

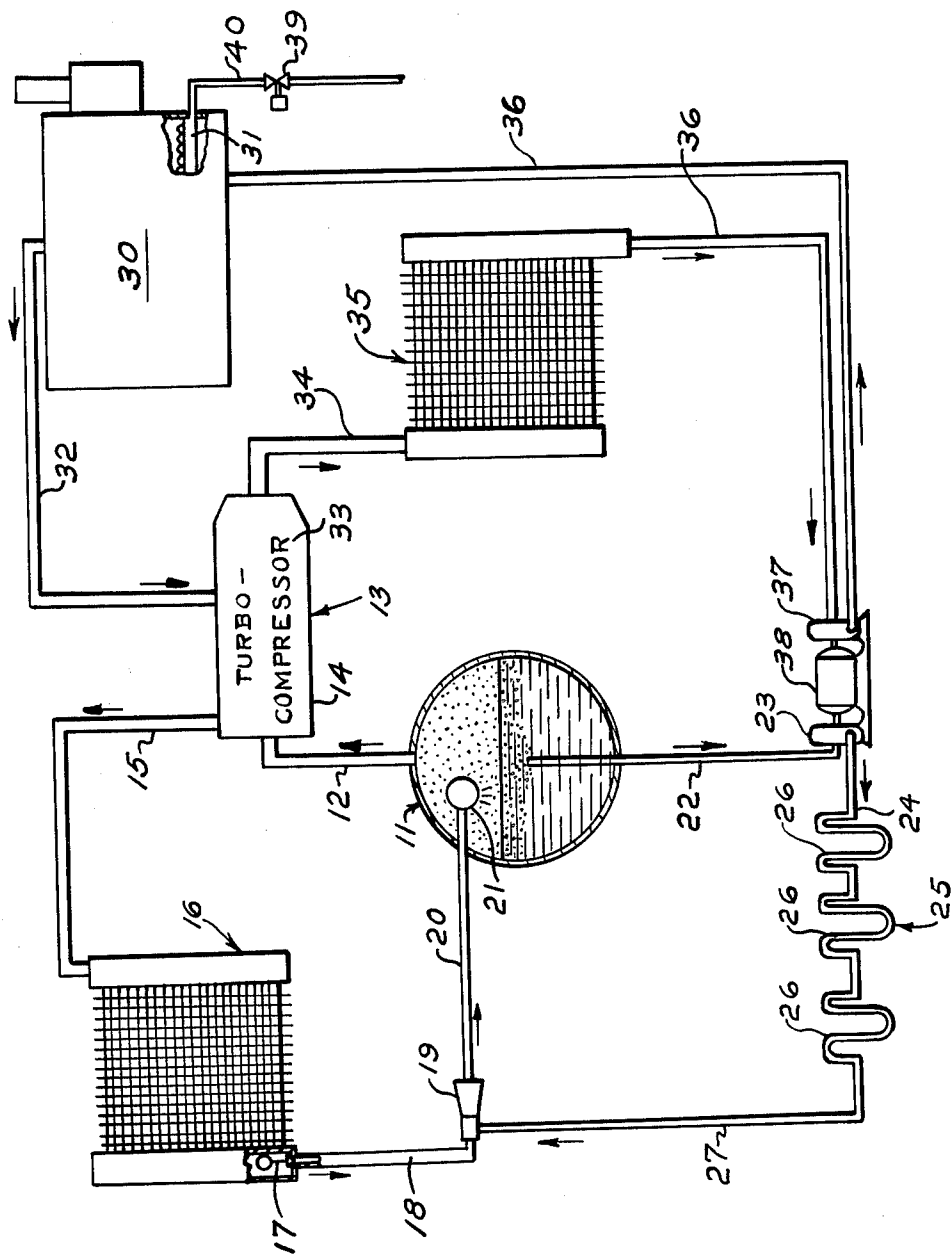
June 28, 1966

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3,257,818

COOLING SYSTEM

Filed July 28, 1964



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3,257,818

COOLING SYSTEM

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Filed July 28, 1964, Ser. No. 385,630

4 Claims. (Cl. 62-98)

This invention relates to a system and method for providing cooling wherein a cooling medium comprising a mixture of water and ice particles is circulated to heat exchangers in areas having a cooling requirement.

It is common practice to circulate a cooling medium such as chilled water from a refrigeration machine to heat exchangers located in areas having a cooling requirement. As the chilled water is circulated through the heat exchangers in heat exchange relation with a medium to be treated its temperature may increase approximately 15° after leaving the refrigeration machine at a temperature of 40° to 45° F.

