July 13, 1948. A. E. WILLIAMS 2,445,199

APPARATUS FOR EVAPORATIVE COOLING OF LIQUIDS

Filed Dec. 22, 1943

2 Sheets-Sheet 1

Fig. 1.

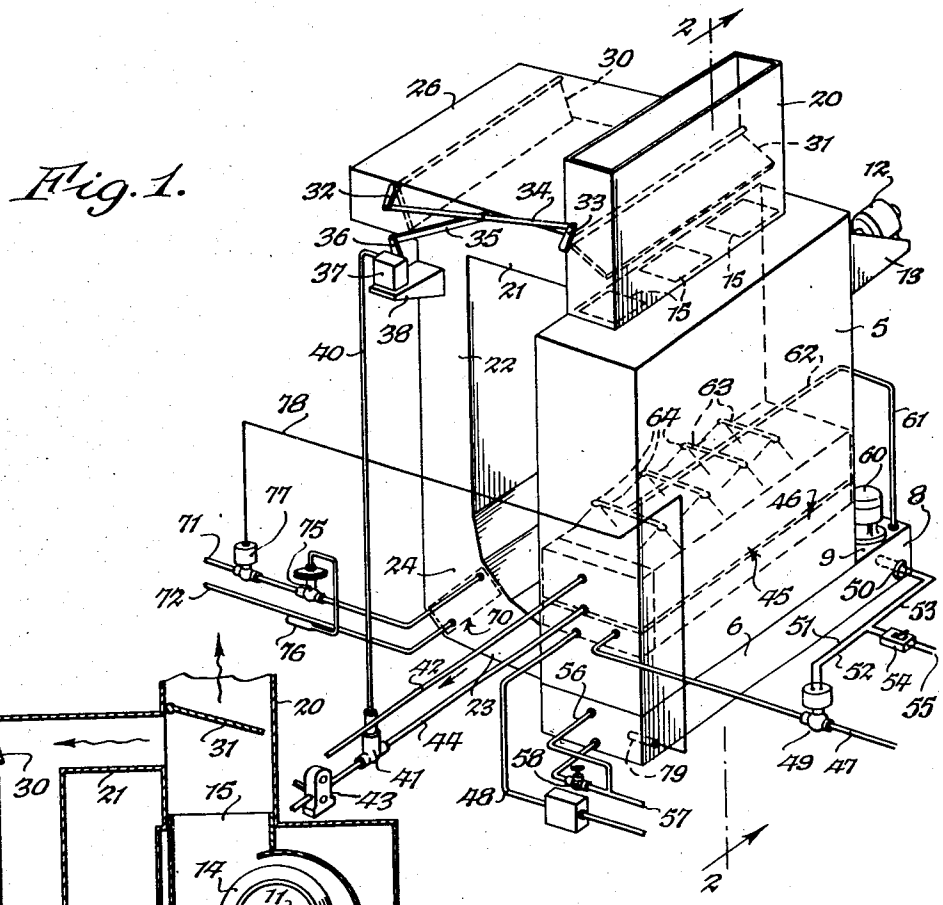


Fig. 2.

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Fig. 3.

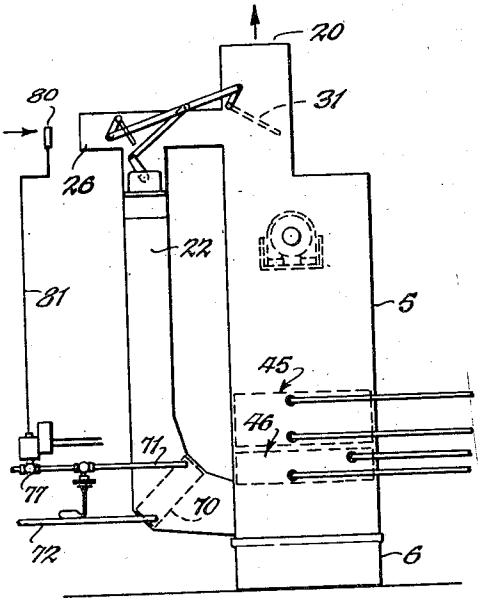


Fig. 4.

