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(54) HEAT EXCHANGER

(71) We, NIHON RADIATOR CO. LTD. (NIHON RAJIEETA KABUSHIKI KAISHA) of 15 of 24, Minamidai 5-chome, Nakano-ku, Tokyo, Japan; a Japanese company do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improvements in heat exchangers such as parallel flow type evaporative coolers for air to be used in cars and the like.

It is a general object of this invention to provide such a heat exchanger having simple structure and favourable performance.

It is a still more specific object of the invention to provide such heat exchangers wherein uneven flow of cooling medium in lateral direction as mentioned above is eliminated or minimized as well as to improve longitudinal flow thereof, thus to raise the efficiency of such heat exchangers.

According to the present invention there is provided a heat exchanger comprising a first and a second tank, a plurality of hollow plates communicating between said first and second tanks, fins inserted between adjacent hollow plates, an outlet pipe extending into the substantially innermost regions of said first tank and an inlet pipe attached at its inlet end portion to an inlet portion of said second tank, said outlet pipe being provided with a plurality of bores adjacent said hollow plates communicating between said first and said second tanks.

In a first embodiment a parallel flow evaporative air cooler comprises an upper header or tank portion and a lower header or tank portion, a plurality of flat hollow plates communicating said upper and lower tanks with fins inserted between each of said hollow plates and an outlet pipe and an inlet pipe respectively provided in the upper and lower tanks, at least said outlet pipe extending into the innermost region of said upper tank remote from the entrance point of said outlet pipe into the outlet tank and provided with bores at respective positions above each of said flat pipes, and said outlet and inlet pipes are respectively inserted on the windward side of said upper and lower tanks relating to the intended direction of air flowing therethrough in use.

In a second embodiment of the invention a parallel flow evaporative air cooler comprises an outlet header or tank portion and an inlet header or tank portion arranged side by side before and after along the wind course, a plurality of hollow plates formed into inverted U-shape communicating said outlet and inlet tanks, fins inserted between each of said plates, each of said tanks is respectively communicated with said inlet and outlet pipes, and at least said outlet pipe being inserted into the innermost region of said outlet tank remote from the entrance point of said outlet pipe into the outlet tank and provided with bores at respective positions below each of said plates, and said outlet and inlet pipes are respectively inserted on the windward of said tanks relative to the intended direction of air flowing therethrough in use.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is an elevation partly in section, showing a conventional known parallel flow type evaporator.

Fig. 2 to Fig. 5 show a first embodiment of the present invention, wherein:

Fig. 2 is an approximate longitudinal sectional view, and Fig. 3 to Fig. 5 are sectional views taken along A—A line of Fig. 2, showing some examples of pipe arrangement.

Fig. 6 to Fig. 9 show a second embodiment of the invention, wherein:

Fig. 6 is a perspective view thereof, Fig. 7 to Fig. 9 are sectional views taken along B—B line of Fig. 10.

Fig. 10 is a sectional view taken along C—C line of Fig. 6.

A known evaporative cooler for air for use in cars is of a parallel flow type as is shown in Fig. 1, in which deep recesses are formed at end portions of a metallic plate and interconnected by a shallower recess, a fin is in-

serted between them and joined together facing each other to form a unit having upper and lower tanks 1 and 2 and a flat pipe or hollow plate 3, then a plurality of these unit pipes are arranged in parallel and fins 4 are inserted between hollow plates 3 respectively. Walls of adjacent tanks 1, 1 and 2, 2 are bored for mutual communication to form upper and lower tanks. An inlet pipe 5 is provided for cooling medium and a pipe 6 as an outlet pipe therefor.

Liquid cooling medium supplied from the inlet pipe 5 into the lower tank 2 flows through the flat pipes 3 into the upper tank 1, during which course the cooling medium absorbs heat of air flowing through the space between the plates 3 and the fins 4.

Such an evaporative air cooler functions well when the flow rate of cooling medium fed from the inlet pipe 5 is sufficiently large, but as the flow rate thereof decreases, the quantity of the cooling medium flowing through each flat hollow plate 3 will vary between hollow plates located near the inlet pipe 5 and hollow plates located far from pipe 5, and in extreme case the cooling medium will not flow through the remote pipes, but flows only through pipes adjacent to the inlet pipe to circulate within the cooler with attendant disadvantages.

As shown in Fig. 2, in an evaporative cooler for air according to the first embodiment of the invention, an outlet pipe 6 fitted to an upper tank 1 extends through whole length of the tank 1. The pipe 6 is provided with bores 7, 7 at respective positions above each of flat pipes or hollow plates 3, 3. In use, liquid cooling medium supplied to an inlet pipe 5 and flowing therefrom into a lower tank 2 and hollow plates 3, 3 into the upper tank 1, flows into the outlet pipe 6 through said bores 7, 7. Inlet pipe 5 is connected by its end portion 11 to an inlet portion 12 of said second tank 2.