The present invention contemplates circulating a chilled medium including a mixture of water and discrete ice particles through heat exchangers. As the chilled medium passes through the heat exchangers the ice particles melt so that the heat of fusion of the ice provides cooling and the temperature of the chilled medium may remain substantially constant. Thus, the size of the heat exchangers and related piping for carrying the mixture to the heat exchangers may be smaller than comparable components required for circulating chilled water in keeping with conventional practice.

It is a primary object of this invention to provide a new and improved system and method for providing refrigeration and, more particularly, cooling to an area having a cooling requirement.

Another object is to provide a new and improved system and method for cooling wherein a chilled medium comprising a mixture of water and ice particles is utilized for cooling a load.

A more specific object is provision of a new and improved cooling system including a heat exchanger for cooling a load, and a refrigeration machine for providing a chilled medium comprising a mixture of water and ice particles and circulating the chilled medium through the heat exchanger so that the temperature throughout the heat exchanger remains substantially constant, generally at the freezing temperature of the water, as the ice particles melt to cool the load.

Another more specific object of this invention is the provision in a cooling system including a heat exchanger for cooling a load, of a new and improved method of providing cooling including forming a chilled medium comprising a mixture of water and ice particles to provide a medium temperature at about the freezing temperature of the water, and passing the chilled medium through the heat exchanger to cool the load, so that the temperature of the chilled medium remains substantially constant and about the freezing temperature of water throughout the heat exchanger.

These and other objects of this invention will become more apparent by referring to the following detailed description and accompanying drawing which is a diagrammatic view, partially in cross-section, illustrating a preferred embodiment of a cooling system embodying features of the invention.

As is more fully described in a copending United States patent application of Louis H. Leonard for a "Method and Apparatus for Heating and Cooling," Serial No. 112,679, and filed May 25, 1961, the drawing illustrates a direct contact type evaporator 11 which provides a container from which refrigerant vapor is withdrawn through a suction line 12 by means of a turbocompressor 13 and,

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more particularly, a centrifugal compressor section 14 thereof. The refrigerant vapor is forwarded through a high pressure line 15 to a refrigerant condenser 16 for accumulation of condensed refrigerant vapor. Refrigerant condensate in the condenser 16 passes a float valve 17 and through a refrigerant condensate line 18 into a jet ejector or pump 19 and then through a supply line 20 to spray header 21 in the evaporator 11. Suitable expansion means provide a refrigerant flow restriction in the path of refrigerant returned from the condenser to the evaporator and may comprise the restricted throat portion of the venturi in ejector 19, alone or in combination with the float valve 17, or the return line 18 may be sized to provide the required restriction.

A chilled medium or heat exchange liquid in the lower portion of the evaporator 11 is passed through a chilled medium discharge line 22, as by a chilled medium pump 23, and then through a leaving trunk line 24 to an external heat exchanger means 25, for example one or more heat exchangers 26 in one or more areas, as rooms, having a cooling requirement. Thus the heat exchanger means 25 provides cooling to satisfy a cooling requirement and may be located in the path of air to be conditioned and circulated to the room. From the heat exchanger means 25 the heat exchange liquid passes through a return trunk line 27 to the restricted throat of the ejector 19 and is mixed with the refrigerant returning from the refrigerant condenser 16 and passes through the supply line 20 and the spray header 21 into the evaporator 11 for re-evaporation of the refrigerant and re-cooling of the heat exchange liquid.

A suitable refrigerant for use in the system should be substantially immiscible and completely stable with water. Particularly, the refrigerant should not react with water or decompose to form corrosive compounds which are a major source of corrosion difficulties in many cooling systems. In addition, the vapor pressure of the refrigerant at operating temperatures should be substantially greater than that of water so that it readily vaporizes in preference to water in the direct contact evaporator 11. One particularly suitable refrigerant for the system is refrigerant C318 having the formula C_4F_8 and known as octafluorocyclobutane. This refrigerant has a relatively high molecular weight and only a minimum head need be developed by the compressor to adequately cool the water in the evaporator 11 for a given condensing temperature.

Since the refrigerant passing through the ejector 19 is in intimate association with the water or other heat exchange liquid, the two fluids present a relatively large area of surface contact for effective heat transfer to take place when they are sprayed through the spray header 21 in the evaporator 11. This results in effective cooling and the formation of ice particles in the body of water in the evaporator vessel.

A steam generator 30, for example a boiler, having burner 31 for providing a gas flame, or another suitable heat source, provides steam power fluid through a steam line 32 to a turbine section 33 of the turbocompressor 13. Discharged steam from the turbine 33 passes through a steam discharge line 34 to a steam condenser 35 from which the steam condensate is pumped through a steam condensate line 36 by a steam condensate pump 37 in the line 36 and back to the steam generator 30. The pumps 23 and 37 may be driven by a common motor 38.