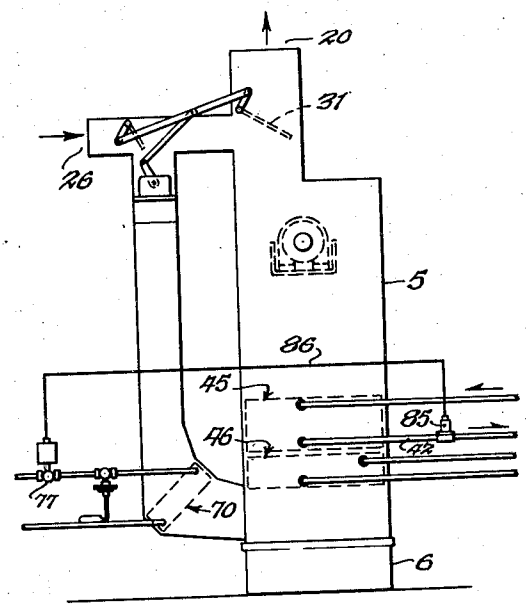


Fig. 5.

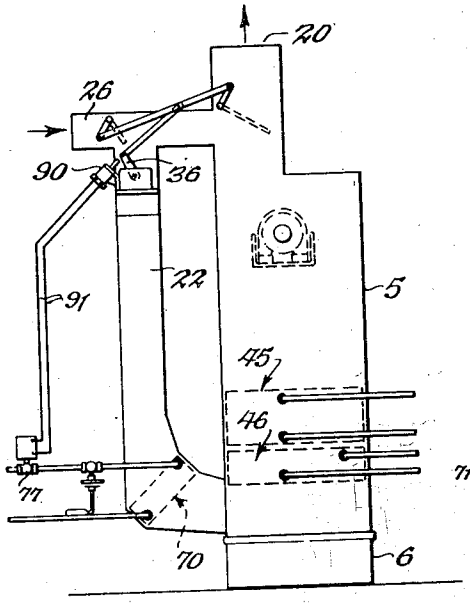
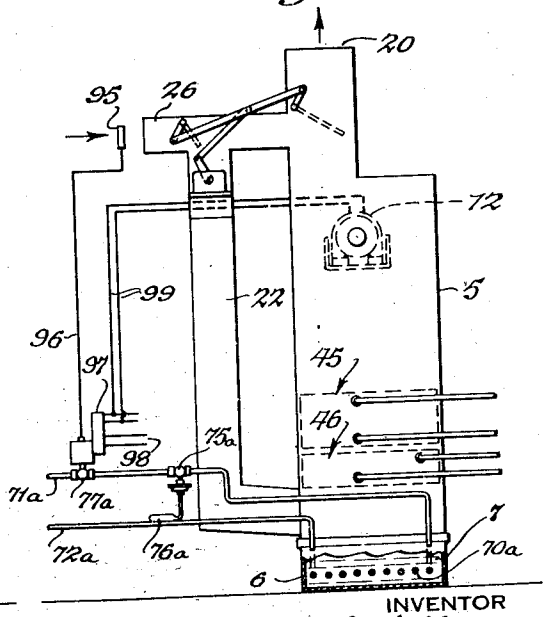


Fig. 6.



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UNITED STATES PATENT OFFICE

2,445,199

APPARATUS FOR EVAPORATIVE COOLING OF LIQUIDS

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Application December 22, 1943, Serial No. 515,320

16 Claims. (Cl. 62—140)

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This invention relates to an apparatus for maintaining the desired temperature of a fluid and more particularly is shown, as an example of its use, as embodied and carried out in a heat exchanger for maintaining the desired temperature of a liquid, such as in cooling water from Diesel or other internal combustion engines or other purposes, cooling oil used in tempering steel, for cooling transformers, or other purposes, or for cooling acids or other chemicals. However, the invention can be used for cooling other fluids, such as compressed air or other gases, and also has a wide range of other uses, as in condensing steam. The invention is therefore not to be construed as limited to any particular fluid or any particular use.

This application is a continuation in part of my copending application Serial No. 453,213, filed August 1, 1942 now Patent No. 2,378,964, granted June 29, 1945 for Method and apparatus for cooling or dehumidifying air.

