United States Patent [19]

Harada et al.

[11] **3,916,989**

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[54] **HEAT EXCHANGER**

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[30] **Foreign Application Priority Data**

Sept. 3, 1973 Japan 48-98277

[52] **U.S. Cl.** **165/151;** 165/181

[51] **Int. Cl.**[2] **F28F 1/16**

[58] **Field of Search** 165/151, 2

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Assistant Examiner—Theophie W. Streule, Jr.
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[57] **ABSTRACT**

A crossed fin-and-tube type heat exchanger comprising a plurality of fins arranged in juxtaposition to each other, each said fin having a suitable surface area, and a plurality of heat conductive tubes passed through and securely fixed to said fins such that the heat exchanging medium in said heat conductive tubes and another heat exchanging medium (air) passing between said fins will perform heat exchange through said heat conductive tubes and said fins. Each of said fins is provided with a plurality of rectangular slits formed by raising up the cut edges such that they are all transverse to the air stream flowing between the fins sinously along the outer peripheries of said heat conductive tubes, the raised-up portion of each said slit forming a ridge having a wall continuous to the upright at both ends of the slit and parallel to the fins.

9 Claims, 16 Drawing Figures

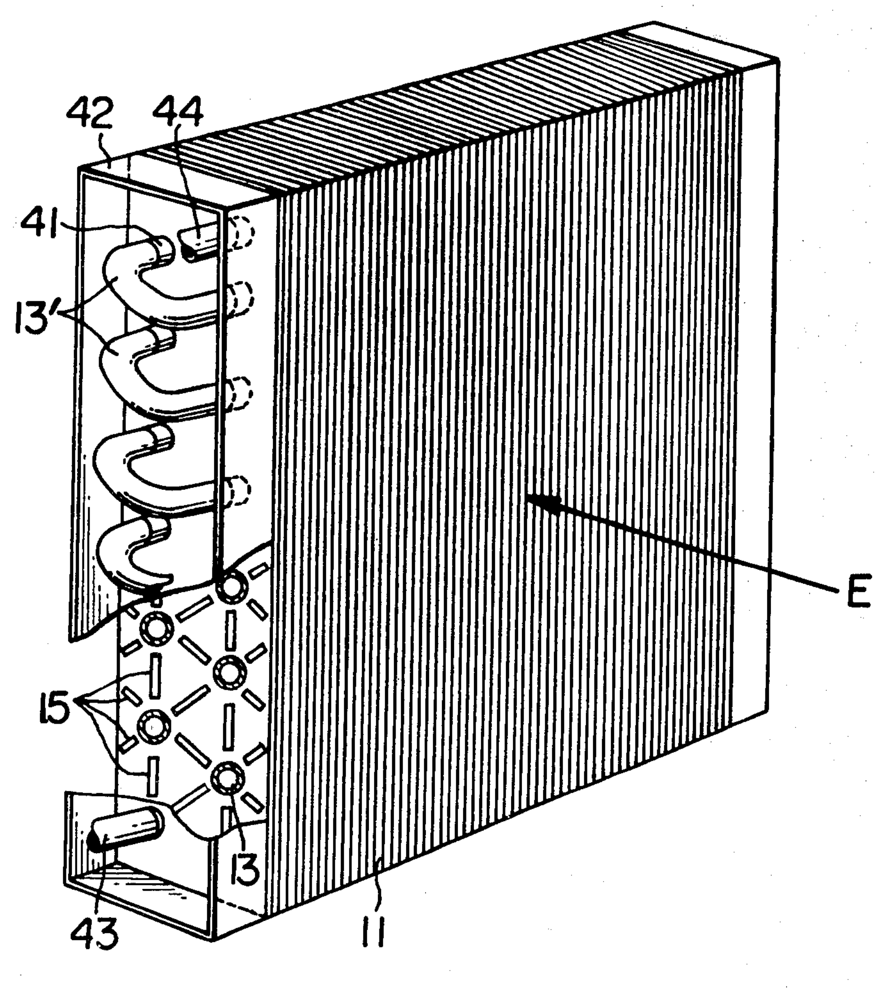


FIG. 1

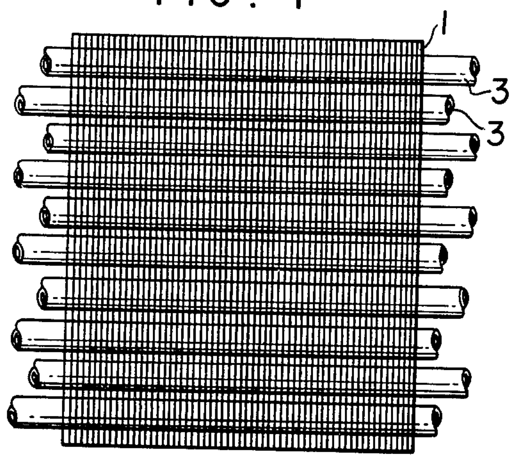


FIG. 2

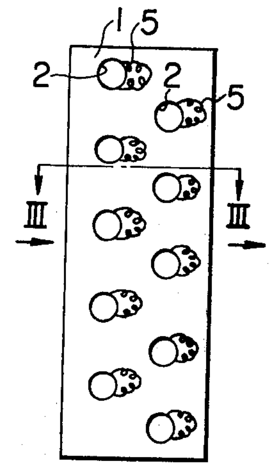


FIG. 3

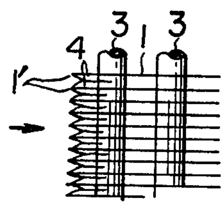


FIG. 4

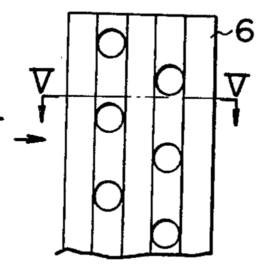


FIG. 5

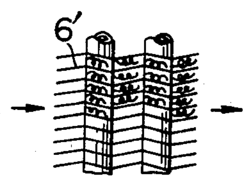


FIG. 6

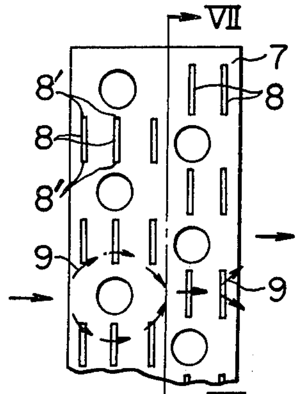


FIG. 7

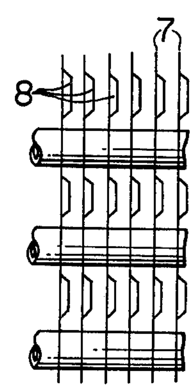


FIG. 8

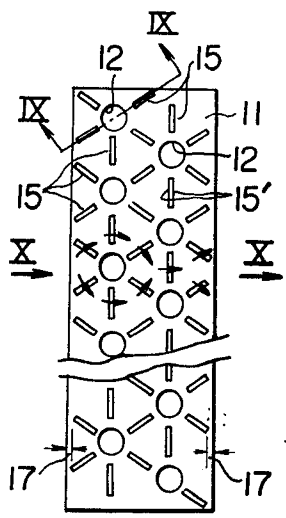


FIG. 9

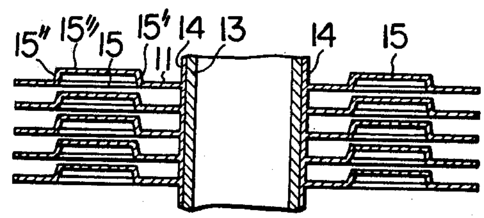


FIG. 10

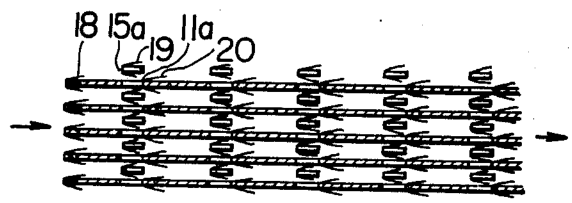


FIG. 11

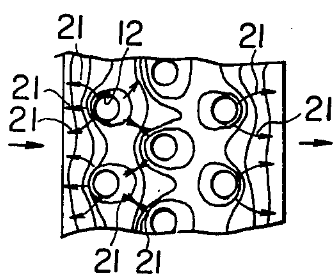


FIG. 12

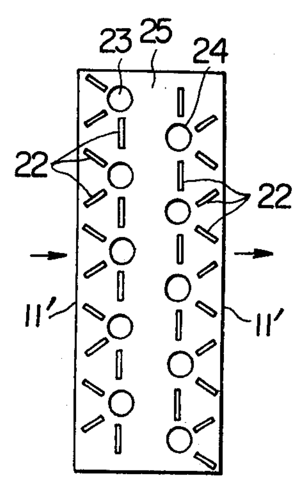


FIG. 13 FIG. 14 FIG. 15

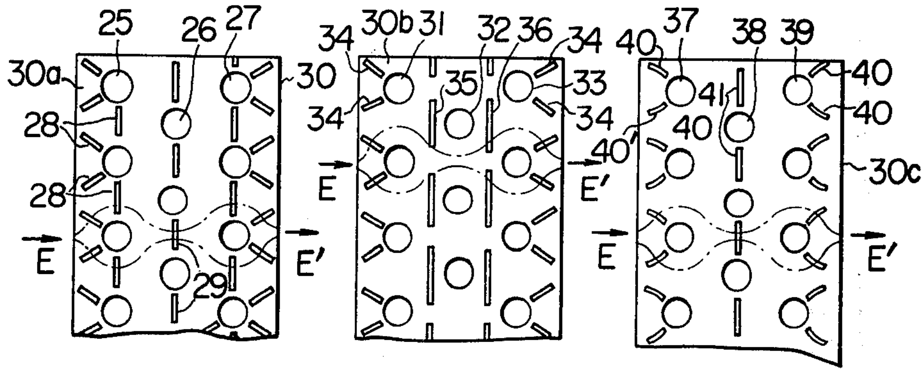
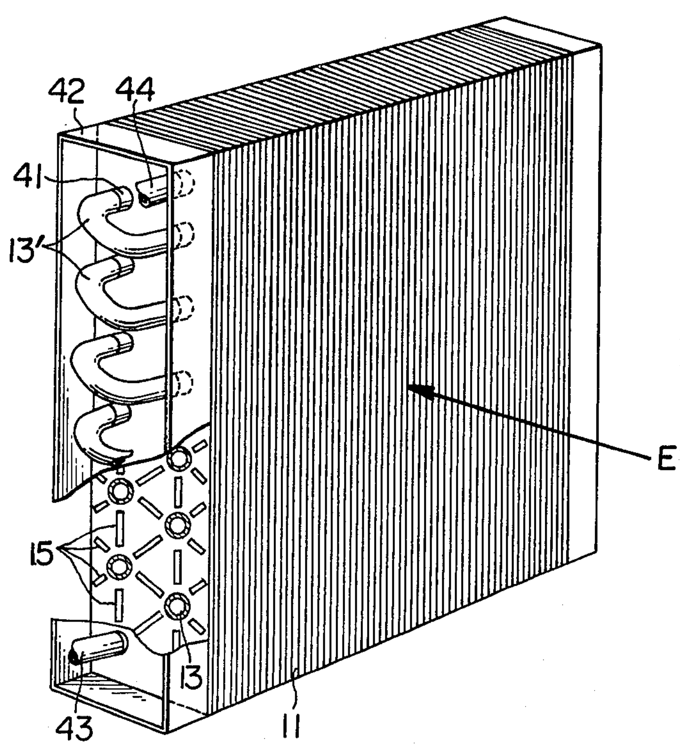


FIG. 16



HEAT EXCHANGER

This invention relates to a crossed fin-and-tube type heat exchanger comprising a plurality of slitted fins arranged in juxtaposition to each other and a plurality of heat conductive tubes passed through said juxtaposed fins in securely fixed relation to each other.

Generally, in the crossed fin-tube type heat exchangers, a plurality of fins made of aluminium material and having a suitable surface area are arranged in juxtaposition at a pitch of several mm, and a plurality of heat conductive tubes such as for example copper tubes are passed through said fins, with the joined portions being securely fixed by expanding the tubes or by using other means: In the heat exchangers of the type used for air conditioners or refrigerators, said heat conductive tubes are connected by U-shaped bent pipes on the outside of the fins so as to form a suitable number of heat conductive tube passages which extend meanderingly. In each of said heat conductive tubes is disposed a nichrome wire or passed a heat exchanging medium such a cold water, hot water or coolant, while another heat exchanging medium, represented by air, is passed between and parallel to the fins on the outside of the tubes so as to effect heat exchange between the heat exchanging medium in said tubes and the another heat exchanging medium such as air flowing outside of said tubes through the media of tube walls and fins. The heat exchanging medium in the tubes may be either higher or lower in temperature than the one passing between the fins, depending on circumstances.

Now, the heat exchanging operation is briefly described by taking an instance where the heat exchanging medium in the tubes is higher in temperature than that passing between the fins. Heat of the heat exchanging medium in the tubes is transferred to the heat conductive tubes and then further transmitted therefrom in a radially diffused form to the plurality of fins which are closely attached to said tubes, so as perform heat exchange between said medium in the tubed and air passing along the fins.

