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[54] **GRADUATED HEAT EXCHANGE FINS**
5 Claims, 11 Drawing Figs.

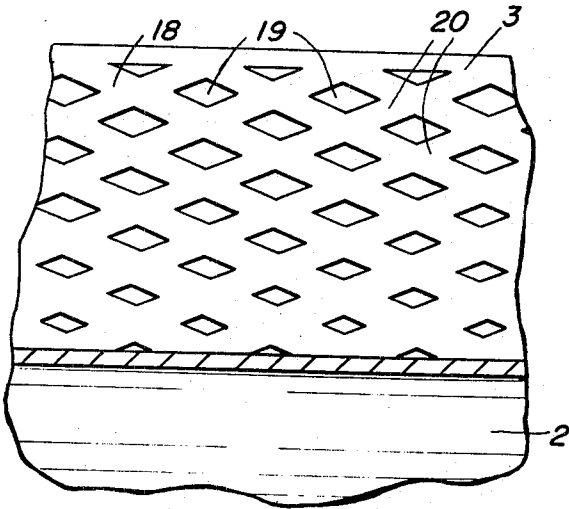
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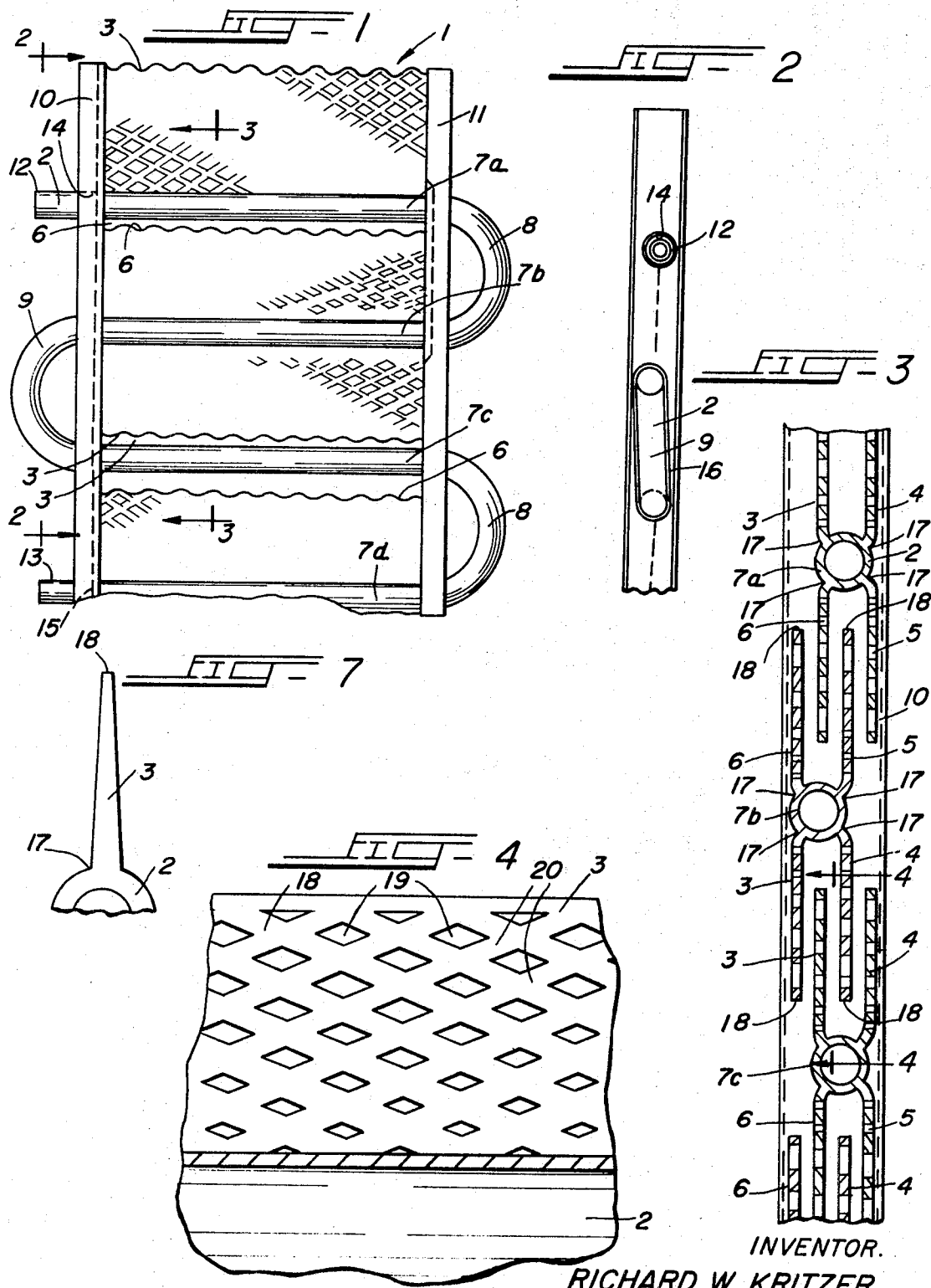
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181, 171, 146, 172