The apparatus forming the subject of the present invention embodies the improvements described in patents of Martin H. Olstad and myself, Nos. 2,296,946 and 2,321,933, granted September 29, 1942 and June 15, 1943, respectively, in that the cooling effect is obtained from the evaporation of water, thereby to greatly reduce the amount of cooling water necessary for the operation of the apparatus. However, the apparatus shown in the said patents of Martin H. Olstad and myself may suffer from the disadvantage, in certain sections of the country, that the wet bulb temperature of the outside air is too high to permit of the evaporation of the water to the extent necessary to effect the desired cooling. Even in extremely adverse sections of the country this condition of too high an outside wet bulb temperature to permit of the effective use of evaporative cooling obtains for only brief intervals of time.

It is the principal object of the present invention to provide a simple and efficient apparatus adapted to cool a fluid in which the cooling effect is obtained from the evaporation of water, thereby to greatly reduce the amount of cooling water necessary for the operation of the apparatus and in which provision is made to cool the fluid to the desired temperature even when the wet bulb temperature of the outside air is too high to effect evaporative cooling.

Another object is to provide such an apparatus in which the shift to and from evaporative cooling, when adverse outside wet bulb temperatures are encountered, is effected automatically and without attention on the part of the operator.

Another object of the invention is to provide such an apparatus in which the temperature of the fluid being treated can be maintained within very close limits under all conditions of operation.

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Another object of the invention is to provide a simple and effective control to prevent the temperature of the fluid being treated from falling below a predetermined minimum.

Another object of the invention is to provide such an apparatus in which the amount of moisture evaporated to provide the cooling effect is reduced to a minimum.

Another object of the invention is to provide for dewaxing the heat exchange surface, when used for quenching oil or transformer oil or the like, so as to insure the proper heat transfer between the heat exchange surface and the oil at all times.

Another object of the invention is to provide for heating the fluid, when desired, so as to bring it up to the proper temperature.

Another object is to provide a simple and effective means for maintaining any desired minimum temperature of the spray water which is evaporated, thereby to provide a more exact control of the cooling effect of the apparatus.

Another object is to maintain the apparatus under such conditions that no substantial amounts of lard oil or other ingredients are precipitated out on the heat exchange surface as when used for cooling liquids which tend to form precipitates when cooled below a desired temperature.

Other objects are to provide such apparatus which is simple and inexpensive in construction and which will stand up under conditions of severe and constant use without getting out of order or requiring repairs.

In the accompanying drawings:

Fig. 1 is a diagrammatic perspective view of a heat exchanger embodying and adapted to carry out my invention.

Fig. 2 is a fragmentary, vertical, transverse section, taken on line 2—2, Fig. 1.

Figs. 3, 4, 5, and 6 are diagrammatic end views of the apparatus shown in Figs. 1 and 2 and showing modified forms of control arrangements in shifting to and from evaporative cooling when the wet bulb temperature of the outside air passes through a period where it is too high to permit of cooling by evaporation alone.

In common with the apparatus shown in the said patents of Martin H. Olstad and myself, the apparatus shown in the accompanying drawings is particularly designed for maintaining the desired temperature of a liquid, in which it operates at most times to cool the liquid, provision being made, however, for heating the liquid and also to prevent the temperature of the liquid from dropping below a predetermined minimum. While the apparatus is designed to cool a liquid it will be understood that the apparatus is ap-

plicable to the cooling of other fluids such as compressed air, steam or other gases.

The apparatus is shown as comprising a sheet metal casing 5 which is mounted on a tank 6 forming the base of the casing, this tank 6 containing a body of water 7 which is evaporated to provide the cooling effect. The tank 6 is preferably extended beyond one end of the casing 5, as indicated at 8, and this extension is shown as provided with a top 9.

A plurality of fan housings 10 are mounted in the upper part of the casing 5, the inlets of these fan housings being in communication with the interior of the casing 5 so as to exhaust air therefrom. A common shaft 11 extends through the several fan housings 10 and is shown as driven by a motor 12 mounted on a bracket 13 at one end of the casing 5. Within each fan housing the shaft 11 carries a fan 14 of any suitable construction, these fans drawing the air from the interior of the casing 5 and discharging it through the outlets 15 of the several fan housings which project upwardly through the top of the casing 5. These outlets discharge the air into a vertical duct 20, the upper end of which forms an air discharge duct for exhausting the air to the outer atmosphere. A horizontal bypass air duct 21 communicates with one side of the vertical duct 20, this bypass air duct discharging into a vertical duct 22 arranged in rear of the casing 5 and this vertical duct 22 is provided with a lower horizontal leg 23 which is in communication with the lower part of the casing 5 immediately above the tank 6. The bend 24 between the vertical duct 22 and its lower horizontal leg 23 is preferably enlarged to receive a cooling coil unit as hereinafter described. A cold air intake duct 26 also discharges into the vertical duct 22, this cold air intake duct being preferably in horizontal alinement with the bypass air duct 21.

