

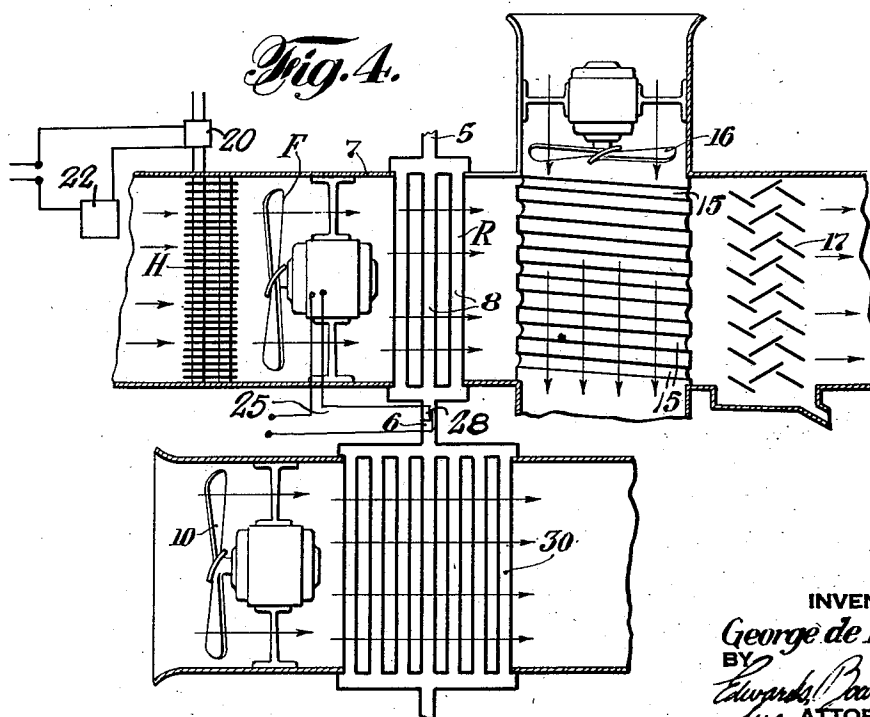
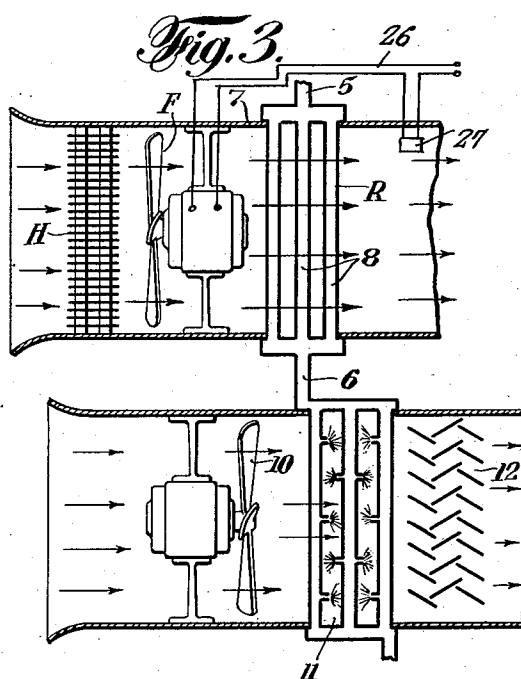
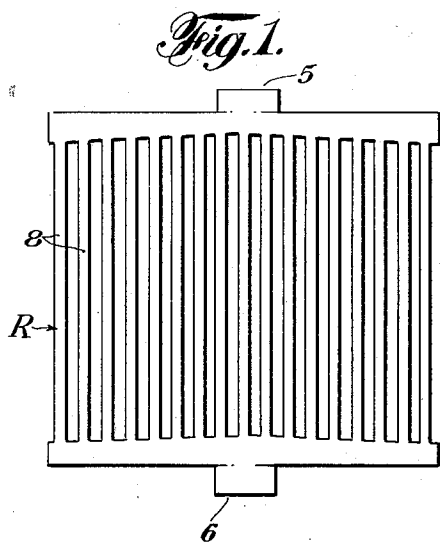
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COOLING SYSTEM

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COOLING SYSTEM

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7 Claims. (Cl. 261—95)

This invention relates to cooling systems and particularly to the cooling of a liquid such as water.

The object of the invention is to provide a supply of liquid cooled by evaporation of a portion of the liquid and without the use of compressors and the like.

A further object of the invention is to provide a compact and efficient cooling means in which there is evaporation at substantially constant pressure from a liquid surface that is very large in comparison with the volume of the liquid to be cooled.

In the accompanying drawing illustrating the invention.

Fig. 1 is an elevational view of a radiator adapted for use in the system of this invention,

Fig. 2 is a horizontal cross sectional view across the tubes of the radiator shown in Fig. 1.

Fig. 3 is a diagrammatic view of one embodiment of the system, and

Fig. 4 is a similar view illustrating a modification.

