

SERPENTINE-TYPE HEAT EXCHANGER
HAVING FIN PLATES WITH LOUVERS

The present invention relates to serpentine-type heat exchangers, and in particular, to louvers of fin plates of such heat exchangers.

Heat exchangers of the serpentine-type have been used for, for example, a refrigerant evaporator in an automotive air conditioning system, as shown in, for example, U.S. patents Nos. 4,350,025 and 4,353,224.

The serpentine-type heat exchanger comprises a flat metal tube having a refrigerant passageway or parallel passageways therein extending in a longitudinal direction of the tube. The flat tube is bent to weave up and down, or formed in a serpentine-anfractuous shape, and therefore, has a plurality of parallel portions spaced apart from one another and a plurality of U-shaped curved portions connecting adjacent ones of the parallel portions, respectively. A plurality of corrugated fin units are disposed in spaces between

adjacent ones of the parallel portions of the tube and are joined thereto by brazing. Each of the corrugated fin units is formed by bending a thin plate in a corrugated form so that a number of generally parallel fin plate portions extend with gaps from one another while a number of crests being formed in opposite side surfaces of the unit alternatively. The crests in the opposite sides of the unit are joined by brazing to flat side surfaces of the opposite parallel portions of the tube.

The heat exchanger is usually used together with a suitable air-flow inducing means such as a fan, blower or the like to establish a continuous flow of air from one side to the other of the heat exchanger through the gaps of each fin units disposed in the spaces between adjacent parallel portions of the flat tube.

Since the flat tube and each fin units are cooled by refrigerant flowing in the flat tube, air is cooled by heat exchange during passing through gaps in each fin units.

In order to improve heat exchange rate, each fin plate portion has louvers for disturbing and deflecting air flows passing through fin units, as disclosed in, for example, U.S. patent No. 4,353,224.

In a known arrangement, several groups of louvers are inclined in an opposite direction to the other groups of louvers so that air generally flows along wave-like course in the fin unit. In the arrangement, since the air flow direction is deflected at a number of times, air flow resistance is disadvantageously large. On the other hand, moisture in the air flow condenses on fin plate portion, and the condensed water is carried by the wave-like air flow and is undesirably splashed outside of the heat exchanger from

the air flow output end of the heat exchanger.

It is an object of the present invention to provide a serpentine-type heat exchanger having fin units with louvers wherein air flow resistance is reduced with a high heat exchange rate.

5 It is another object of the present invention to provide a serpentine-type heat exchanger having fin units with louvers wherein water condensed on fin plates is not almost carried by the air flow but easily flows down in the heat exchanger to be drained from the bottom of the heat exchanger.

10 According to the present invention there is provided a heat exchanger of a serpentine-type comprising a flat metal tube which is provided with at least one refrigerant passageway therein and formed in a serpentine-anfractuous shape in a longitudinal direction of said tube to have a plurality of parallel portions spaced apart
15 from one another, and a plurality of metal fin units being fixedly disposed within the spaces between adjacent ones of said parallel portions of said serpentine-anfractuous flat metal tube, each of said fin units having a plurality of fin plate portions which extend generally parallel with one another from one side to the other side
20 of the space between adjacent ones of said parallel portions, said a plurality of fin plate portions having gaps therebetween through which air flows from said one side to said the other side for heat exchange, each of said fin plate portions being provided with louvers for controlling air flow directions in each fin unit,
25 wherein each of said fin plate portions is provided with a first group of louvers in a windward region thereof and a second group

of louvers in a leeward region thereof, said first group of louvers being substantially parallel to said fin plate portions, and said second group of louvers being inclined downward.

One embodiment of the invention is a serpentine-type heat
5 exchanger which comprises a flat metal tube formed in a serpentine-anfractuous shape, and a plurality of fin units joined to the flat metal tube, each fin unit having a plurality of parallel fin plate portions, each fin plate portion having a plurality of louvers for disturbing air flow passing from one side to the other side of the
10 heat exchanger.

Each fin plate portion is provided with a first group of louvers in a windward region thereof and a second group of louvers in a leeward region thereof. The first group of louvers are substantially parallel to the fin plate portion and the second group of louvers
15 are inclined in a same direction.