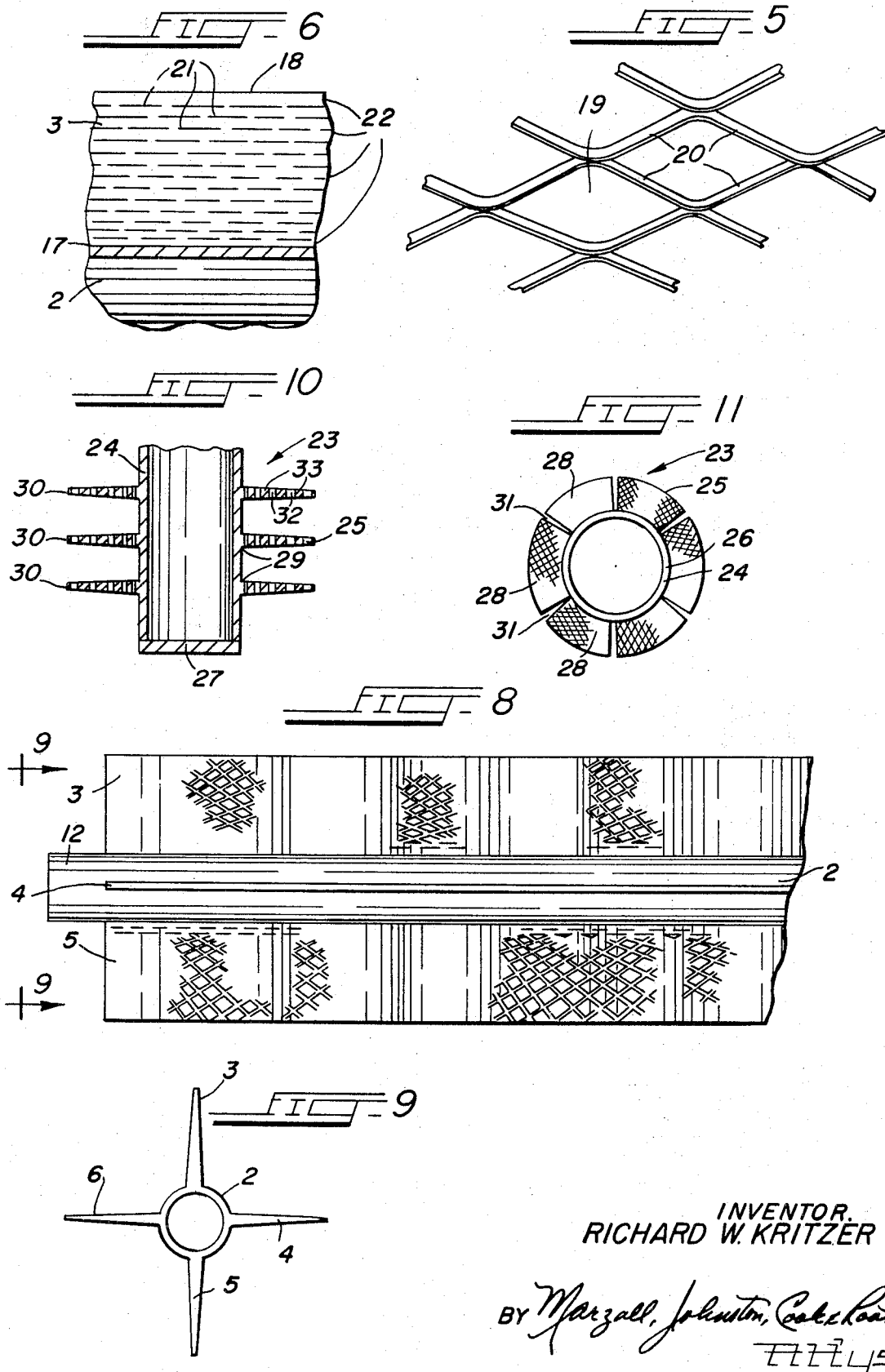
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ABSTRACT: A heat exchanger embodying integral fin and body portions with the fins being of expanded metal.