As to the size of bores 7, 7 to be provided for the outlet pipe 6, it will be more effective when the bores are made larger as they proceed in a direction away from the entrance point of the inlet pipe for obtaining uniform supply of the cooling medium to each of hollow plates 3, 3, or when the bores 7 are made larger at a central portion where airflow blowing through the space between the hollow plates is large, for obtaining increased supply of the cooling medium to the central hollow plates 3, 3. Here, the bores 7 may include slits.

In the above mentioned embodiment, both the inlet pipe 5 and the outlet pipe 6 are respectively inserted at the center of the lower and upper tanks 2 and 1. However, when the pipes 5 and 6 are respectively inserted near the windward side of the tanks 1 and 2 with respect to the direction of flow of air in use as shown in Fig. 3, or when the bore 7 is provided on the windward side of the evaporator relative to the air flow direction as shown in Fig. 4, or when the outlet pipe 6 provided with the bore 7 on the windward side of the evaporator and the inlet pipe 5 positioned near the windward side of the tanks 1 and 2 as shown in Fig. 5, then a large quantity of cooling medium will flow on the windward side, where the temperature of the uncooled air blowing between the hollow plate 3 is the highest and liquid cooling medium may be most easily evaporated.

Since the parallel flow type evaporative air cooler according to the first embodiment of this invention is constructed as mentioned above, even when the flow rate of cooling medium is small, a proper quantity of cooling medium is distributed to each hollow plate, and within one hollow plate, and a large quantity of cooling medium is made to flow through such portions where the medium may be easily evaporated, so that the efficiency of evaporative cooler may be largely improved to be used effectively in practice.

As shown in Fig. 6, in an evaporative cooler for air according to a second embodiment of this invention, flow of cooling medium is deflected by forming the hollow plates 3 into an inverted U-shape. On both ends of the inverted U-shaped hollow plates 3, an inlet tank 8 is formed on the leeward and an outlet tank 9 on the windward relative to blow through air flow *a*. To form such hollow plate 3, tanks 8 and 9, relatively deep recesses 8*a*, 9*a* are formed at lower portion of a rectangular metallic plate 10 (Fig. 7), two of which plates are interconnected via a relatively shallow U-shaped recess 3*a* and joined face to face at peripheral edge 10*a* of the metallic plate and at intermediate portion 10*b* of the recess 3*a* of the U-shape, thus to form a unit having inlet and outlet tank portions 8, 9 and a hollow plate portion 3. To make an evaporative air cooler, a plurality of thus formed unit plates are arranged in parallel and fins 4 are inserted between hollow plates 3 respectively, then walls of adjacent tanks 8, 8, and 9, 9 are bored for mutual communication to form inlet and outlet tanks, within which an inlet pipe and an outlet pipe are respectively communicated to complete an evaporative cooler as shown in Fig. 6.

Herein, as the case of Fig. 2, the outlet pipe 6 is inserted into the innermost region of the outlet tank 9 remote from the entrance passage for pipe 6 and bores 7, 7 are provided at respective positions below the hollow plates 3 of said pipe 6. It is of course that as the case of Fig. 2 to Fig. 5 of the first embodiment, said bores 7, 7 may have different sizes depending upon their positions, or as shown in Fig. 7, the inlet pipe 5 and the outlet pipe 6 may be fitted by locating such adjacent the windward side, or as shown in Fig. 8, the bores 7 may be provided by

directing them toward the windward, or as shown in Fig. 9, the pipes 5, 6 may be located adjacent the windward side as well as the bores 7 may be provided by directing them toward the windward side.

Since the parallel flow type evaporator according to the second embodiment of this invention is constructed as mentioned above, it will take favorable effect such as (1) the pressure-resisting property of the evaporative cooler will be improved, because partitions are formed due to the intermediate portions joined at the central portion of passage for cooling medium by forming the hollow plates into U-shape; (2) the performance of the evaporative cooler will be improved, because temperature distribution on the air outlet side is averaged due to the reciprocation of cooling medium across the air course; and (3) the outlet tank does not project above compared with the straight-flow type of evaporative coolers shown in Fig. 2 to Fig. 5 having upper and lower tanks, because the hollow plates are formed into U-shape and the tanks are brought together at the lower portion, and even though the heat transmission area is made equal to the straight-flow type, the front area of core porton may be made smaller and the height of the evaporative cooler may be made considerably small, resulting in favorable installation of the evaporative cooler.

While preferred embodiments have been described, variations thereto will occur to those skilled in the art within the scope of the present invention concepts which are depicted by the following claims.

