumidifier on initial resumption of operation of the refrigerator until the liquid is cooled to a predetermined temperature.

16. A method of conditioning air which consists in circulating liquid through air cooling devices, intermittently cooling the liquid and by-passing it around the cooling devices when the cooling of the liquid begins and until the liquid is cooled to a predetermined temperature.

17. A method of conditioning air which consists in circularing liquid through cool-

ing devices, intermittently cooling the liquid, stopping the circulation of the liquid when the cooling thereof is stopped and the liquid rises to a predetermined temperature, restoring the circulation when the cooling is resumed, and by-passing the liquid around the cooling devices until the liquid is cooled to a predetermined temperature.

18. Air conditioning apparatus having, in combination, air cooling devices, means for circulating liquid through said devices including a motor driven pump and a motor switch thermostatically controlled by the temperature of the liquid, a by-pass for the liquid around said devices, a valve thermostatically controlled by the temperature of the liquid for controlling the flow of liquid through said devices and by-pass, and means for cooling the liquid.

19. Air conditioning apparatus having, in combination, air cooling devices, means for circulating liquid therethrough, a by-pass for the liquid around said devices, means thermostatically controlled by the temperature of the liquid for controlling the flow of liquid through said devices and by-pass, and means for intermittently cooling the liquid.

In testimony whereof I have signed my name to this specification.

SAMUEL M. ANDERSON.