Means are provided for delivering different proportions of fresh outside air from the duct 26 and bypassed or return air from the duct 21 into the duct 22. For this purpose a fresh air damper 30 is arranged in the fresh air duct 26 and a bypass damper 31 is arranged in the vertical air discharge duct 20 in position to close the opening into the bypass air duct 21. This bypass damper 31, when moved away from the opening into the bypass air duct, is also moved to restrict the air discharge duct 20, thereby to reduce the amount of air exhausted to the atmosphere in relation to the amount of air recirculated through the bypass duct 21.

The fresh air damper 30 is provided with an operating lever 32 which projects downwardly and the bypass damper 31 is provided with a lever 33 which projects upwardly. The free ends of these levers 32 and 33 are connected by a bar 34, the central part of which is connected by a link 35 with the arm 36 of a damper motor 37, this damper motor 37 being shown as being mounted on a bracket 38 secured to the exterior of the duct 22. The control line 40 to the damper motor 37 connects with a thermostat 41, the sensitive parts of which are shown as immersed in the liquid or other fluid being cooled which leaves the apparatus through a return line 42, this return line returning the liquid or other fluid being treated into a storage tank, bath or other place where it is to be used. The liquid or other fluid to be treated is supplied, as by a pump 43, through a line 44, the inlet and outlet lines 42, 44 for the liquid to be treated connecting with the headers of a bank of coils 45 arranged within the casing 5 immediately above the opening from the duct 23, these coils being arranged in the path of the air drawn from the duct 23 and upwardly through the casing 5 by the fan wheels 14.

Immediately below the bank of coils 45 a second bank of coils 46 is arranged, this second bank of coils 46 being supplied with steam from a steam line 47, the condensate being withdrawn from these coils through a line 48. The steam or other heating medium supplied to the coils 46 is under control of a valve 49 which is actuated in response to an immersion thermostat 50, the sensitive parts of which are immersed in the body of water 7 contained within the tank 6. The steam valve 49 can also be placed under manual control and for this purpose the immersion thermostat 50 is shown as connected to the steam valve 49 by a wire 51 and the other wires 52 and 53 connected, respectively, with the steam valve 49 and immersion thermostat 50 are shown as connected through a manual switch 54 with the main power lines 55.

The water 7 to the tank 6 can be supplied in any suitable manner and is shown as maintained at a constant level by an overflow connection 56 in the upper part of the tank 6, this overflow 56 leading to a drain line 57 connected with the bottom part of the tank 6. A drain valve 58 is provided in the drain line 57 between the tank 6 and the connection of this drain line 57 with the overflow line 56.

The water 7 in the tank 6 is withdrawn by a centrifugal spray water pump 60 and is discharged through a vertical line 61 into a horizontal pipe 62 extending lengthwise through the interior of the casing above a bank of coils 45. This pipe 62 carries a suitable number of branch pipes 63, each of which carries a downwardly discharging nozzle 64. The nozzles 64 are arranged above the bank of coils 45 which carry the liquid or other fluid to be cooled so that these coils 45 are constantly flushed with water. The excess water from the coils 45 falls back into the tank 6 to be again recirculated by the spray water pump 60.

The apparatus as above described will effectively cool the fluid to be treated and maintain the leaving temperature of this fluid within any desired range or at any desired level in the manner set forth in the said patents of Martin H. Olstad and myself. In some sections of the country, however, the outside wet bulb temperature rises for brief periods during the summer months to a point where there is insufficient evaporation of the spray water 7 to secure the necessary cooling effect. Thus, at these intervals, the outside fresh air is so humid and warm that very little water is evaporated in the spray chamber and hence insufficient evaporation provided to cool the fluid passing through the coil 45.

