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WATER PRE-COOLED HEAT EXCHANGER SYSTEMS

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FIG. 1.

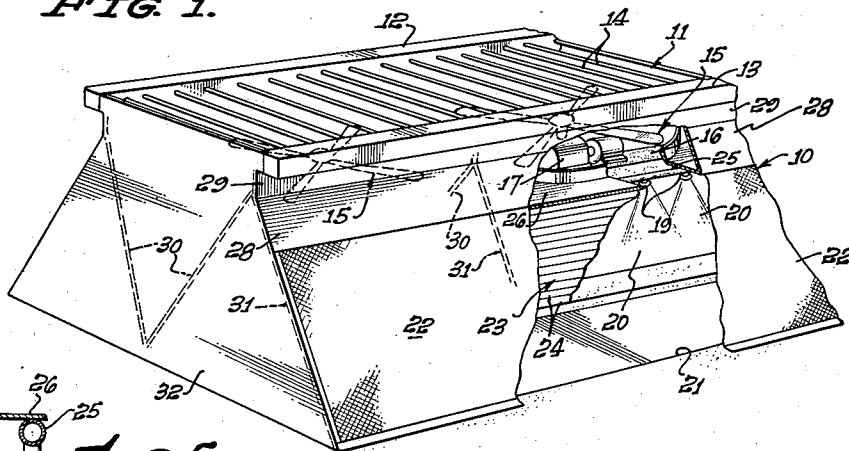


FIG. 5.

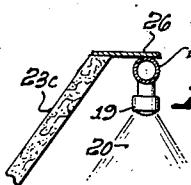


FIG. 2.

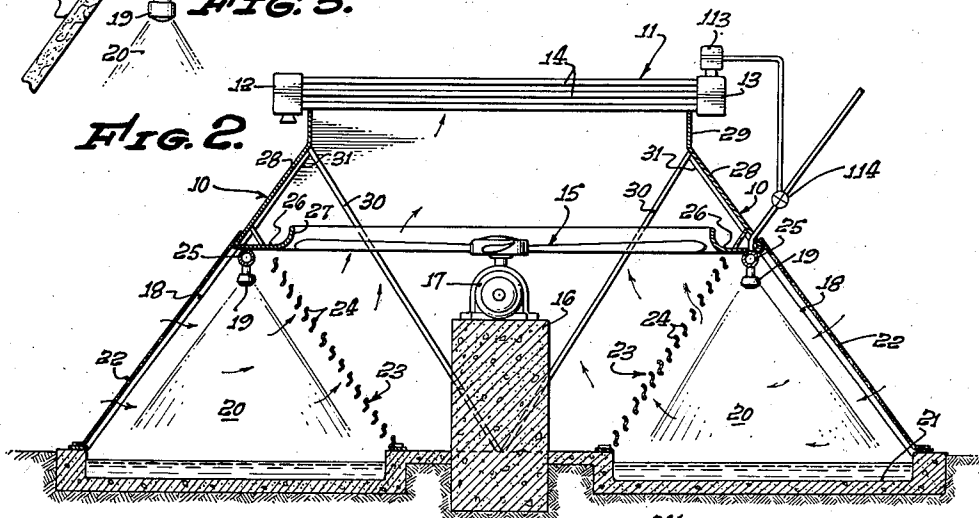


FIG. 4.

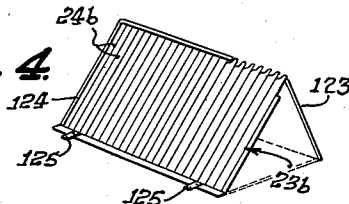
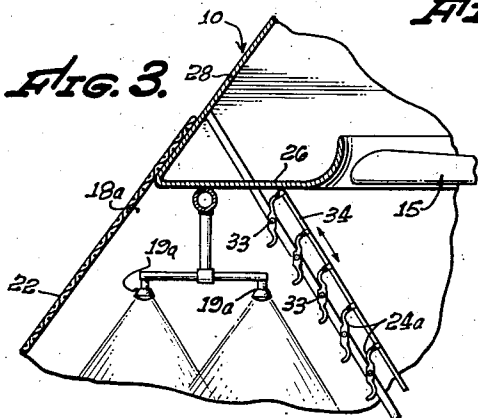


FIG. 3.



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WATER PRE-COOLED HEAT EXCHANGER SYSTEMS

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5 Claims. (Cl. 62—2)

This invention relates to improved heat exchanger units of a type including a fan positioned beneath a heat exchanger coil and operable to produce a draft of cooling air upwardly past the coil.