Since the first group of louvers are parallel to the fin plate portion, it is also parallel to the air flow direction in a gap between adjacent fin plate portions so that air flow resistance is reduced. Furthermore, since second group louvers are inclined
20 downwards, water condensed on the fin plate portion easily drops down to the lower fin plate portion so that the condensed water can be drained at the bottom of the heat exchanger.

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

25 Fig. 1 is a perspective view of a typical heat exchanger of a serpentine type;

Fig. 2 is a sectional view of a fin unit in the heat exchanger for illustrating a known louver arrangement;

Fig. 3 is a sectional view of a fin unit in an embodiment according to the present invention;

5 Fig. 4 is a perspective view of a fin plate portion in Fig. 3;

Fig. 5 is a partial perspective view of a fin plate portion prior to formation of louvers;

Fig. 6 is a sectional view similar to Fig. 3 but illustrating another embodiment of the present invention; and

10 Fig. 7 is a sectional view illustrating still another embodiment.

Prior to a description of embodiments of the present invention, a known heat exchanger is described with reference to Figs. 1 and 2.

15 Referring to Fig. 1, a typical serpentine-type heat exchanger comprises a flat metal tube 1 which has one or more refrigerant passageways therein and is formed in a serpentine-anfractuous shape, as described hereinbefore. A plurality of corrugated fin units 2 are disposed in spaces between adjacent ones of parallel portions of serpentine-anfractuous flat metal tube 1 and joined

thereto.

An inlet header pipe 3 is mounted on an end of flat tube 1 to introduce refrigerant fed through a refrigerant feeder pipe (not shown) to the refrigerant passageways of the flat tube. Flat tube 1 has an outlet header pipe 4 on the other end thereof to lead the refrigerant passing through the flat tube into a refrigerant return pipe (not shown).

The heat exchanger has protective side plates 5 for protecting corrugated fin units 2 at opposite sides of the heat exchanger.

As described above, the heat exchanger is used together with, for example, a blower (not shown) to generate air flow passing the fin units 2 from one side to the other side of the exchanger, as indicated by an arrow A. Since flat tube 1 and fin units 2 are cooled by refrigerant flowing in the flat tube, air is cooled by heat exchange during flowing in the fin units.

In order to improve the heat exchange rate, louvers are provided to each fin plate portion of each fin unit, as described above.

Referring to Fig. 2, fin unit 2 has a plurality of fin plate portions 21 which generally extend in parallel with one another from an air inlet end (right side in the drawing) to an air outlet end (left side in the drawing), as described above. The parallel fin plate portions 21 have gaps between adjacent ones, through which air flows. Each fin plate portion 21 is provided with louvers to disturb the air flow.

In a known louver arrangement, a first group of louvers 6a in a region adjacent the air input end are inclined in a direction to guide air flow upwardly. A second group of louvers 6b subsequent



thereto is inclined in an opposite direction to pilot air flow downwardly. The next group of louvers 6c are inclined in the same direction as the first group louvers 6a, and the final group of louvers 6d are inclined in the same direction as the second group
5 louvers 6b.

Each louver is formed by cutting a portion of the fin plate portion 21 and raising the cut portion, for example, by the use of a louvering die and punch.

In the known arrangement, air generally flows along a
10 wave-like course as indicated by arrows in Fig. 2. In the case, there are some disadvantageous problems as described above.

The present invention attempts to improve louver arrangement so as to resolve those problems.

Referring to Figs. 3 and 4, each fin unit 2 of an embodiment shown therein also has a plurality of parallel fin plate portions
15 21 with gaps therebetween.

Each fin plate portion 21 has two groups of louvers 7a and 7b. One group louvers 7a are provided in a region adjacent the air input end, or a windward region, while the other group louvers 7b
20 are in a leeward region. Louvers 7a are parallel to fin plate 21 and therefore, to air flow introduced through the air input end. Louvers 7b are inclined downwardly.