The present invention is designed to take care of these intervals and to this end a cooling coil 70 is arranged in the enlarged bend 24 between the vertical and horizontal legs 22, 23 of the air duct in such manner that the air flowing down the duct 22 and into the bottom of the casing 5 passes around the exterior of the tubes of the coil 70 in heat exchange relation therewith. A cooling medium is supplied to the coil 70 from an inlet pipe 71 and passes out through a return pipe 72. The cooling medium can be brine or can be an expansible refrigerant. The temperature of the cooling coil 70 is preferably maintained at the minimum required, say 32° F., for the maximum load conditions and to this end a valve 75 is

shown as provided in the inlet pipe 71 and controlled by a thermostat 76 in the return line, the thermostat 76 operating to move the valve 75 toward its closed position when the temperature of the returning refrigerant falls below its setting.

At temperatures above this minimum the refrigerant admitted to the cooling coil 70 is under control of a valve 77 which is operated, through a line 78, by a thermostat 79 which is shown as being immersed in the spray water 7 contained within the tank 6. This thermostat is adjusted so that refrigerant is admitted to the cooling coil only when sufficient cooling cannot be obtained through evaporation of the spray water within the casing 5.

In the operation of the form of the invention shown in Figs. 1 and 2, assuming that the fluid to be treated is operating under heavy cooling load conditions and hence requires a substantial cooling in the heat exchanger forming the subject of the invention, this fluid enters the bank of cooling coils 45 from the supply line 44 and is returned to the tempering bath or other tank through the line 42. The fluid so passing through the bank of coils 45 is arranged in the stream of air which, under heavy cooling load conditions, is drawn by the fan wheels 14 from the cold air intake duct 26 through the vertical duct 22 and horizontal leg 23 into the bottom of the casing 5, this cold outside air being drawn vertically upward through the casing 5 and discharged by the fan wheels 14 into the air discharge duct 20. At the same time the body of water 7 in the tank 6 is being pumped by the spray water pump 60, through pipes 61, 62 and 63 and is sprayed onto the bank of coils 45 by the nozzles 64, the excess spray water collecting in the tank 6. The bank of coils 45 carrying the hot fluid to be treated is thereby sprayed with water, this water evaporating on these coils, the coils 44 tending to assume the wet bulb temperature of the air drawn upwardly through these coils by the fan wheels 14. The fluid passing through the bank of coils 45 is thereby subjected to evaporative cooling and leaves through the return line 42 in a cooled condition.

With a decrease in the cooling load upon the apparatus, the falling temperature of the fluid leaving the apparatus through the return line 42 actuates the thermostat 41 and the damper motor 37 connected to this thermostat through the control line 40 to move the fresh air damper 30 toward its closed position and the bypass damper 31 toward its open position. When this occurs bypass air from the air discharge duct 20 is drawn, together with the fresh air from the cold air intake duct 26, through the vertical duct 22 and its horizontal leg 23 into the bottom of the casing 5. Since this bypass air withdrawn from the air discharge duct 20 has been heated by passing the bank of coils 45 and also is substantially saturated with the moisture evaporated in passing through these flooded coils 45 and the sprays from the nozzles 64, it will be seen that the mixed fresh and bypassed air now supplied to the bottom of the casing 5 has a higher wet bulb temperature and hence the evaporative cooling effect of the water and air passing over the bank of coils 45 is reduced. It will therefore be seen that the immersion thermostat 41 maintains a constant minimum temperature of the fluid by the inverse operation of the bypass damper 31 and fresh air damper 30, a falling temperature of the fluid being treated opening the bypass damper 31 and closing the cold fresh air damper 30. This modulating control of the dampers 30 and 31 allows the intermediate position of these dampers to hold a constant minimum temperature of the fluid being treated by the use of bypassed air and fresh air. The bypassing of the necessary amount of air from the air discharge duct 20 to the bottom of the casing 5 in so maintaining a constant minimum temperature of the fluid being treated also keeps the amount of evaporated moisture to a minimum. The arrangement of the bypass damper 31 in the air discharge duct 20 also serves to reduce the amount of air exhausted through the outlet of the discharge duct 20 with an increase in the amount of bypassed air returning to the bottom of the casing 5.