In exchangers of the above general character, it has heretofore been proposed to contact the cooling air with water as it flows toward the fan, in order to initially reduce the temperature of the air and thus increase its cooling effect. Such contacting of the air with water has been attained by passing the air through a vertical wall of fibrous material, which is kept moist by passage of a stream downwardly therealong. However, the use of such moistened fibrous material has had the disadvantage of introducing an appreciable pressure drop into the air flow system, and also has been subject to clogging by dust and other impurities which may be present in the area. The use of any packed material in a vertical wall has the further disadvantage of not providing maximum area for air passage and of providing poor water distribution because the air stream forces the water toward the inner surface.

The general object of the present invention is to provide an improved heat exchange system of this type, and particularly one in which the air may be contacted by water without introducing an excessive pressure drop. Especially contemplated is an arrangement which is designed throughout for maximum compactness, structural simplicity, and most effective utilization of space, so that the unit may have a minimum overall size. Further, the apparatus is preferably so constructed as to permit very efficient low pressure drop operation with the cooling water turned off, when the air temperature is such that the precooling of the air is unnecessary.

To achieve the above results, we construct the device to include one or more air inlet chambers through which air may flow generally horizontally toward the underside of the air circulating fan, and within which are provided one or more sprayers acting to spray cooling water downwardly within the chambers in contact with the air. Preferably, two such chambers are formed at opposite sides of the fan, to pass cooled air to the fan from two different sides. Of particular importance to the attainment of maximum compactness is the formation of the air inlet chambers of a downwardly enlarging sectional configuration, this being attained by providing the chambers with inner and outer air passing walls which diverge downwardly. The water is then sprayed downwardly in a diverging or enlarging spray stream, so that most complete utilization of the space within the chambers is made possible.

In order to minimize the overall horizontal dimension of the entire heat exchanger unit, the inner wall of each air inlet chamber may extend to a location directly beneath the fan itself. For this purpose, the inner wall may be inclined downwardly and inwardly from a point at the outside of the fan to a point therebeneath. This inner wall preferably comprises a water eliminator struc-

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ture acting to remove entrained water from the air stream before it passes to the fan. The structural form of the outer wall is of less importance than the inner wall, as the former does not affect operation of the unit. A loose mesh screen is preferred for the outer wall in order to prevent persons or debris from entering the spray zone. However, the outer wall might in some instances be completely open between supports, in which case the outer boundary of the chamber would be defined by the spray pattern itself.

The above and other features and objects of the present invention will be better understood from the following detailed description of the typical embodiments illustrated in the accompanying drawing, in which:

Fig. 1 is a fragmentary perspective view, partially broken away of a heat exchanger system constructed in accordance with the present invention;

Fig. 2 is a vertical transverse section through the Fig. 1 heat exchanger unit;

Fig. 3 is an enlarged fragmentary vertical section through a variational form of heat exchanger embodying the invention;

Fig. 4 is a perspective of a further variation of the invention in fragmentary form; and

Fig. 5 is a vertical section of another variation of the invention in fragmentary form.

The cooling unit illustrated in Figs. 1 and 2 comprises a housing 10, across the upper open end of which is positioned a horizontally extending heat exchanger coil or tube bank 11. This tube bank may include a pair of spaced parallel fluid conducting inlet and outlet headers 12 and 13, between which extend a large number of tubes 14 for conducting fluid to be cooled from the inlet header to the outlet header. A number of fans 15 are mounted in the housing 10 beneath tube bank 11 at locations spaced along the center of the housing, and act to blow air upwardly between the tubes of bank 11 to cool the fluid in the tubes. These fans 15 may be mounted on individual pedestals 16 for rotation about individual vertical axes, and are driven by power units 17, typically comprising electric motors and suitable speed reduction gears.

The housing 10 is so constructed as to form along opposite sides of the fans 15 a pair of parallel elongated horizontally extending air inlet chambers 18, through which air is drawn horizontally inwardly toward the underside of fans 15, to be taken by the fans and blown upwardly thereby through the tube bank. These air inlet chambers 18 have the illustrated essentially triangular (preferably isosceles) configuration, and contain a number of spray nozzles 19 at their upper ends for directing downwardly spreading or diverging spray streams 20 downwardly within chambers 18 from their upper ends. A pair of basins or sumps 21 are formed along the bottoms of chambers 18, to collect the water sprayed by nozzles 19, for recirculation back to the nozzles.