In the embodiment of the invention shown in the drawing the radiator R has its tubes 8 formed in whole or in part of a porous material such as porous hygroscopic clay or porcelain or the like, permitting a liquid such as water to seep through at sufficient rate to maintain the outer surfaces of the tubes wet with a constant supply of water. Preferably these tube walls are very thin, a few millimeters in thickness, and with the inside surfaces of the side walls spaced only a few millimeters apart. The thickness of the walls may be varied for instance with different materials and in different sizes of radiators for structural reasons, but these walls should be maintained thin for the efficient supply of moisture to the surface and the conduction of heat to the outside of the tube. The spacing of the inner walls and the cross section of the tube bore may also be varied, the closer spacing and smaller bore giving a desirable large surface area in proportion to the volume of the liquid being cooled. As shown in Fig. 2 the tubes may be stream line in cross section or they may be of any other desired form, such as elliptical or circular, the stream line being preferred because of the lessened resistance to the passing of the evaporating cooling air stream.

The water to be cooled enters the radiator R at the inlet 5 and the cooled water passes out by discharge 6. The radiator R is preferably set in a conduit or tunnel 7 as shown, and means is provided such as a fan F to force air through the radiator at desired velocity, the speed of the

fan being controllable for this purpose. A heating means H is provided either in advance of the fan as shown or between the fan and radiator, if preferred, and the supply of energy to the heater H is accurately controllable to regulate the heating of the air stream.

The fan F is preferably of the disk type and the heater H comprises elements heated by any industrial means, such as gas, steam, electricity, etc., these elements being preferably so formed as to provide large spaces offering little resistance to the flow of the air. The amount of heat to be added to the air will depend mainly upon the temperature and moisture content of the air as it enters the system, and in some cases no heating of the air will be desirable. The fan F sucks the air through the heating coil H and blows it on the refrigerating radiator R. This produces an evaporation of the water on the surfaces of the refrigerating radiator and consequently causes a cooling of the water in the radiator tubes. The preheating of the air increases the drying ability (or evaporating ability) of the air and it is particularly desirable when the degree of humidity of the air (relative humidity) is high.

The evaporation of 1 kilogram of water under usual temperature conditions requires about 500 large calories so that evaporation of 10 grams of water requires about 5 large calories. By definition of the calorie—amount of heat corresponding to 1° C. temperature variation of 1 kilogram of water—if 1% of 1 kilogram of water is evaporated, the temperature is reduced about 5° C. If the refrigerating radiator R is such that it has one square meter of radiating surface for every kilogram of water in its tubes 8, the thickness of the water layers in the tubes will be about 2 millimeters. To evaporate in one second 1% of 1 kilogram it will be sufficient to evaporate from the radiating surface a layer of water only 0.01 millimeter in thickness, an extremely thin layer of water. Assuming that the air blowing on the refrigerating radiator is at a temperature of 35° C. (308 absolute temperature) and 90% humidity, and if the air is heated from 35° to 50° and again saturates to 90% humidity when passing through the radiator, it can be shown that the air behind the radiator will then contain about 74 grams of water vapor per cubic meter of air, and since this air contains about 36 grams of water before entering the radiator, it is carrying away about 38 grams of water corresponding to a drop of temperature of the water of about 19° C. The actual cooling of the water will, of course, be less than this theoretical amount.

By thus forming the radiating tubes of a material, such as porous hygroscopic clay or the like, water circulating through said tubes will seep through the surface to be cooled by air passing over said surfaces and the circulating water within the tubes is correspondingly cooled by conduction of heat outward to the evaporating surfaces of the tubes.

Where the air passing through the radiator R is higher in temperature than the water, any tendency of the air to heat the water is dependent mainly upon the difference in temperatures between the two irrespective of the velocity of the air as it passes, but the cooling effect by evaporation depends essentially upon the speed of the air through the radiator, and by properly increasing the velocity of air flow the cooling by evaporation can always be made to greatly exceed any heating effect. For every degree of humidity of the air there will be a best temperature to which the air should be heated and a minimum air velocity through the radiator at which the most efficient cooling will be obtained. It follows that a very energetic efficient cooling of the water can be obtained if water flowing through a cooling passage, such as a radiator tube 8, is allowed to seep through the material of the tube to wet the surface thereof while at the same time a stream of air of proper humidity is blown over the wetted surfaces, the size and length of the tubes and the velocity of the water therethrough being properly related to the speed and temperature of the air through the radiator and the degree of humidity of this air.

This process dispenses with the use of compressors and can be used to replace the cooling tower process, and where only slight cooling of the water is required a preheating of the air can be omitted. The cooled water produced can be used for the air conditioning of homes, buildings, theatres, etc., and in such installations the process would be used in connection with an air washer 11 in which a second fan 10 (Fig. 3) circulates the ventilating air through the air washer 11 and delivers this cooled air through the baffles 12 to the spaces to be cooled. The water cooling and air cooling means may be positioned as shown receiving air at one end and discharging it at the other, and the water from the air washer may be recirculated through the refrigerating radiator R.