Heat transmittability of such heat exchanger is greatly affected by heat transfer between the fin surfaces and the air passing therealong. The air stream flowing between the flat fins forms a boundary layer of the air stream, and such boundary layer grows thicker as the distance from the fin end increases (that is, said boundary layer is thicker in the downstream side of the fin), while the similar boundary layer which develops on the opposed fin surface joins with the first-said layer at a position slightly downstream of the fin end. Heat transfer in this boundary layer is excessively lower than that in the turbulent area.

Also, the air stream flowing between the fins is disturbed after passing the heat conductive tubes to break the boundary layer, and a stagnation is produced behind each heat conductive tube. In this portion, little heat transfer is effected due to small temperature difference between the fin surfaces and air. The most effective measure for improving the rate of heat transfer between the fins and the air stream flowing between the fins is to prevent formation of said boundary layers. In view of this fact, the present invention is designed to provide an improved crossed fin-tube type heat exchanger wherein generation of such boundary layers is minimized to improve the heat transfer rate.

An object of the present invention is to realize improvement of the heat transfer rate in the heat exchangers of the type discussed by providing in each fin a plurality of rectangular slits arranged transversely to the flow lines of air passing between the fins, said slits being formed of raised-up portions of the fins, providing louvers designed to intercept said air flow lines over a wide range to prevent formation of the boundary layers.

Another object of the invention is to lower resistance of air flow passing between the fins by arranging the upright walls of the louvers parallel to the air flow lines.

Another object of the invention is to provide an arrangement in which said slits are formed along the flow lines of heat which is transferred from the heat conductive tubes to the fins so that said slits will not prevent transfer of heat from said tubes to said fins.

Still another object of the invention is to form the slits by stamping louvers in the fins to facilitate manufacture of the heat exchanger.

FIG. **1** is a front view of a known type of crossed fin-tube heat exchanger;

FIG. **2** is a front view of a flat fin in the heat exchanger of FIG. **1**;

FIG. **3** is a sectional view taken along the line III—III and in the direction of arrows of FIG. **2**;

FIG. **4** is a front view of the conventional corrugate fins;

FIG. **5** is a sectional view taken along the line V—V and in the direction of arrows of FIG. **4**;

FIG. **6** is a partial front view of a conventional slitted fin;

FIG. **7** is a sectional view taken along the line VII—VII and in the direction of arrows of FIG. **6**;

FIG. **8** is a front view of a fin used in a slit-formed crossed fin-tube type heat exchanger according to the embodiment of the present invention;

FIG. **9** is a partial sectional view taken along the line IX—IX and in the direction of arrows of FIG. **8**;

FIG. **19** is a partial sectional view taken along the air flow line X—X of FIG. **8**;

FIG. **11** is a drawing showing the isothermal lines and heat flow lines on the fin surface;

FIG. **12** to **15** are front views showing other embodiments of the present invention; and

FIG. **16** is a perspective view, with parts shown in section, of a crossed fin-tube type heat exchanger provided with the fins shown in FIG. **8**.

Before describing the embodiments of the present invention, we briefly describe some typical known type of crossed fin-tube heat exchanger.

Referring to FIGS. **1** and **2**, there is shown an essential arragement of one of such known types of crossed fin-tube heat exchanger. In the figures, reference numeral **1** indicates a plurality of fins made from aluminium plates or the like, each said fin having a suitable surface area and formed with a plurality of holes **2** for inserting the heat conductive tubes. These fins **1** are arranged in juxtaposition to each other at a pitch of several mm (usually 2 to 5 mm), and a plurality of heat conductive tubes **3** are passed through said holes in the respective fins. Said tubes **3** and fins **1** are secured to each other by expanding the tubes or by using other means. In each of said heat conductive tubes **3** is disposed nichrome wire or passed a heat exchanging medium such a cold water, hot water or coolant (freon coolant), while another heat exchanging medium represented by air is passed between and parallel to the fins 1 on the outside of the heat conductive tubes so that the heat exchanging medium in said tubes 3 and another heat exchanging medium such as air will perform heat exchange through the tube walls and fins.