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GRADUATED HEAT EXCHANGE FINNS

BACKGROUND OF THE INVENTION

This invention relates to heat exchangers and, more particularly, to heat exchangers of the finned type.

It is a primary object of the present invention to afford a novel heat exchanger.

Another object is to afford a novel heat exchanger embodying novel heat transfer fins constituted and arranged in a novel and expeditious manner.

A further object is to afford a novel heat exchanger of the type which embodies heat transfer fins projecting outwardly from a body portion, and wherein the fins are formed integral with the body portion as distinguished from fins formed separately and then attached to a body portion.

Heat exchangers embodying fins integral with, and projecting outwardly from body portions, have been heretofore known in the art. It is an important object of the present invention to afford novel improvements in such heat exchangers.

In heat exchangers embodying outwardly projecting heat transfer fins, one of the factors determining the amount of heat transfer between such fins and the surrounding medium to be cooled or heated, such as, for example, the air or atmosphere, or the like, is the amount of surface area on the fins available to be contacted by the aforementioned medium. In such heat exchangers heretofore known in the art wherein the fins thereof are solid, imperforate members, the surface area is limited to the opposite faces and the peripheral edges of the fins. It is an object of the present invention to increase the heat transfer surface area of finned heat exchangers in a novel and expeditious manner.

Also, in heat exchangers heretofore known in the art embodying outwardly projecting solid fins, the fins afford obstructions to the flow of air, or the like, transversely therepast. It is another object of the present invention to reduce such obstruction to air flow.

Another object is to enable air, and the like, to circulate, in a novel and expeditious manner, through and between outwardly projecting fins integral with the body portion of a heat exchanger.

Heretofore, one of the limiting factors with respect to the amount of heat transfer surface area on externally finned heat exchangers has been the amount of fin material used in the manufacture of such heat exchangers. It is a further object of the present invention to enable such heat transfer surface area to be substantially increased over that heretofore known in the art without increasing the amount of fin material used.

Another object is to afford a novel heat exchanger embodying integral, outwardly projecting fins which have openings therein for the passage of air, or the like, therethrough.

An object ancillary to the foregoing is to enable such openings to be afforded without removing any of the fin material.

Yet another object of the present invention is to enable the overall width of integral, outwardly projecting fins on heat exchangers to be increased in a novel and expeditious manner.

A further object is to enable a heat exchanger to be manufactured in a novel and expeditious manner.

