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APPARATUS FOR MAINTAINING THE DESIRED TEMPERATURE OF A LIQUID

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Fig. 1.

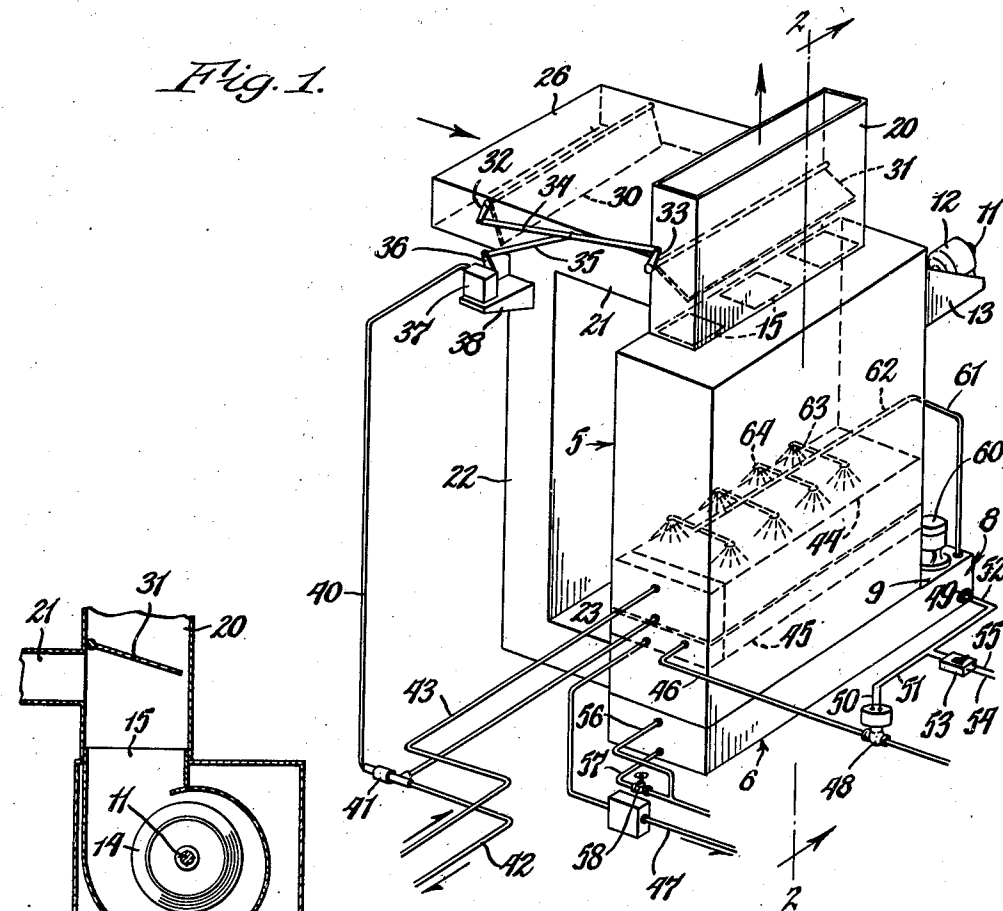
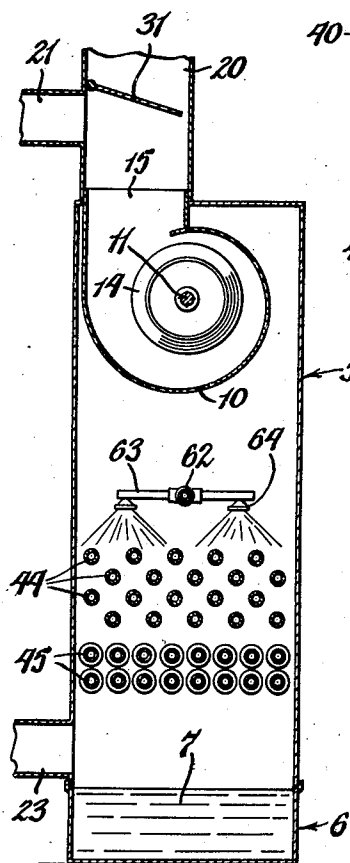


Fig. 2.



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APPARATUS FOR MAINTAINING THE DESIRED TEMPERATURE OF LIQUIDS

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2 Claims. (Cl. 257-2)

This invention relates to apparatus for maintaining the desired temperature of a liquid 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 quenching oil used in tempering steel. However, the invention can be used in conjunction with liquids other than quenching oils and the invention is therefore not to be construed as limited to any particular liquid to be treated.

In the tempering of steel, the steel at temperatures as high as 2000° F. is quenched in a bath of quenching oil which must be maintained near the proper temperature in order that the cooling of the steel, in tempering, be effected at a certain rate. The bath of quenching oil is heated by the batches of steel being tempered and in order to maintain the proper temperature of the quenching oil, the quenching oil must be continuously recirculated through a cooler so as to maintain the desired temperature of the quenching bath while tempering the steel. The quenching oil may include a large percentage of lard oil which may deposit on the heat transfer surface of the cooler in the form of a wax. This wax builds up until the heat transfer between the cooling surface and the quenching oil is greatly reduced and the capacity of the cooler greatly diminished.