In this heat exchanger, air flows in the direction vertical to the surface of the drawing sheet in FIG. 1 (in the direction of arrows in FIG. 2). Heat of the heat exchanging medium in the heat conductive tubes 3 is first transferred to said tubes and then further transferred to the fins 1 which are closely attached to said tubes. This heat transfer is effected substantially radially from the peripheries of the tubes to the entirety of the fins, thus performing heat transmission through the fin and tube surfaces and the air passing thereover. In this case, the air flow passing between the fins 1 forms boundary layers 4 as shown in FIG. 3. Heat transmission in such boundary layers is very bad. Each said boundary layer 4 grows thicker as the distance from the fin ends 1′ toward the downstream side increases as shown in the figure, and another boundary layer which developed on the opposed fin surface is joined with the ajoining boundary layer at a position slightly downstream of the fin ends 1′, so that heat transmissability in the area downstream of said position is excessively lowered.

Each air flow passing between the fins is disturbed after passing the assembly of the heat conductive tubes 3 to break up the boundary layers, but since a stagnation 5 of air flow is produced behind each tube as shown in FIG. 2, the heat transfer rate in this section is lowered due to the small temperature difference between the fin surfaces and air. As described above, in the crossed fin-tube heat exchangers using flat fins, the heat transfer rate is low owing to the boundary layers of laminar air flows produced on the fin surfaces. Therefore, prevention is required of the formation of such boundary layers for improving the heat transfer rate on the air side.

There are known the corrugated fin devices for preventing generation of said boundary layers. In FIGS. 4 and 5 is shown a part of a crossed fin-tube heat exchanger using such corrugated (or angular) fins 6. According to this system, when air flows in the direction of arrows, the air flow which has passed the crest 6′ of undulation tends to separate from the fin surfaces giving rise to swirls as noted from FIG. 5, and these swirls prevent formation of the boundary layers improving the heat transfer rate. However, since the air passages between the fins bend in undulation, the passing air flow suffers greater loss of collision, resulting in excessively enlarged air flow resistance. It is therefore required to use an air blower of large cpacity, and also noise is increased. There is also proposed provision of slits with raised-up portions 8 in each fin 7 as shown in FIGS. 6 and 7, such slits being designed to prevent formation and development of the boundary layers of air flow to thereby improve the heat transfer rate. According to this construction, however, since the raised-up walls 8′ of such portions 8 are not parallel to the flow lines 9 of air between the fins as shown by arrows, air flow resistance is increased. Also, since the flow lines of heat transferred from the heat conductive tubes to the fins 7 are intercepted by the slitted portions 8 as shown in FIG. 6, heat transfer must be accomplished by detouring the slits, resulting is reduced heat transmissability of the fins.

In view of the above, the present invention is intended to provide a high-performance crossed fin-and-tube type heat exchanger with slitted fins, which has been realized by making improvements over various defects of the conventional devices such as above-mentioned. According to the improved heat exchanging system of the present invention, a plurality of slits are formed in each fin such that said slits will be always transverse to the direction of air flow, thereby to cut off or intercept the air flow lines over a wide range of check generation and development of the boundary layers. Also, the raised-up walls of the portions forming the slits are formed parallel to the air flow line so as to minimize air flow resistance and not to hinder heat transmission by intercepting the flow lines of heat transmitted from the heat conductive tubes to the respective fins.

Now, the present invention is described in detail by way of some preferred embodiments thereof with reference to the accompanying drawings.

FIG. 8 is a front view of a fin used in a crossed fin-tube heat exchanger according to one embodiment of the present invention, and FIG. 9 is an enlarged sectional view as taken along the line IX—IX and in the direction of arrows of FIG. 8. It will be seen that there are provided in each fin 11 a plurality of holes 12 for inserting the heat conductive tubes 13, each said hole 12 having formed at its edge a wall raised up in one direction for increased securement with the tubes 13 and for regulating the fin pitch. Formed substantially radially around each said hole 12 are the rectangular slits 15. At both sides in the longitudinal direction of each said slit 15 are raised up portions of the fin to form upright walls 15″ as well as a ridge having a wall 15‴ continuous to said upright walls 15″ and parallel to the fin 11 as shown in FIG. 9, thereby forming louvers in the fin 11. Said fins 11 are provided in plurality in juxtaposed relation to each other, and heat conductive tubes 13 are inserted in the holes 12 in each said fin. Said tubes 13 and fins 11 are secured to each other by enlarging the tubes 13 after the latter have been fitted in the respective holes 12. The width of each said slit 15 is several mm (for instance 2.5 mm) and the length thereof is for instance 10 plus mm. It is desirable that the starting point of each said upright walls 15″ is as close to the hole edge as possible. These slits extend toward the outer periphery of each hole 12, but those which are opposed at the ends to the outer edge of the fin should be of a length that provides a suitable space 17 between said ends and the outer edge of the fin, while those which are directed toward the adjoining hole have formed at their ends the upright walls 15″ similar to the above-siad, the height of such upright walls being preferably about one-half of the distance between the adjoining fins.