Referring to Fig. 5, each parallel louver 7a is formed by cutting a pair of slits 22 in fin plate portion 21 and drawing a
25 portion 23 between the paired slits in a direction as indicated by arrow A in Fig. 5. Each inclined louver 7b is formed by cutting a U-shaped slit 24 in fin plate 21 and raising a portion 25 surrounded by the U-shaped slit from the surface of the fin plate in a direction

as indicated by arrow B in Fig. 5. Thus, parallel louvers 7a and inclined louvers 7b are disposed on the bottom side surface of fin plate 21.

Referring to Fig. 3, since louvers 7a are parallel to the air flow in the windward region, air flows along fin plate portions 21 in the fin unit 2 smoothly so that the air flow resistance is small. After passing through the parallel louver region, the air is partially guided downwardly by inclined louvers 7b, as indicated by thin arrows.

In the louver arrangement, any upward air flow is not caused. Therefore, water condensed on fin plate portions 21 and flat tube 1 partially flows downwardly and is partially carried downwardly in fin unit 2. Thus, the water is not almost splashed from the air output end by air flowing out therethrough, but is collected at the bottom of the heat exchanger and can be drained.

In the windward region, since louvers 7a are parallel to the air flow, the air flow is not so disturbed so that heat exchange rate is lowered. However, air flow collides to windward end 8 of each parallel louver 7a and therefore, is disturbed, so that a high heat exchange rate is obtained in comparison with a case in which no louver is provided.

Since a temperature difference between air and refrigerant gas in the windward region is quite large, air is sufficiently cooled in the windward region of the lowered heat exchange rate. The cooled air is further cooled in the leeward region of a higher heat exchange rate. Accordingly, the heat exchange rate of the heat exchanger is not reduced by the use of parallel louvers 7a. That is, all of the refrigerant flowing through flat tube 1 effects to cool air passing

through the heat exchanger not only the windward region but also the leeward region.

Referring to Fig. 6, parallel louvers 7a are formed on opposite sides of each fin plate 21. Inclined louvers 7b are formed to project not only downwardly but also upwardly to guide air flow on the fin plate downwardly.

In the arrangement of Fig. 6, it will be understood that the air flow resistance is reduced in comparison with the prior art without degradation of heat exchange rate of the heat exchanger. Condensed water is not almost splashed outside by outgoing air flow but can be drained from the bottom of the heat exchanger.

Referring to Fig. 7, a modification shown therein is similar to the embodiment of Fig. 6 except that adjacent parallel louvers are spaced from one another in the air flow direction. Functions of louvers 7a and 7b are similar to those of the embodiment of Fig. 6. Further description will not be necessary.



WHAT IS CLAIMED IS:

1. A heat exchanger of a serpentine type comprising a flat metal tube which is provided with at least one refrigerant passageway therein and formed in a serpentine-anfractuous shape in a longitudinal direction of said tube to have a plurality of parallel portions spaced apart from one another, and a plurality of metal fin units being fixedly disposed within the spaces between adjacent ones of said parallel portions of said serpentine-anfractuous flat metal tube, each of said fin units having a plurality of fin plate portions which extend generally parallel with one another from one side to the other side of the space between adjacent ones of said parallel portions, said a plurality of fin plate portions having gaps therebetween through which air flows from said one side to said the other side for heat exchange, each of said fin plate portions being provided with louvers for controlling air flow directions in each fin unit, wherein each of said finplate portions is provided with a first group of louvers in a windward region thereof and a second group of louvers in a leeward region thereof, said first group of louvers being substantially parallel to said fin plate portions, and said second group of louvers being inclined downward.

2. The heat exchanger as claimed in Claim 1, wherein each of said first group louvers is formed by cutting two parallel slits in said fin plate portions and drawing a portion between said parallel slits.

3. The heat exchanger as claimed in Claim 1, wherein each of said second group louvers is formed by cutting a U-shaped slit in said fin plate portion and raising a portion surrounded by said



(Claim 3 continued)

U-shaped slit.

4. The heat exchanger as claimed in Claim 1, wherein said first and second groups of louvers are provided on a single side surface of said fin plate portion.

5. The heat exchanger as claimed in Claim 1, wherein said first group louvers are provided to be disposed on opposite side surfaces alternately, and said second group louvers project from the opposite side surfaces.

6. A heat exchanger constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Figures 3 to 7 of the accompanying drawings.