The primary purpose of the immersion thermostat 50 in the spray water tank 6 is to keep the water temperature above a predetermined minimum. Other means can, of course, be provided for so maintaining the minimum temperature of the spray water as more fully set forth in the said patents of Martin H. Olstad and myself, the maintenance of this minimum temperature by the use of steam being useful with liquids which form precipitates at reduced temperatures and with compressed air or other gases where it is important to prevent the moisture in the compressed air from freezing. In the event that the temperature of the fluid being treated drops below that required in using the fluid for processing, as at the start of operation or in an extended period between processing operations, the immersion thermostat 50 is actuated by the lowering temperature of the water 7 in the tank 6 to open the steam valve 49 and admit steam to the steam coils 46. This thermostat 50 serves to prevent the spray water from dropping below a predetermined minimum. Under these conditions the immersion thermostat 41 has moved the fresh air damper 30 to its fully closed position and the bypass damper 31 to its fully open position and hence the air heated by the steam coils 46 is continuously recirculated by the fan wheels 14 through the air discharge duct 20, bypass duct 21, vertical duct 22, and horizontal leg 23 to the bottom of the casing 5, this air moving upwardly through the bank of coils 45 carrying the fluid being treated so as to heat the same. Since this recirculating air is saturated with moisture, there is no evaporative cooling effect and hence the fluid passing through the bank of coils 45 is heated so as to keep the fluid at the desired minimum temperature under all conditions of operation.

If the cooling coils 45 become waxed up internally due to the precipitation of lard oil or the like, the heat exchanger can be manually adjusted to dewax the same. Thus, to dewax the cooling coil 45, the fresh air damper 30 is held closed, the recirculated air damper is held open and steam, under control of the manual switch 54, is admitted to the steam coil 46. The air being recirculated through the casing 5 is thereby heated so as to melt the wax in the cooling coils 45, this wax being carried away with the liquid.

In the event that the outside wet bulb temperature rises to a point at which insufficient evaporation of the spray water 7 occurs to cool the fluid flowing through the coils 45 to the desired extent, the thermostat 79 actuates the valve 77 to admit refrigerant to the cooling coils 70. At this time the thermostat 41 has, of course, actuated the damper motor 37 to move the fresh air damper 30 to its fully opened position and the damper 31 to its fully closed position in an effort to effect the maximum cooling by evapora-

tion through supplying fresh air exclusively to the casing 5. The opening of the refrigerant valve 77 permits refrigerant to flow from the inlet pipe 71 through the coil 70 and out through the return pipe 72. The fresh air passing down through the duct 22 and through the bend 24 between this duct and the horizontal duct 23 is thereby cooled and since this fresh air has a high wet bulb temperature a part of the moisture is condensed out of the air on passing the cooling coil 70, the air being thereby partly dehumidified and placed in condition to be effective in evaporating the spray water 7. The water so precipitated out of the air flows through the horizontal leg 23 into the tank 6 where it joins the spray water 7 to be used for evaporative cooling after the temporary need for reducing the wet bulb temperature of the air has passed. If an increased demand is made upon the apparatus while the valve 77 is open to permit the refrigerant to flow through the air cooling coil 70, the thermostat 79 opens the valve 77 further so as to admit more refrigerant to the cooling coil 70 and thereby to dehumidify the fresh air admitted to the casing 5 to a greater extent. Conversely, as the need for refrigeration drops off the thermostat 79 moves the valve 77 toward its closed position until it is fully closed, following which the control of the apparatus is taken over by the thermostat 41 which controls the fresh and recirculated air dampers 30, 31 in the manner previously described.

The modified forms of controls illustrated in Figs. 3–6 are adapted for use with apparatus similar to that described with reference to Figs. 1 and 2, but show modified arrangements for cooling either the air or the spray water in the apparatus to effect the controlled use of a refrigerant when the outside wet bulb temperature rises to a point at which insufficient evaporative cooling takes place.

Thus, in the modified form of the invention shown in Fig. 3, the refrigerant valve 77 is under control of a wet bulb thermostat 80 through a control line 81 instead of being responsive to the temperature of the spray water as in the form of the invention shown in Figs. 1 and 2. When the outside wet bulb temperature rises above the desired leaving temperature of the fluid to be cooled, the wet bulb thermostat 80 opens the valve 77 to admit refrigerant to the cooling coil 70 and thereby dehumidify the air admitted to the spray chamber in the same manner as in the form of the invention shown in Figs. 1 and 2.