With oil cooling systems now in use, no adequate provision is made for dewaxing the cooling surface and also, with systems now in use, while it is possible to cool the quenching oil bath, no provision is made for heating the bath. Therefore, at the start of the operation of tempering steel, or in shifting to higher temperature quenching, it has been the practice for the operator to pass a few batches of hot steel through the bath merely to bring the bath up to the desired quenching temperature. The passing of hot steel merely to bring up the temperature of the quenching bath to that desired involves, of course, waste labor and also the possible loss of a large quantity of steel in the event that it cannot be retempered at the desired temperature.

It is one of the principal objects of the present invention to provide a simple and efficient apparatus adapted to cool a liquid 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.

Another object of the invention is to provide such apparatus in which the cooling effect is obtained from the evaporation of water and in which the temperature of the liquid being treated

is maintained within very close limits, that is, within 10° F. when used to cool quenching oil.

Another object of the invention is to provide such apparatus which is fully automatic in maintaining the desired temperature of the liquid being treated.

Another object of the invention is to provide a simple and effective control for the minimum temperature of the liquid being treated by the adjustment of the character of the air supplied to the apparatus.

Another object of the invention is to provide such apparatus in which such control can be effected entirely automatically in response to the temperature of the liquid being treated.

Another object is to provide such 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 cooling surface, when used for cooling quenching oil, so as to insure the proper heat transfer between the cooling surface and the quenching oil at all times.

Another object of the invention is to provide for heating the quenching oil, when desired, so as to bring it up to the proper temperature for use in tempering steel, and thereby avoid the necessity of passing batches of hot steel through the quenching bath merely to bring it up to proper temperature.

Another object of the invention is to provide a simple and effective means for maintaining any desired minimum temperature of the spray water which is evaporated, thereby to provide to 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 are precipitated out on the cooling surface, when used for cooling quenching oil.

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 drawing:

Fig. 1 is a diagrammatic perspective view of a heat exchanger embodying and carrying out the invention.

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

The heat exchanger shown, by way of example, in the accompanying drawing is particularly designed for maintaining the desired tempera-

ture of the quenching oil used in tempering steel, in which use it operates at most times to cool the quenching oil, provision also being made, however, for heating the quenching oil and also to maintain the desired minimum temperature of the water used for cooling, through the heating means. The apparatus shown includes a sheet metal casing 5 which is mounted upon 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 by-pass air duct 21 communicates with one side of the vertical duct 20, this by-pass air duct discharging into a vertical duct 22 arranged in rear of the casing 5 and this vertical duct 22 being provided with a lower horizontal leg 23 which is in communication with the lower part of the casing 5 immediately above the tank 6. 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 by-pass air duct 21.

Means are provided for delivering different proportions of cold outside air from the duct 26 and by-passed or return air from the duct 21 into the duct 22. For this purpose a fresh air damper 30 is arranged in the cold outside air duct 26 and a by-pass damper 31 is arranged in the vertical air discharge duct 20 in position to close the opening into the by-pass air duct 21. This by-pass damper 31, when moved away from the opening into the by-pass 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 by-pass duct 21.

The fresh air damper 30 is provided with an operating lever 32 which projects downwardly and the by-pass 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 immersed in the quenching oil or other liquid being cooled which leaves the apparatus through a return line 42, this return line discharging the quenching oil bath into the quenching tank (not shown). The quenching oil or other liquid to be treated is supplied through a line 43, the inlet and outlet lines 42, 43 for the quenching oil connecting

with the headers of a bank of coils 44 arranged within the casing 5 immediately above the opening from the duct 23, these coils being thereby 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 44 a second bank of coils 45 is arranged, this second bank of coils 45 being supplied with steam from a steam line 46, the condensate being withdrawn from these coils through a line 47. The steam or other heating medium supplied to the coils 45 is under control of a valve 48 which is actuated in response to an immersion thermostat 49, the sensitive parts of which are immersed in the body of water 7 contained within the tank 6. The steam valve 48 can also be placed under manual control and for this purpose the immersion thermostat 49 is shown as connected to the steam valve 48 by a wire 50, and the other wires 51 and 52 connected, respectively, with the steam valve 48 and immersion thermostat 49 are shown as connected through a manual switch 53 with the main power lines 54 and 55.

The water 7 in 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 pipe 61 into a horizontal pipe 62 extending lengthwise through the interior of the casing above the bank of coils 44. 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 44 which carry the quenching oil or other liquid to be cooled so that these coils 44 are constantly flushed with water. The excess water from the coils 44 falls back into the tank 6 to be again recirculated by the spray water pump 60.