Other liquids than water may be cooled by this process, for instance, more easily evaporating liquids, so as to decrease the dimensions of the apparatus and the amount of air to be circulated through the radiator R. With liquids of lower freezing temperatures lower temperatures can be obtained, and the liquid used can always be recondensed from the air and reused in the refrigerating radiator.

The air after it passes through the radiator R may be discharged or utilized in any desired manner, or may have its moisture content recondensed so as to control the humidity before it is passed on to other spaces or discharged into the outside atmosphere. For instance as shown in Fig. 4, this air from the radiator R could be passed through condenser tubes 15 around which cooler air is circulated by a fan 16, the final mist or droplets being separated out by banks of baffles 17. If desired, the air thus discharged from the condenser 15 can be returned again to the system, and thus used over and over again in the refrigerating circuit. Such an arrangement would be

specially desirable when poisonous or otherwise objectionable vapors would be involved.

Similarly the cooled liquid from the radiator R may be discharged directly into a cooling radiator or other container 30, and such a system would be particularly necessary when the liquid involves unpleasant or dangerous vapors.

This cooling process may be subjected to automatic control as when a constant temperature of the liquid coming out of the radiator is desired or constant temperature of air passing through the air washer. The amount of preheating at heater H may be made dependent upon the degree of humidity of the air and the amount of air passing through the radiator, which depends upon the speed of the fan, or the adjustment of louvers, if such are used, may be controlled by the temperature of the liquid coming out of the radiator or the temperature of the air coming out of the air washer in which the refrigerated liquid is used.

For instance, as illustrated diagrammatically in Fig. 4, the supply to heater H may be varied by valve 20 controlled by the conventional hygrometer 22 in the entering air. The speed of the fan may as illustrated in Fig. 3 be regulated as by a rheostat controlled through circuit 26 from the thermostat 27 in the discharged air. Similarly, as indicated in Fig. 4, the fan rheostat may be controlled through circuit 25 from thermostat 28 in the cooled liquid discharged from the radiator.

I claim:

1. A cooling system consisting of a refrigerating radiator with tubes having walls of porous hygroscopic clay or porcelain through which water is circulated and adapted to permit the water to seep to the exposed surface of the tubes, means for producing a current of air through said radiator, and means for preheating the air in advance of the radiator automatically controlled by the degree of humidity of the air, the cooling of the water inside the radiator being obtained by evaporation on the surface of the radiator tubes.

2. A cooling system consisting of a refrigerating radiator with tubes having walls of porous hygroscopic clay or porcelain through which water is circulated and adapted to permit the water to seep to the exposed surface of the tubes, and means for producing a current of air through said radiator automatically controlled by the temperature of the cooled liquid discharged from the radiator.

3. A cooling system consisting of a refrigerating radiator with tubes having walls of porous hygroscopic clay or porcelain through which water is circulated and adapted to permit the water to seep to the exposed surface of the tubes, and means for producing a current of air through said radiator automatically controlled by the temperature of the cooled liquid discharged from the radiator, and means for preheating the air in advance of the radiator controlled in accordance with the degree of humidity of the air.

4. A cooling system comprising a source of air, means for giving the air a predetermined humidity, a radiator connected to said air supply and comprising a number of parallel closely spaced tubes, means for controlling the velocity of the air over the exposed surfaces of said tubes, means for supplying a liquid to the opposite sides of said tubes within the radiator, said tubes being porous so as to provide outlets subjecting a portion of said liquid to the action of said air

stream in said radiator so as to cool the remainder of the liquid therein.

5 5. A cooling system consisting of a refrigerating radiator with a number of closely spaced tubes having walls of porous material through
10 which a liquid is adapted to seep and means for producing an air current over the exposed surfaces of said tubes comprising automatic means for controlling said air current according
15 to the temperature of the air after it has passed said tubes, the cooling of the liquid inside the radiator being obtained by evaporation on the exposed surface of the radiator tubes.

6. The combination with spaces to be ventilated, of an air conditioning system therefor comprising a plurality of separated air supply means leading to said spaces, means employing the first
15 air supply to cool a liquid, means in the sec-

ond supply using said liquid to cool the air supply, and means for simultaneously furnishing air to said spaces through said air supplies in parallel, receiving air at one end and discharging it at the other.

7. The combination with spaces to be ventilated, of an air conditioning system therefor comprising a plurality of separated air supply means leading to said spaces, means employing the first air supply to cool a liquid, means in the
10 second supply using said liquid to cool the air supply, and means for simultaneously furnishing air to said spaces through said air supplies in parallel, receiving air at one end and discharging it at the other, the cooling means of the second
15 supply system acting to spray liquid in the air stream.

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