In the form of control shown in Fig. 4 the refrigerant valve 77 is under control of a thermostat 85 through a line 86 and the thermostat has its sensitive parts immersed in the return line 42 for the fluid to be treated. When the temperature of the returning fluid rises above the setting of the thermostat 85 even with the fresh air damper 30 fully opened and the recirculated damper fully closed by the control described with reference to Figs. 1 and 2, this thermostast 85 opens the valve 77 so as to admit refrigerant to the coil 70 and thereby dehumidify the fresh air before it is admitted to the spray chamber.

In the form of the invention shown in Fig. 5, a switch 90 is shown as arranged in the path of the damper motor arm 36 and is connected by lines 91 with the refrigerant control valve 77. The control apparatus shown in Figs. 1 and 2 actuates the dampers 30 and 31 in the same manner as described and the final closing movement of the recirculated air damper 31 and opening of the fresh air damper 30, in an effort to secure maximum cooling, by evaporation, serves to close the switch 90 and thereby open the valve 77 to admit refrigerant to the cooling coil 70 and thereby effect dehumidification of the air before entering the spray chamber.

In the form of the invention shown in Fig. 6, the cooling coil 70*a* which carries the refrigerant and which corresponds to the cooling coil 70 in the forms of the invention shown in Figs. 1–5, is submerged in the body of water 7 contained within the tank 6. The refrigerant supply pipe 71*a* to this coil contains a valve 77*a* corresponding to the valve 77 and the return line 72*a* from the refrigerant coil 70*a* has associated therewith a thermostat 76*a* controlling a valve 75*a* to maintain a minimum temperature of, say, 32° F. of the refrigerant passing through the coil 70*a* in the same manner as with the valve 75 in the forms of the invention shown in Figs. 1–5. The refrigerant valve 77*a* is shown as being under control of a wet bulb thermostat 95 which has its sensitive parts in the fresh air admitted through the fresh air inlet 26 and connected to the valve 77*a* by a line 96. In addition the valve 77*a* actuates a switch 97 which controls the power supplied from the power lines 98 to the fan motor 12 by lines 99.

With this form of the invention, when the outside wet bulb temperature is too high to permit of effective evaporative cooling, the wet bulb thermostat 95 opens the switch 77*a* so as to admit a refrigerating medium to the submerged coils 70*a*. This cools the spray water 7 which is sprayed over the cooling coils 45 in the same manner as in the form of the invention shown in Figs. 1 and 2, thereby to reduce the temperature of the fluid flowing through the coils 45 to the level which the apparatus is set to maintain. Under this condition of operation there is no reason for drawing air through the apparatus since the cooling effect is supplied exclusively by the refrigerant passing through the submerged coil 70*a*. Therefore, when the refrigerant valve 77*a* opens, it also opens the switch 97, thereby to deenergize the fan motor 12 and cut off the circulation of air through the apparatus.

While the invention has been described particularly in conjunction with the cooling of liquids, it will be understood that it is not limited to any particular use and may be used in conjunction with any fluid to be cooled.

So far as the forms of the invention shown in Figs. 1, 2 and 4 are concerned, it will be seen that the control of the admission of a cooling medium to the cooling coil 70 is essentially responsive to the temperature of the fluid being cooled. As illustrated, this control can either be accomplished directly, as with the thermostat 85, Fig. 4, or indirectly, as with the thermostat 79, Fig. 1. Therefore, those claims which recite a control responsive to the temperature of the fluid to be cooled are not to be construed as specifically limited to an immersion thermostat directly in the fluid being cooled but as including control means which are indirectly responsive to the temperature of the fluid being cooled, as with the thermostat 79 illustrated in Fig. 1. Further, it will be seen that the control can be effected through a dry bulb thermostat, as illustrated in Figs. 1, 2, 4 and 5, or through a wet bulb thermostat, as illustrated in Figs. 3 and 6. The term "thermostat" as used in the accompanying claims is therefore meant to include both types of thermostats unless otherwise indicated.

From the foregoing it will be seen that the present invention provides a simple and efficient method and apparatus for maintaining the desired temperature of a fluid within very close limits; which has a high cooling capacity with a minimum consumption of cooling water; which will prevent the fluid being treated from dropping below the desired minimum temperature, and which can be used to quickly and easily dewax the heat transfer surfaces should they become waxed up due to the deposit of any material from the fluid being handled or should it be desired to bring the fluid up to the desired temperature. Further, at those intervals when the outside wet bulb temperature rises too high for effective evaporative cooling, the apparatus automatically admits a cooling medium to the apparatus so as to either dehumidify the air entering the apparatus or to reduce the temperature of the spray water to the extent necessary to effect the desired cooling of the fluid to be treated.