Assuming that the quenching oil is being used for tempering steel and that the heat exchanger forming the subject of the invention is operating under heavy cooling load conditions, this hot quenching oil enters the bank of cooling coils 44 from the supply line 43 and is returned to the tempering bath through the line 42. The quenching oil so passing through the bank of coils 44 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 the pipes 61, 62 and 63 and is sprayed onto the bank of coils 44 by the nozzles 64, the excess spray water collecting in the tank 6. The bank of coils 44 carrying the hot quenching oil is thereby flooded 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 quenching oil passing through the bank of coils 44 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, as occurs between withdrawing a tempered batch of steel and the introduction of a batch of hot steel into the bath of quenching oil to be tempered, the falling temperature of the quenching oil leaving the apparatus through the quenching oil 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 44 and also is substantially saturated with the moisture evaporated in passing through these flooded coils 44 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 44 is reduced. It will therefore be seen that the immersion thermostat 41 maintains a constant minimum temperature of the quenching oil returned to the quenching bath by the inverse operation of the bypass damper 31 and fresh air damper 30, a falling temperature of the quenching oil or other liquid 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 quenching oil by the use of bypassed air and tempered cold 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 quenching oil or other liquid 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 returned to the bottom of the casing 5.

The primary purpose of the immersion thermostat 49 in the spray water tank 6 is to keep the water temperature above a predetermined minimum. With quenching oils, this minimum is in the range of 50 to 55° F., and by keeping the spray water at this minimum temperature, the minimum amount of lard oil will be deposited out in the cooling coils 44. By setting the thermostat 49 to maintain, through the steam coils 45, this minimum temperature of the spray water, the deposit of wax in the coils 44 is reduced to a minimum since it has been ascertained that at temperatures above 55° F. practically no lard oil will deposit out of quenching oils. Other means could, of course, be provided for so maintaining the minimum temperature of the spray water and the maintenance of this minimum temperature could, of course, be made responsive to the leaving temperature of the quenching oil, as through the thermostat 41.

In the event that the temperature of the quenching oil drops below that required for prop-

erly tempering the steel, as at the start of operation or in an extended period between tempering operations, the immersion thermostat 49 is actuated by the lowering temperature of the water 7 in the tank 6 to open the steam valve 48 and admit steam to the steam coils 45. This thermostat 49 serves to maintain a constant minimum temperature of the spray water. 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 opened position and hence the air heated by the steam coils 45 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 44 carrying the quenching oil or other liquid 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 quenching oil passing through the bank of coils 44 is heated so as to keep the bath of quenching oil at the desired minimum temperature under all conditions of operation.

If the cooling coils 44 which carry the quenching oil become waxed up internally due to the deposit of lard oil in the form of a wax therein, the heat exchanger can be manually adjusted to operate in the same way as when the quenching oil is below the set temperature as just described. Thus, to dewax the cooling coil 44, the fresh air damper 30 is held closed, the recirculated air damper is held open and steam, under control of the manual switch 53, is admitted to the steam coil 45. The air being recirculated through the casing 5 is thereby heated so as to melt the wax in the cooling coils 44, this wax being carried away with the quenching oil.

While the invention has been described particularly in conjunction with the cooling of quenching oils, it will be understood that it is not limited to this particular use but may be used in conjunction with any liquid to be treated as indicated in the accompanying claims.

It will be seen, so far as the control of the proportions of fresh and recirculated air admitted to the casing 5 is concerned, that an important feature of the invention resides in this control being responsive to the temperature of the liquid being cooled. It will also be apparent that this control can be accomplished directly, as by the immersion thermostat shown, or indirectly, as by response to a temperature which varies in substantial proportion to the temperature of the liquid being cooled. The claims are therefore not to be construed as specifically limited to the use of the immersion thermostat 41 but as including control means which are indirectly responsive to the temperature of the quenching oil or other liquid being cooled.

From the foregoing it will be seen that the present invention provides a simple and efficient apparatus for maintaining the desired temperature of a liquid, such as quenching oil, within very close limits; which has a high cooling capacity with a minimum consumption of cooling water; and which will prevent the liquid being treated from dropping below the desired minimum temperature. Further, when the cooling surfaces become waxed up due to the deposit of any material, such as lard oil, on the cooling surface, this surface can quickly and easily be dewaxed.

We claim as our invention:

1. A heat exchange device for cooling a stream of liquid, comprising means forming a chamber having an air inlet at one end and an air outlet at its opposite end, 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 water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for continuously conducting the said stream of liquid to be cooled through said cooling coil, a duct for conducting outside air to said air inlet, a bypass duct conducting a part of the stream of air leaving said chamber back to said air inlet and 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 25

and vice versa and a thermostat responsive to the temperature of said stream of liquid and regulating said dampers.

2. A heat exchange device for cooling a stream of liquid, 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 water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, means for continuously conducting the said stream of liquid to be cooled through said cooling coil, means for conducting outside air to said air inlet, bypass means for conducting a part of the stream of air leaving said chamber back to said air inlet and thermostat means responsive to the temperature of said stream of liquid and adjusting the amount of air so conducted back by said bypass means to maintain a minimum surface temperature of said cooling coil.

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