In the crossed fin-tube heat exchanger of the present invention having the above-described arrangement, air passes between the fins so as to flow in the manner shown by arrows X—X in FIG. 8. That is, air flows sinuously along the periphery of each heat conductive tube 13. Therefore, the slits 15 are provided substantially radially as said before such that these slits extend transverse to the direction of air flow shown by arrows X—X as this arrangement permits each individual slit 15 to pass the air flow lines over a wide range. In other words, it is possible to have the slits always positioned transverse to the air flow lines X—X if they are arranged radially. FIG. 10 shows a section of a fin assembly as it was cut along the air flow line X—X and developed. As shown in FIGS. 8 and 10, the same air stream passes plural times through the slits provided in plural number around each heat conductive tube 13, and any laminar flow boundary layer produced by the air flow passing between the fins is cut or intercepted as many times as the number of slits through which the air flow passes, so that no boundary layer of air flow is permitted to develop. Thus, the fin ends (including the front ends **15***a* of the ridged and front edges **11***a* of the slits formed by cutting the ridges) are formed twice as many in number as the slits to provide many (twice as many) high-heat-transfer-rate areas which almost no boundary layer is present, thereby greatly improving the heat transfer rate as a whole. Further, the boundary layers **18, 19 20** produced downstream of the ridge front ends **15***a* and the slit front edges **11***a* are left in an underdeveloped state, and also coincidence of the boundary layers on the opposed upper and lower fin surfaces as observed in the conventional devices such as shown in FIG. **3** is obstructed to markedly improve the heat transfer rate in these sections.

Further, as described above, since any of the louvered slits **15** (slits with raised-up portions) is provided to always be transverse to the air flow, the upright walls **15''** of the louvers (such walls being usually formed at right angles relative to the longitudinal direction of the slits) stand parallel to the air flow X—X, so that air flow is minimally hindered to minimize air resistance. Such air resistance is even more lessened if said upright walls **15''** are positioned within the laminar flow boundary layers created on the surfaces of the upright walls **14** at the hole edges. Such arrangement of the slits **15** also proves extremely advantageous in respect of heat transfer from the heat conductive tubes **13** to the fins. In case of forming slits in the fins, it is desirable to make arrangement such that the slits will not intercept that heat flow lines but run radially toward the holes of the heat conductive tubes, as desclosed in Patent Pub. No. 4087/1956. In the present invention, all of the slits **15** extend substantially radially relative to each heat conductive tube such that the slits will be substantially transverse to the air flow lines, so that none of the slits **15** intercept the heat flow lines and hence heat transmission is not hindered. FIG. **11** shows an example of temperature distribution on the fin surface. In the figure, numeral **12** indicates the holes into which the heat conductive tubes are to be inserted, and the solid-line curves and the lines surrounding the holes **12** are the isothermal lines. According to this arrangement, heat of the heat conductive tubes **13** is first transmitted to the rise-up walls **14** at the hole edges secured to said tubes and then is further transferred along the broken lines (heat flow lines) **21** which cross the isothermal lines at right angles. Thus, if the slits are provided so as not to obstruct the heat transfer, they will not intercept the heat flow lines, that is, they are formed substantially radially around each heat conductive tube. FIGS. **12** to **15** show other embodiments of the present invention where particular consideration is paid to the effective arrangement of the slits to reduce the number of slits for facilitating manufacture. In these embodiments, although heat transfer is somewhat deteriorated as compared with the previous embodiment where the louvered slits are provided radially over the entire area of each fin, manufacture of the fins becomes easier as the number of slits provided is reduced. FIG. **12** shows an example where two rows of heat conductive tubes are provided in each fin. When it is desired to reduce the number of slits for simplification of manufacture, it is preferred to eliminate the slits immediately behind the tubes where the flow is disturbed as illustrated in FIG. **2.** That is, no slit is provided in the area **25** intermediate the two rows of tubes **23** and **24,** and the slits **22** are provided radially only within the range of about 180° on the side of the tubes facing the outer edges **11'** of the fin. Although the number of slits is reduced, this arrangement permits attainment of the desired heat exchanging effect.