Another object of the present invention is to afford a novel heat exchanger embodying outwardly projecting, integral fins, which is practical and efficient in operation and which may be readily and economically produced commercially.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what I now consider to be the best mode in which I have contemplated applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a fragmentary, side elevational view of a heat exchanger embodying the principles of the present invention;

FIG. 2 is a fragmentary, end elevational view of the heat exchanger shown in FIG. 1, looking in the direction of the arrows 2-2 in FIG. 1;

FIG. 3 is a fragmentary, detail sectional view taken substantially along the line 3-3 in FIG. 1;

FIG. 4 is a fragmentary, somewhat diagrammatic, detail side elevational view of a portion of the heat exchanger shown in FIG. 1, looking in the direction of the arrows 4-4 in FIG. 3;

FIG. 5 is an enlarged, fragmentary perspective view of a portion of the fin construction shown in FIG. 1;

FIG. 6 is a fragmentary, somewhat diagrammatic, side elevational view, similar to FIG. 4, and shows the fin thereof at an early stage of manufacture;

FIG. 7 is an end elevational view of the portion of a heat exchanger shown in FIG. 6, at an even earlier stage in the manufacture thereof;

FIG. 8 is a fragmentary side elevational view of an end portion of the tubular member shown in FIG. 1, prior to bending of the body portion or fins thereof;

FIG. 9 is an end elevational view looking in the direction of the arrows 9-9 in FIG. 8;

FIG. 10 is a longitudinal sectional view of a modified form of the present invention; and

FIG. 11 is a top plan view of the heat exchanger shown in FIG. 10.

DESCRIPTION OF THE EMBODIMENTS SHOWN HEREIN

A heat exchanger 1, embodying the principles of the present invention, is shown in FIGS. 1 to 9, inclusive, of the drawings to illustrate the presently preferred embodiment of the present invention.

The heat exchanger 1 shown in the drawings embodies, in general, a hollow body portion or body member in the form of an elongated tubular member 2, FIGS. 1 and 3, with four elongated fins 3, 4, 5 and 6 integrally formed with the body member 2. The fins 3-6 extend longitudinally of the body member 2 and project laterally therefrom, with the bases of the fins 3-6, at which they engage the body member 2 being substantially equally spaced around the periphery of the body member 2, FIG. 3. In the heat exchanger 1 shown in the drawings, the body member 2 is bent into a serpentine pattern to afford four substantially parallel passes 7a, 7b, 7c and 7d, with adjacent pairs of passes 7a-7d alternately connected at their opposite ends by return bends 8 and 9, respectively. The opposite ends of the passes 7a-7d are mounted in respective channel-shaped end members 10 and 11, with the end portions 12 and 13 of the body member 2 projecting outwardly through openings 14 and 15 in the end member 10, and with the return bends 8 and 9 projecting outwardly through suitable openings such as slots 16 in the end members 10 and 11.

Preferably, in the type of heat exchangers shown in FIG. 1, the fins 3-6 are disposed between the end members 10 and 11, with the portions of the body member 2 disposed outwardly of the end members 10 and 11 being free of such fins. In the formation of the body member 2 with the fins 3-6 integrally formed therewith, the body member 2 with the fins 3-6 thereon may be formed in any suitable manner such as, for example, by extruding the same into an elongated, continuous, substantially straight form. Thereafter, the fins 3-6 may be removed from the body portion 2 at desired intervals, such as, for example, at the end portions 12 and 13, and at the portions which are to constitute the reverse bends 8 and 9. Such removal may be accomplished in any desired manner, such as, for example, by cutting or grinding.

In the formation of the fins 3-6 on the body member 2, each of them is preferably formed in radially outwardly extending relation to the body member 2, as illustrated by the fin 3 shown in FIG. 7. Preferably, the base 17 of each of the fins

3—6, at which the respective fin joins the outer periphery of the body member 2, is substantially thicker than the outer free end 18 thereof, FIG. 7. For example, if the outer end portions 18 of the fins 3—6 are .025 inches in thickness, the thickness thereof at the base portion 17 preferably is in the order of .05 inches. This is for a purpose which will be discussed in greater detail presently.

As shown in FIG. 3, the bases 17 of the fins 3—6 are joined to the body member 2 at substantially equally spaced relation to each other around the periphery of the body member 2. In the final form of the heat exchanger 1, each of the fins 3—6 is perforated, having a plurality of spaced openings 19 extending therethrough, with suitable dividers 20 separating adjacent openings, as may be seen in FIG. 4. In the preferred form of the heat exchanger 1, each of the fins 3—6 is of the type of construction commonly known in the art as "expanded metal".