The outer sides of chambers 18 are formed by a pair of downwardly and outwardly inclined perforated air passing walls 22, allowing horizontal air flow through these walls directly into chambers 18. Outer perforated walls 22 may typically be formed of screen or air passing louvre assemblies, or in certain instances may be completely open between such supports as may be necessary for supporting strength. The inner sides of air inlet chambers 18 are defined by inner wall structures 23 which are inclined downwardly and inwardly from a location at the outside of fans 15 to positions extending directly beneath the fans. Each of these inner walls preferably is formed of a large number of parallel water eliminator plates 24, which define between the plates a large number of circuitous air paths through which the air flows in

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passing from chambers 18 to the fans. As will be understood, the eliminator plates act to remove entrained moisture from the air stream, to protect the fans and tube bank against corrosion, scaling or other deterioration by the moisture.

There may be several of the spray nozzles 19 spaced along the upper portion of each of the two air inlet chambers 18. These spray nozzles may be designed to produce sprays which occupy the major portion, and desirably substantially all, of the transverse extent of triangular chambers 18. For this purpose, the downward flare of the spray streams desirably corresponds essentially to the downward flare of the triangular chambers themselves. The various spray nozzles 19 may be carried and fed by a pair of parallel elongated water supply headers 25 extending horizontally along the upper ends of chambers 18. These headers 25 may be attached to the underside of horizontal imperforate walls 26, which may carry annular shrouds or fan rings 27 extending about fans 15 to confine the air flow upwardly there-through. If desired, horizontal walls 26 may extend across the entire horizontal area of the housing between and about fans 15, to positively close off all vertical air flow within the housing except past the fans.

Upwardly beyond outer perforated walls 22 of chambers 18, the housing has a pair of opposite imperforate side walls 28, which are inclined in correspondence with, and form in effect upper continuations of the perforated walls 22. The uppermost portions of imperforate walls 28 may extend vertically at 29 to points of connection with headers 12 and 13 of the upper tube bank.

Between adjacent fans 15, the side walls 22, 28 of housing 10 may be supported or braced in their inclined positions by oppositely inclined braces 30. These braces 30 may be directly connected at their upper ends to frame members 31 extending along and attached to the inner sides of outer walls 22, 28 of the housing. The opposite ends of housing 10 may be closed by a pair of imperforate end walls 32.

When the apparatus of Figs. 1 and 2 is in operation, fans 15 act to draw air horizontally inwardly through air inlet chambers 18, and then blow the air upwardly through tube bank 11, to cool the fluid flowing through that bank. If the ambient air is of a sufficiently high temperature to make desirable initial cooling of the air before passage to the fans, the water supply to spray nozzles 19 may be turned on, to direct a finely divided downwardly spreading spray stream through the air, and thus transmit some of the heat from the air to the relatively cooler water, for ultimate extraction therefrom in any suitable manner before recirculation of the water to the nozzles. If the entering air is sufficiently dry, evaporation of water will cool the air while maintaining the water at a low temperature so that no external cooling of the water is required. Before the cooled air then passes to the fans, eliminator assemblies 23 act to remove entrained moisture from the air.

We find it desirable in many instances to automatically control the admission of water to sprayers 19 in accordance with variations in the temperature of the fluid leaving header 13 of coil 14. For this purpose, a thermostat 113 responsive to the discharge temperature of the fluid in coil 14 may act to control a valve 114 connected into the water supply line leading to both of the water spray headers 25. The thermostat and valve are so constructed as to automatically close off the water supply to sprayers 19, and thus cease the spray cooling operation, when the temperature of the fluid leaving coil 14 falls to a predetermined value, and to then reopen the valve upon a predetermined rise in coil fluid temperature.

Fig. 3 illustrates fragmentarily a slightly varied form of the invention, in which parts corresponding to those shown in the first form of the invention are given similar numbers but with the letter *a* added thereto. One difference found in the second form of the invention resides

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in the provision of two spaced series of spray nozzles 19_a along the upper ends of chambers 18_a rather than a single series of spray nozzles. A second variation involves the mounting of eliminator plates 24_a of eliminator unit 23_a for pivotal movement about individual horizontal shafts 33, to permit opening and closing movement of the eliminator plates or louvers 24_a in Venetian blind fashion. The plates may be actuated in any suitable manner, as for instance by a rod 34 pivotally connected to all of the plates 24_a. When plates 24 are in their most nearly closed position, the air paths through the eliminator assembly between the various plates are sufficiently restricted and narrow as to effect removal of the major portion of the entrained moisture from the air stream. The purpose of providing for adjustment of plates 24_a to a more open and less restricted condition is to allow for a substantially unobstructed flow of air through assembly 23_a during those times when sprayers 19 may not be in operation or to provide a means for reducing the flow of air past the tubes when excessive cooling would otherwise occur.