FIG. **13** shows another example where the heat conductive tubes are provided in three rows **25, 26** and **27.** It is of course possible and most preferable for efficient heat transfer to provide the louvered slits radially around the heat conductive tubes over the entire span of each fin **30** as in the embodiment of FIG. **8,** but in this example, the number of slits is reduced for the same reason as said above. That is, no slit is provided behind each tube as turbulence can occur at such part as in the case of the example of FIG. **12,** and for the rows of tubes **25** and **27** on both sides, the slits **28** are formed radially within the range of about 180° only on the side facing the fin edge, while for the central row of tubes **26,** the radial slits **29** are provided only in the direction of the tube line. It is possible with this arrangement to obtain the desired effect in spite of the reduced number of slits.

FIG. **14** shows a modification of the preceding example where the heat conductive tubes are provided in three rows, **31, 32** and **33.** For each of the tubes in the rows **31** and **33** on both sides, the louvered slits **34** are provided radially within the range of about 60° toward the fin periphery, and similar slits **35** and **36** are also provided in the areas between the tube rows **31** and **32** and between rows **32** and **33.** In these intermediate areas, heat transfer is effected from both adjoining rows of tubes, that is, heat is transferred to the peripheries of the slits **35** from the lines of tubes **31** and **32** and to the peripheries of the slits **36** from the lines of tubes **32** and **33,** so that these slits may not necessarily be arranged radially relative to each heat conductive tube; they may be arranged parallel to the tube lines as shown in the figure. In this case, too, the slits **35** and **36** are of course positioned substantially transverse to the air flow lines E—E', and also the upright walls **35', 36'** at both ends in the longitudinal direction of each of said slits **35, 36** are formed parallel to said air flow lines. This arrangement can also produce the desired effect in spite of the reduced number of slits.

FIG. **15** shows still another modification of the embodiment where the heat conductive tubes are provided in three rows **37, 38** and **39.** For each of the heat conductive tube in the rows **37** and **39** on both sides, the louvered slits **40** which are curved along the heat flow lines shown in the embodiment of FIG. **11** are provided within the range of about 60° toward the fin periphery, and for the tubes in the central row, the radial slits **41** are provided only in the direction of the tube row. The curved slits **40** are of course positioned transverse to the air flow lines E—E' and the upright walls **40'** at both ends of each slit are formed parallel to said air flow lines. The desired effect can be also obtained with this arrangement of slits.

The term "substantially radial" as used in the foregoing description refers not only to the arrangement of slits which run radially from the center of each heat conductive tube but also to the arrangement of slits which radiate eccentrically from the outer periphery of each tube and also a curved or otherwise deformed arrangement along the heat flow line as shown in FIG. **15.**

It also includes the configuration of slits which radiate from the entire peripheral range of each tube, this is, in all directions from the tube, as well as the arrangement of slits which are provided radially within the range of 180° as in the embodiment of FIG. **13** or within the range of 60° as in the embodiments of FIGS. **14** and **15**, and also the arrangement of slits radiated only in a limited direction as for example only in the diametrical direction as in the embodiment of FIG. **13.** All of these modified arrangements of slits are embraced within the scope of the present invention.

Further, although in the foregoing embodiments the slits are formed by raising up the cut portions in each fin to form louvers, it is also possible to form such slits by stamping pr punching to even more simplify the manufacture. In this case, the fin end portions where almost no boundary layer is present (such as front edges **11***a* of slit openings and slit front ends **15***a* as shown in FIG. **10,** such portions being formed twice as many as the slits in the foregoing embodiments) are provided same in number as the slits and hence the heat transfer area is reduced accordingly, so that the heat transfer rate is slightly lowered as compared with the embodiments formed with the slits with the raised-up portions, but air flow resistance is reduced and also the manufacture of the fins is greatly simplified.

In the foregoing description of the embodiments of the invention, it is assumed that heat of the heat exchanging medium in the tubes is transferred to another heat exchanging medium passing between the fins, but in case said another heat exchanging medium is higher in temperature than the medium in the tubes, the direction of heat transfer is just reversed but no change occurs in the action and effect of the system.

As viewed above, there is provided according to the present invention a crossed fin-and-tube type heat exchanger in which a plurality of slits having the raised-up portions are provided in each fin such that all of such slits will be positioned transverse to the flow of air passing sinously along the outer periphery of each heat conductive tube, raised-up portions of said slits forming the ridges having walls continuous to the upright side walls of the slit louvers and parallel to the fins, so that said slits intercept the air flow lines as well as the laminar flow boundary layers over a wise range corresponding to the slit length. Thus, any air flow is obliged to pass the slits and ridges a number of times and hence development of any boundary layer is substantially suppressed. Also, each fin is provided with a great many slit end portions where no boundary layer is present and hence the heat transfer rate is high, thus greatly improving heat transfer efficiency of the heat exchanger.