WHAT WE CLAIM IS:—

1. A heat exchanger comprising a first and a second tank, a plurality of hollow plates communicating between said first and second tanks, fins inserted between adjacent hollow plates, an outlet pipe extending into the substantially innermost regions of said first tank and an inlet pipe attached at its inlet end portion to an inlet portion of said second tank, said outlet pipe being provided with a plurality of bores adjacent said hollow plates communicating between said first and said second tanks.

2. A heat exchanger as claimed in claim 1, in which said outlet pipe and said inlet pipe are positioned adjacent that side of said first and second tanks which, in use, is to be the upstream or windward side of the exchanger relative to the direction of air flowing therethrough.

3. A heat exchanger as claimed in claim 1, in which said bores provided in said outlet pipe are arranged on the windward side of said outlet pipe.

4. A heat exchanger as claimed in claim 3, wherein said outlet pipe and said inlet pipe are positioned near the windward side of each said first and said second tanks.

5. A heat exchanger as claimed in claim 1, in which said first tank is arranged above said second tank and said plurality of bores are provided at a region on said outlet pipe above each of said hollow plates communicating between said upper and said lower tanks.

6. A heat exchanger as claimed in claim 1, in which said first tank is an outlet tank, said second tank is an inlet tank and each of said tanks is arranged in side-by-side fashion before and after relative to the direction of air flowing through the exchanger, such plurality of said hollow plates being formed into an inverted U-shape communicating between said outlet tank and said inlet tank and a plurality of said bores being disposed in said outlet pipe at positions below each of said hollow plates.

7. A heat exchanger as claimed in claim 6, in which said outlet pipe and said inlet pipe are positioned near the windward side of said outlet tank and said inlet tank respectively.

8. A heat exchanger as claimed in claim 6, in which said plurality of bores on said pipe are disposed on the windward side of said outlet pipe.

9. A heat exchanger as claimed in claim 8, in which said outlet pipe is inserted into the windward side of said outlet tank and said inlet pipe is positioned near the windward side of said inlet tank.

10. A heat exchanger substantially as herein described with reference to and as illustrated in any of Figs. 2 to 10 of the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG. 1

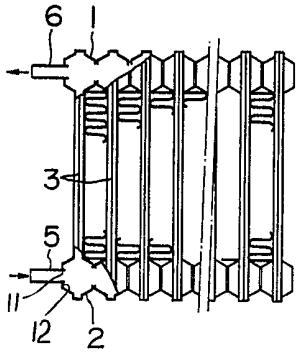

FIG. 2

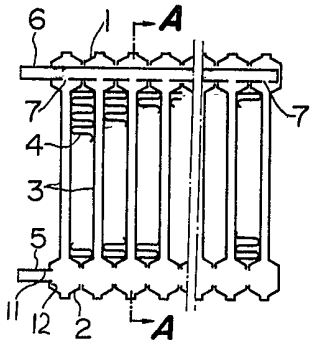

FIG. 3

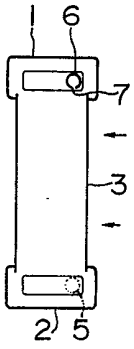

FIG. 4

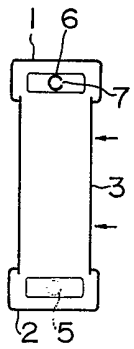

FIG. 5

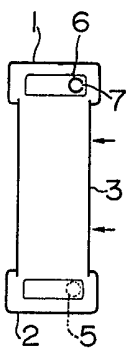

FIG. 6

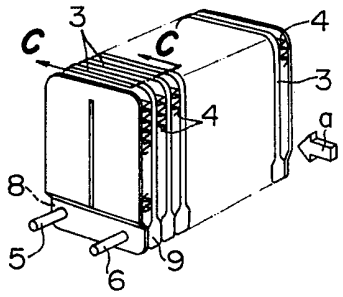

FIG. 7

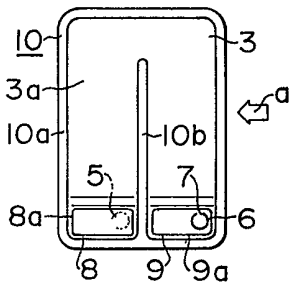

FIG. 8

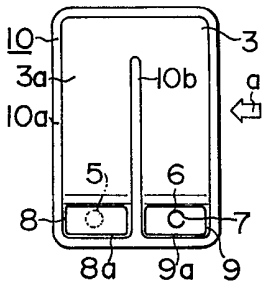

FIG. 9

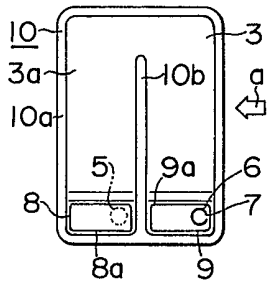

FIG. 10