Preferably, the fins 3—6 are so constructed that the openings 19 adjacent the bases 17 thereof are smaller in size, and spaced further apart than the openings 19 adjacent the outer edges 18 thereof, with the opening size becoming progressively larger from the base 17 to the outer edges 18, and with the spacing between the openings 19 becoming progressively less from the bases 17 to the outer edges 18, as illustrated in FIG. 4. With this construction it will be seen that, with the thickness of the fins 3—6 progressively increasing from the outer edges 18 to the bases 17 thereof, and with the width of the dividers 20 progressively increasing from the outer edges 18 to the bases 17, a progressively greater mass of metal is afforded from the outer edge 18 to the base 17 of each of the fins 3—6 so as to afford an ever increasing heat flow path toward the inner edges of the fins 3—6.

This, it will be seen, is effective to afford a fin construction wherein the mass thereof is so distributed as to afford efficient heat transfer between the body member 2 and the surrounding medium, whether the heat exchanger is being used to heat or cool the aforementioned medium. Thus, for example, when the heat transfer is from the surrounding atmosphere through the fins 3—6 to the body member 2, as more heat is picked up by the fins 3—6 and moves inwardly therealong toward the body member 2 the metal mass of the fins 3—6 increases to accommodate the increased volume of heat. On the other hand, when the heat transfer is from the body member 2 through the fins 3—6 to the surrounding atmosphere, the distribution of the metal mass in the fins 3—6 is such that it is greater closer to the body member 2, where the heat flow through the fins 3—6 is greatest, and is smaller at the outer free edges 18 thereof, where the heat flow therethrough is smallest because of the heat having been dissipated during the flow thereof from the body member 2 to the outer edges 18.

The expanded metal construction of the fins 3—6 may be afforded in any suitable desired manner without departing from the purview of the broader aspects of the present invention. However, I prefer that this be accomplished by progressively slitting and expanding each of the fins 3—6 from the outer edge 18 to the base 17 thereof.

As is diagrammatically illustrated in FIG. 6, the slits 21 in the fins 3—6 are preferably formed in parallel relation to the body member 2, along parallel lines 22 extending longitudinally of the respective fins 3—6, with the length of the slits 21 progressively decreasing from the line 22 disposed closest to the outer edge 18 to the line 22 disposed closest to the base 17. Preferably, as each slit 21 is formed, it is expanded outwardly away from the body member 2 to afford one of the openings 19, with the slits in each of the lines 22 being consecutively thus formed and expanded into openings 19 before forming or expanding the slits 21 on the next innermost line 22. Such slitting and expanding of the fins 3—6 may be accomplished in any suitable manner, such as, for example, on a suitable rotary cutter or punch press.

When the openings 19 are formed in this manner, the width of the dividers 20 may be controlled by controlling the distance between the adjacent lines 22 of slits 21, and between

adjacent slits 21 in the same lines 22. Thus, when, as in the preferred form of the present invention, the width of the dividers 20 is progressively greater from the outer edges 18 to the bases 17 of the fins 3—6, the distance between the lines 22 is correspondingly progressively greater from the outer edges 18 to the respective bases 17, and, also, between adjacent slits 21 in the same line 22 from the outer edges 18 to the respective bases 17. For example, when the distance between the two outermost rows 22 of slits 21 is in the order of .025 inches, the distance between the two innermost rows 22 of slits 21 is preferably in the nature of .050 inches; and when the space between adjacent slits 21 in the outermost row 22 is in the order of .025 inches the corresponding spaces in the innermost row 22 is in the order of .05 inches.

It will be remembered that the openings 19 toward the outer edges 18 of the fins 3—6 are preferably larger than the openings 19 toward the bases 17 of the fins 3—6. This, in part, may be accomplished by forming the aforementioned slits 21 in the aforementioned manner wherein the slits 21 are progressively shorter from the outer edges 18 to the bases 17. In addition, to afford this decreasing hole size for the holes 19, the slits 21 may be expanded outwardly away from the body member 2 a progressively smaller distance from the outer edge 18 to the base 17 of each of the fins 3—6. For example, when the outermost openings 19 are expanded to afford a distance between the innermost and outermost edge portions thereof of .15 inches, the innermost slits 21 may be expanded to afford a corresponding dimension in the order of .08 inches.