Further, according to the above-described arrangement, the erect walls at both ends in the longitudinal direction of each slit stay parallel to the sinous air flow so that air flow resistance is markedly reduced as compared with the conventional slitted fins.

Further more, since the slits are arranged radially relative to each heat conductive tube, they are positioned substantially parallel to the heat flow lines in the fins to even more improve heat transfer efficiency of the heat exchanger without hindering heat transfer of the fins.

If the slits are formed by stamping or punching, there can be obtained a heat exchanger in which air flow resistance is extremely low as the slits produce no air resistance as in the case of flat fins and in which, although the heat transfer rate is slightly lowered as compared with the fins formed with louvered slits, generation and development of the laminar flow boundary layers are greatly suppressed and also the manufacture is simplified.

What is claimed is:

1. In a crossed fin-and-tube type heat exchanger including a plurality of juxtaposed fins each having a suitable surface area and a plurality of heat conductive tubes passed through and securely fixed to said juxtaposed fins such that a first heat exhanging medium in said tubes and a second heat exchanging medium passing between the fins will perform heat exchange through said heat conductive tubes and said fins, the improvement comprising a plurality of louvers defining slits formed in said fins to extend substantially raadially around said heat conductive tubes and transversely to said second heat exchange medium passing between the fins, each of said plurality of louvers being formed from slotted and raised-up portions of said fins, each of said raised-up portions having upright walls longitudinally opposed to each other and a ridge wall continuous to said upright walls therebetween, said ridge wall being formed substantially parallel to said juxtaposed fins and positioned in a space between said juxtaposed fins.

2. A crossed fin-and-tube type heat exchanger as set forth in claim **1,** wherein said upright walls are formed substantially parallel to said second heat exchanging medium passing between said fins along the outer peripheries of said heat conductive tubes.

3. A crossed fin-and-tube type heat exchanger as set forth in claim **2,** wherein said plurality of heat conductive tubes include at least one row of aligned heat conductive tubes, and wherein said plurality of louvers include first louvers extending between each adjoining heat conductive tubes in the direction of the tube row and second louvers extending obliquely on each side of the tube row so that said second louvers are equiangular with said first louvers.

4. A crossed fin-and-tube type heat exchanger as set forth in claim **2,** wherein said plurality of heat conductive tubes include at least two rows of aligned heat conductive tubes, and wherein said plurality of louvers include first louvers extending between each adjoining heat conductive tubes in respective rows of said at least two rows in the direction of the tube rows and second louvers extending obliquely only on each outer side of said two tube rows so that said second louvers are equiangular with said first louvers and the section of the fin between said tube rows is free of louvers.

5. A crossed fin-and-tube type heat exchanger as set forth in claim **2,** wherein said plurality of heat conductive tubes include at least three rows of aligned heat conductive tubes, and wherein said plurality of louvers include first louvers extending between each adjoining heat conductive tubes in opposed outer rows of said three rows of tubes in the direction of the tube row, second louvers extending obliquely on each outer side of the opposed outer tube rows so that said second louvers are equiangular with said first louvers extending between adjoining tubes in said outer rows, and third louvers extending between each adjoining heat conductive tubes in a middle tube row of said three rows of tubes in the direction of the tube row.

6. A crossed fin-and-tube type heat exchanger as set forth in claim **2,** wherein said plurality of heat conductive tubes include at least three rows of aligned heat conductive tubes, and wherein said plurality of louvers include first louvers extending between each adjoining hat conductive tubes in the middle row of said three rows of tubes in the direction of the tube row and second louvers extending obliquely only on each outer side of opposed outer tube rows of said three rows of tubes.

7. A crossed fin-and-tube type heat exchanger as set forth in claim 2, wherein said plurality of heat conductive tubes include at least three rows of aligned heat conductive tubes, and wherein said plurality of louvers include first louvers extending between each of two adjoining tube rows of said three rows of tubes in the direction of the tube row and second louvers extending obliquely on each outer side of opposed outer tube rows of said three rows of tubes.

8. A crossed fin-and-tube type heat exchanger as set forth in claim 2, wherein said plurality of louvers include oblique slits, said oblique louvers being slightly curved.

9. A crossed fin-and-tube type heat exchanger asset forth in claim 1, wherein said plurality of louvers are rectangularly shaped with the long dimension of the rectangular shape extending the radial direction from each of said plurality of tubes, said long dimension being transverse to the direction of passing of said second heat exchanging medium.

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