Fig. 4 illustrates fragmentarily a variational form of the invention, which is the same as that of Fig. 1, except as to the manner of formation and mounting of inner wall structures 23 of the air inlet chambers. In Fig. 4, the water eliminator plates 24_b extend generally vertically (at the inclination of the wall structure 23_b) rather than horizontally, so that the water separated by inner wall 23_b may flow downwardly along elongated plates 24_b toward the bottom of the chamber. The plates 24_b may be carried by a surrounding rectangular frame 124, which is attached by hinges 125 to the floor of the device in a manner mounting inner wall 23_b for swinging movement downwardly from its full line inclined active position, to its broken line horizontally extending inactive position. In the inactive position of wall structure 23_b, this wall extends across the bottom of the air inlet chamber, and is positioned out of the path of the inlet air to avoid the introduction of any pressure drop by plates 24_b. In its active position, wall 23_b is supported in any suitable manner, as for instance by a number of inclined braces, one of which is typically represented at 123. To allow downward swinging movement of wall 23_b, the braces 123 are swung or otherwise moved out of their active positions. The outer wall 22 of the apparatus (not seen in Fig. 4) is of course so positioned as not to interfere with the retracting movement of wall 23_b.

Fig. 5 illustrates fragmentarily a further variational form of the invention, in which the inner wall 23_c is inclined and positioned substantially the same as in the other forms of the invention, but is formed of closely packed fibrous material, through which the inlet air may pass, and which acts to remove water from the air by contact of the fibers of wall 23_c with the water.

We claim:

1. A heat exchanger unit comprising a housing having air inlets at two opposite sides thereof and having an open upper end through which air from the housing may discharge upwardly, a fluid conducting heat exchanger coil positioned in the path of air discharging upwardly through said upper opening, a fan positioned in the housing beneath said coil and turning about a vertical axis and operable to blow cooling air upwardly through said coil and through said upper opening to the outside of the housing, the underside of said fan being in communication with said two inlets at opposite sides of the housing to draw air generally horizontally inwardly from the inlets to the fan for delivery upwardly by the fan to said coil, said housing including means forming a pair of air inlet chambers at said opposite sides of the housing and through which the air flows generally horizontally inwardly to the fan, each of said air inlet chambers being of generally triangular vertical cross section and having an outer air passing wall structure which is inclined downwardly and outwardly and an inner air passing wall struc-

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ture diverging away from said outer inclined wall structure and inclined downwardly and inwardly to a location directly beneath said fan, sprayers near the upper ends of said chambers and operable during peak load periods to spray water downwardly through said inlet chambers to precool the air flowing horizontally through said chambers to the fan, said sprayers being constructed to produce downwardly directed sprays which flare to progressively increasing horizontal widths as the sprays advance downwardly and which flare essentially in correspondence with and generally along said diverging inclined inner and outer wall structures and to locations beneath said wall structures, said inner wall structure being an inclined water eliminator acting to remove entrained water from the air passing to the fan when the sprayers are in operation.

2. A heat exchanger unit as recited in claim 1, in which said water eliminators are adjustable to decrease their resistance to air flow therethrough when the sprayers are not in use to thus minimize the air pressure drop through the unit when it is completely air cooled.

3. A heat exchanger unit as recited in claim 1, in which said housing has two essentially imperforate walls extending between said two inlet sides of the housing at opposite ends thereof.

4. A heat exchanger unit as recited in claim 1, including a pair of water supply headers extending along

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the upper ends of said chambers, there being a plurality of said sprayers connected into each of said headers at locations spaced therealong, and water collecting sumps at the bottom of said chambers, said housing including imperforate walls inclined essentially in correspondence with said outer wall structures of the chambers and extending upwardly therefrom toward said coil.

5. A heat exchanger unit as recited in claim 1, including temperature controlled means responsive to the temperature of fluid leaving said coil, and a water flow controlling means responsive to said temperature controlled means and acting to start said sprayers only when the temperature of the fluid leaving said coil rises above a predetermined temperature.

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