It will be observed that in forming the expanded metal fins 3—6, no appreciable material is removed therefrom and the width thereof is increased. This is an important aspect of the present invention, enabling the width of each of the fins 3—6 to be increased without any appreciable loss of material. Preferably, such expansion is in the order of two and one-half times the original width of the fins 3—6.

Preferably, in the formation of the heat exchanger 1, the fins 3—6 are slit and expanded into their expanded metal form while they are all projecting radially outwardly from the body member 2, as illustrated in FIGS. 8 and 9. Thereafter, the fins 3—6 are preferably bent around their respective bases 17 into such position that the fins 3 and 4 are disposed in uniplanar relation to the fins 6 and 5, respectively, with the fins 3 and 6 being disposed in substantially parallel relation to the fins 4 and 5, respectively, FIG. 3. Thereafter, the body member 2 may be bent so as to dispose the pairs of fins 3 and 4, and 5 and 6 on each of the adjacent passes 7a—7d in interleaved parallel relation to the pairs of fins 3 and 4, and 5 and 6, respectively, on the next adjacent one of the passes 7a—7d, FIG. 3. Preferably, the fins 3—6 are of such width that, when the body member 2 is disposed in the aforementioned serpentine pattern, they terminate in spaced relation to the adjacent portions of the body member 2 toward which they project, as shown in FIG. 3.

With the heat exchanger 1 constructed in this manner, it will be seen that the fins 3—6 embody a perforated construction which is effective to permit air to pass transversely through the fins 3—6 in good heat transfer relation thereto. Furthermore, the openings 19 are so constituted and arranged that the volume of air passing through the fins 3—6 may be controlled to afford the most effective heat transfer and air flow. As will be appreciated by those skilled in the art, such construction is particularly well adapted for use in refrigerators, air conditioners and space heaters, and the like, wherein it is desired to have the medium, such as, for example, air pass directly through the heat exchanger in good, intimate heat transfer relation thereto.

It will be noted that in the preferred form of the present invention illustrated in FIGS. 1 and 9, inclusive, four fins 3—6 project laterally from the body member 2, and, in the assembled form of the heat exchanger the adjacent pairs of fins are interleaved in spaced parallel relation to each other. While this is the preferred form of the present invention, this is merely by way of illustration, and not by way of limitation, and, as

will be appreciated by those skilled in the art, heat exchangers embodying a greater or lesser number of fins, and embodying fins arranged in a different manner with respect to the body member 2 and with respect to each other may be afforded without departing from the purview of the broader aspects of the present invention.

In FIGS. 10 and 11 of the drawings, a heat exchanger 23 is shown to illustrate a modified form of the present invention. The heat exchanger 23 embodies an elongated, substantially straight, hollow body portion or body member in the form of a cylinder 24 having radially outwardly projecting fins 25 formed integrally therewith and extending therearound. The cylinder 24 has an open end 26, FIG. 11, and is closed at the other end thereof by a wall 27, FIG. 10.

The fins 25 are identical in construction, being disposed in parallel relation to each other, and being spaced from each other longitudinally of the cylinder 24. Each of the fins 25 is in the form of an annular ring divided into spaced segments 28, FIG. 11.

The body member 24, with the fins 25 thereon, may be formed of any suitable material such as, for example, aluminum, by any suitable method, such as, for example, by impact molding. Like the fins 3—6 shown in FIGS. 1—9, the fins 25 are preferably formed with the bases 29 thereof having a greater thickness than the outer ends 30 thereof. As originally formed, the fins 25, like the fins 3—6, are preferably solid in construction. Thereafter, they may be slit, as at 31, to afford the spaced segments 28. Each of the segments 28 may then be formed into an expanded metal member, having openings 32 therethrough, in the same manner as that heretofore described with respect to the fins 3—6 shown in FIGS. 1—9. Like the fins 1—9, the openings 32 in the fins 25 are preferably successively larger from the bases 29 to the outer edges 30 of the fins 25, and adjacent openings 32 are separated by dividers 33 which are progressively thicker and wider from the outer edges 30 to the bases 29 of the fins 25.