Turbocompressor output is controlled by regulating the steam output of the steam generator 30, as by a modulating fuel valve 39 which controls the supply of gas or other fuel passing through a fuel supply line 40 to the generator burner 31, to regulate the supply of steam to the turbine 33 and therefore the cooling capacity of the system. Thus, by adjusting the valve 39, the refrigerant output of the turbocompressor 13 may be adjusted to the cooling

demand required of the heat exchanger means 25 for providing a chilled medium comprising a mixture of water and ice particles. This mixture is circulated by the chilled medium pump 23 through the heat exchanger means 25 and back to the evaporator.

In order to pump the mixture of water and ice particles while avoiding excessive wear and erosion of the pump 23 and connecting piping, as 22, 24 and 27, the size of the ice particles may be regulated. While other sizes and proportions may be suitable depending on particular circumstances, it has been found preferable to provide discrete ice particles up to a size equivalent by weight to a sphere having a diameter of about one hundred microns, and when a centrifugal pump is used, the mixture containing up to about ten (and possibly up to thirteen) percent by weight of ice particles to water. A solution of a salt, such as brine, or a solution of water and glycol, for example, may be utilized in lieu of relatively pure water in the mixture, so that the freezing point of the liquid is below that of the ice particles, to more readily form the ice particles. In order to effectively prevent the ice particles from agglomerating and adhering to parts of the system, the mixture may be maintained in motion throughout the system as by operation of the chilled medium pump 23.

A mixture of water and ice particles may alternatively be formed as described in a United States Letters Patent of Carlyle M. Ashley and Cyrus M. Bosworth, No. 3,070,969, and granted January 1, 1963.

The mixture of water and ice particles may be such that no rise in temperature occurs as the chilled medium passes through the heat exchanger means 25, so that the size of the heat exchangers 26 and the related piping may be reduced over that required for the same cooling capacity using conventional chilled water.

To summarize the operation of the system, water and refrigerant is sprayed in intimate association from the spray header 21 into the evaporator 11. The compressor output may be regulated to provide sufficient refrigerant flow and a reduced pressure within the evaporator 11 to facilitate vaporization of the refrigerant for forming the described discrete ice particles in the body of liquid within the evaporator. The chilled medium pump 23 keeps the mixture moving through the system to retard adherence of the ice particles to each other or to parts of the system, and circulates the mixture through the heat exchanger means 25 so that on melting the latent heat of the ice particles substantially increases the cooling capacity of the system.

While a preferred embodiment of the invention has been described and illustrated, it will be understood that the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a cooling system, the combination comprising, heat exchanger means for cooling a load, and refrigeration means comprising a direct contact evaporator for containing a refrigerant and water, and said refrigeration means further comprising means for spraying said refrigerant and said water in intimate association with each other into said evaporator and vaporizing said refrigerant and providing a chilled mixture of water and ice particles and means for passing said mixture through said heat exchanger means, whereby the temperature throughout said heat exchanger means remains substantially constant

generally at the freezing temperature of water as the ice particles melt to cool the load.

2. In a cooling system, the combination comprising, heat exchanger means for cooling a load, refrigeration means including, a direct contact evaporator in circuit with said heat exchanger means, means for spraying water and a refrigerant in intimate association with each other into said evaporator to form a chilled medium of a mixture of water and ice particles of a size equivalent by volume to a sphere having a maximum diameter of about one hundred microns and a maximum of about ten percent by weight of said ice particles to water, and a pump in circuit between said evaporator and said heat exchanger means for circulating said medium therebetween to cool said load, whereby the temperature of the mixture remains substantially constant at about the freezing temperature of water as the ice particles melt while passing through said heat exchanger means.

3. In a system including heat exchanger means for cooling a load, a method of providing cooling comprising the steps of, forming a chilled medium comprising a mixture of water and ice particles to provide a medium temperature at about the freezing temperature of the water by spraying water and refrigerant in intimate association with each other when sprayed, to form said ice particles, and passing said chilled medium through said heat exchanger means to cool said load, whereby the temperature of the chilled medium remains substantially constant at about said freezing temperature as said ice particles melt while passing through said heat exchanger means.

4. In a system including heat exchanger means for cooling a load, a method of providing cooling comprising the steps of, forming a chilled medium comprising a mixture of water and ice particles of a size equivalent by volume to a sphere having a diameter of about one hundred microns and a maximum of about ten percent by weight of said ice particles to water, to provide a medium temperature at about the freezing temperature of the water, and passing said chilled medium through said heat exchanger means to cool said load, whereby the temperature of the chilled medium remains substantially constant at about said freezing temperature as said ice particles melt while passing through said heat exchanger means.

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