I claim as my invention:

1. A heat exchange device for cooling a stream of fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means responsive to the temperature of one of said streams to adjust said additional cooling means and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

2. A heat exchange device for maintaining a fluid in a selected temperature range determined by the character of the fluid by cooling a stream of fluid and preventing the temperature thereof from rising above said temperature range, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means responsive to the temperature of one of said streams to adjust said additional cooling means and prevent the temperature of said stream of liquid from rising above said temperature range.

3. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means responsive to the temperature of said stream of fluid to adjust said additional cooling means and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

4. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means directly responsive to the temperature of said water to adjust said additional cooling means and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

5. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means directly responsive to the temperature of said stream of fluid to adjust said additional cooling means and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

6. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distrib-

uting a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, means in addition to said streams of water and air for cooling said stream of fluid, and thermostat means responsive to the wet bulb temperature of the outside air admitted to said chamber to adjust said additional cooling means and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

7. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, and thermostat means responsive to the temperature of one of said streams to adjust the flow of said cooling medium and prevent the temperature of the stream of fluid from rising above a predetermined maximum temperature.

8. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, and thermostat means responsive to the temperature of one of said streams to adjust the flow of said cooling medium and thereby adjust the relative humidity of the stream of air admitted to said chamber to vary the evaporative effect of said stream of air and prevent the temperature of said fluid from rising above a predetermined maximum temperature.

9. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, means for maintaining the entering temperature of said cooling medium in the order of 32° F., and thermostat means responsive to the temperature of one of said streams to adjust the flow of said cooling medium and thereby adjust the relative humidity of the stream of air admitted to said chamber to vary the evaporative effect of said stream of air and prevent the temperature of said fluid from rising above a predetermined maximum temperature.

10. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, and thermostat means directly responsive to the temperature of said water to adjust the flow of said cooling medium to prevent the temperature of the stream of fluid from rising above a predetermined maximum temperature.

11. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, and thermostat means directly responsive to the temperature of said stream of fluid to adjust the flow of said cooling medium to prevent the temperature thereof from rising above a predetermined maximum temperature.

12. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and dis-

tributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil in the path of the stream of air entering said chamber and conducting a cooling medium, and thermostat means responsive to the wet bulb temperature of the outside air to adjust the flow of said cooling medium to prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

13. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil submerged in the collected water and conducting a cooling medium, and thermostat means responsive to the temperature of one of said streams to adjust the flow of said cooling medium and prevent the temperature of the stream of fluid from rising above a predetermined maximum temperature.

14. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil submerged in the collected spent water and conducting a cooling medium, and thermostat means responsive to the wet bulb temperature of said stream of air to adjust the flow of said cooling medium and prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

15. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through

said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a duct for conducting outside air to said inlet, a bypass duct conducting a part of the stream of air leaving said chamber back to said air inlet, means for adjusting the relative amounts of outside and bypassed air admitted to said air inlet to maintain a minimum surface temperature of said cooling coil comprising damper means in the currents of outside and bypassed air passing through said outside air and bypassed air ducts and movable to restrict the flow of one of said currents of air and to relieve the restriction to the flow of the other of said currents of air, a cooling coil in the path of the current of outside air entering said chamber and conducting a cooling medium, and thermostat means responsive to the temperature of one of said streams to close said outside air damper and open said recirculated air damper and to permit the flow of said cooling medium through said last cooling coil thereby to prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

16. A heat exchange device for cooling a fluid, comprising means forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for collecting the spent water after being so discharged and recirculating it through said discharging and distributing means, means for continuously conducting said stream of fluid to be cooled through said cooling coil whereby said stream of fluid is cooled by said evaporation of said water in said stream of air, a cooling coil submerged in the collected water and conducting a cooling medium, and thermostat means responsive to the temperature of one of said streams to deenergize said fan and to permit the flow of said cooling medium through said submerged coil thereby to prevent the temperature of said stream of fluid from rising above a predetermined maximum temperature.

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