The heat exchanger 23, shown in FIGS. 10—11, affords a cylinder-type heat exchanger embodying integral, radially outwardly projecting, annular fins, wherein air, or the like, may pass transversely through the fins in effective heat transfer relation thereto. Such construction is particularly well adapted for cooling cylindrical shaped members, such as, for example, the cylinders on radial engines, and the like.

With a heat exchanger constructed in the manner of the heat exchanger 23, shown in FIGS. 10 and 11, air, or the like, may not only pass between the fins 25 transversely to the length of the body member 24, but may also pass, and circulate through, the fins 25 longitudinally of the body member 24. Such construction affords highly effective and efficient heat transfer between the heat exchanger 23 and the surrounding medium, such as, for example, the air or atmosphere.

From the foregoing it will be seen that the present invention affords a novel heat exchanger of the integrally finned type which embodies fins which are constituted and arranged in a novel and expeditious manner.

Also, it will be seen that the present invention affords a novel finned heat exchanger wherein the fins are perforated in a novel and expeditious manner.

In addition, it will be seen that the present invention affords a novel finned heat exchanger wherein the heat transfer surface is increased in a novel and expeditious manner.

Also, it will be seen that the present invention affords a novel heat exchanger wherein the width of the fins thereof may be increased in a novel and expeditious manner without

requiring additional material.

Also, it will be seen that the present invention affords a novel heat exchanger of the finned type which is practical and efficient in operation and which may be readily and economically produced commercially.

Thus, while I have illustrated and described the preferred embodiments of my invention, it is to be understood that these are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. A heat exchanger comprising:

a. an elongated tubular body portion;

b. a fin;

1. formed integrally with said body portion; and

2. projecting laterally outwardly from said body portion; and

c. said fin having a plurality of spaced openings therethrough for the passage of air through said fin in heat-exchange relation to said fin;

d. said fin comprising an expanded metal member; and

e. said openings being progressively larger in size the greater distance they are disposed from said body portion and spaced so as to afford progressively increased heat transfer mass the lesser the distance from said body portion.

2. A heat exchanger comprising:

a. an elongated tubular body portion; and

b. a fin;

1. formed integrally with said body portion; and

2. projecting laterally outwardly from said body portion;

c. said fin having a plurality of spaced openings therethrough for the passage of air through said fin in heat-exchange relation to said fin;

d. said fin comprising an expanded metal member; and

e. the heat transfer masses between adjacent pairs of said openings being larger in size the lesser the distance from said body portion.

3. A heat exchanger as defined in claim 1, and in which:

a. said fin comprises an elongated member extending longitudinally along said body portion; and

b. said fin increases in thickness toward said body portion.

4. A heat exchanger comprising:

a. an elongated tubular body portion;

b. a fin;

1. formed integrally with said body portion; and

2. projecting laterally outwardly from said body portion;

c. said fin having a plurality of spaced openings therethrough for the passage of air through said fin in heat-exchange relation to said fin;

d. said fin comprising an elongated expanded metal member,

1. extending longitudinally along said body portion; and

2. having a free longitudinal edge remote from said body portion;

e. certain of said openings being closer to said free edge than other of said openings; and

f. the heat transfer masses between adjacent pairs of said openings which are closer to said free edge being of lesser cross-sectional size than the heat transfer masses between adjacent pairs of said other openings.

5. A heat exchanger as defined in claim 4, and in which said openings which are closer to said free edge are larger in size than said other openings.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,540,530 Dated November 17, 1970

Inventor(s) RICHARD W. KRITZER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 36, "metal metal" should read
-- metal member --.

SIGNED AND
SEALED

FEB 23 1971

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents