CUTUGATED FIN ASSEMBLY

Inventors: Jerome E. Toth, Hatboro, PA (US); Donald M. Ernst, Lancaster, PA (US)

Correspondence Address:
Samuel W. Apicelli
Duane Morris LLP
P.O. Box 1003
Harrisburg, PA 17108-1003 (US)

Appl. No.: 09/990,712
Filed: Nov. 21, 2001

Publication Classification

Int. Cl. F28F 1/20; F28F 1/14; F28F 1/36

ABSTRACT

The apparatus is an assembly of cooling fins attached to pipes or heat pipes. The fins are formed into a corrugated configuration of troughs and peaks with large sections of the peaks removed to permit airflow along the depths of the troughs as well as along the lengths of the troughs. Holes are also formed into the fins to accept and grip a pipe or heat pipe. The preferred embodiment has holes surrounded by split collars formed into each fin, with the collars aligned to accept and grip the pipe.
CUTTED Fin Assembly

FIELD OF THE INVENTION

[0001] The present invention generally relates to cooling fin structures, and more particularly to an assembly of cooling fins attached to a pipe or heat pipes and the method of attaching such fins.

BACKGROUND OF THE INVENTION

[0002] Multiple fin assemblies are commonly used for transferring heat. This heat transfer is frequently between a liquid or vapor flowing in pipes that are in contact with the fins, and air flowing past the fins. Sometimes the fins are in contact with a second liquid rather than air. Perhaps the most common use of such a configuration is a simple household radiator in which hot water flows through a copper pipe that passes through a central hole located in individual aluminum fins. Here, the fins surround the pipe, with the pipe being bonded to the fins at edges that define the holes. The copper pipe heats the fins, which in turn transfer the heat into the air around the pipe by natural convection.

[0003] In more sophisticated installations, it has also been common to use a similar structure to transfer heat from a heat pipe to surrounding air. Here too, the fins are attached to the heat pipe by passing the heat pipe through a hole in the fins. The attachment method is usually brazing, gluing, soldering, mechanical or hydraulic expansion, or welding of the fins to the heat pipe. Unfortunately, this prior art means of attaching fins to pipes is time consuming and expensive. It involves the bonding of each individual fin to the pipe, and regardless of the specific bonding material, the technique requires applying the solder, brazing material, or epoxy to each individual fin, or an additional manufacturing process step to expand the tube mechanically or hydraulically.

[0004] It would be very beneficial and economical to be able to attach fins to a pipe or heat pipe without handling each fin separately and without the use of bonding materials which have to be discretely applied to the fin structure.

SUMMARY OF THE INVENTION

[0005] The present invention provides a unified assembly of fins attached to a pipe or heat pipe without the use of any intermediate bonding material. Because all the fins are formed as a single free standing assembly, the attachment to the pipe or heat pipe is greatly simplified.

[0006] In a preferred embodiment, fins are folded or corrugated to form a serpentine surface with alternating peaks and troughs. The troughs, as viewed from one side, form the peaks as viewed from the opposite side. However, unlike prior art folded assemblies of fins, the fins of the present invention have large sections along the lengths of their peaks removed. These cut out portions along the peaks of the corrugated fins can easily be punched out before the corrugations are formed, when the sheet is still flat, or can be removed after folding. Typically, these sections are removed from all but a small portion of the ends of the peaks, so that in the finished assembly it appears as if alternating sets of fins have been strapped together in a few separate locations. These remaining sections of the peaks hold the fins together to make a single assembly, and also assure that the fins will remain properly separated. This configuration yields fins which do not act like normal corrugated fins.

[0007] In another embodiment of the invention, a fin assembly is provided comprising a sheet of metal folded so as to form a plurality of alternating peaks and troughs having a wall extending between each of the peaks and troughs. A central portion of each of the peaks is removed to form a through-opening that is bounded by spaced-apart straps of the sheet metal so as to permit air flow parallel to the troughs. Each of the walls defines a hole and at least two slits extending radially from the hole and through a portion of the wall so that when a pipe is inserted through the hole, a portion of the wall projects outwardly in the direction of movement of the pipe.

[0008] Typical corrugated fins can only be used with continuous air flow along the troughs of the fins, meaning they can only be oriented in one direction to take advantage of natural or forced convection. For natural convection, the troughs and peaks must be oriented nearly vertically. However, the fins of the present invention are multi-directional. Since the portions of the peaks which remain to hold the fins together are relatively small compared to the sections removed from the peaks, convection can generate air flow in the direction along the depths of the troughs, and that convection has essentially the same cooling effect as it would have on independent fins of the same surface area. This makes fins of the present invention particularly suitable for many installations in which natural convection or unidirected forced air is the cooling mode.

[0009] The fin assembly of the invention is also attached to pipes or heat pipes in a different way than conventional fins. The attachment structure of the present invention comprises a series of holes, one or more in each folded fin, with the holes in all the folded fins aligned so that pipes or heat pipes can be inserted through all the aligned holes. However, the attachment of the fins to the pipes or heat pipes uses no bonding material. Instead, each hole in a fin is formed with radiating slits which form clamping fingers which act as springs by storing elastic energy and thereby exerting a retaining force against the pipes. A concentric radial pattern may be preferred into the material separating the slits so as to provide preferred bend-lines in the material. In a preferred embodiment, the diameter of the pipes are sized so that the pipes are forced into the holes and cause the fingers to bend outward to form a collar. Such split collars can also be formed at the same time the hole is punched into the fin by drawing out the material on the edge of the hole. However, a simpler manufacturing process is provided when the collars are formed by the pipe itself as it is forced through holes with radial cuts extending out from the holes.

[0010] From a manufacturing standpoint it is much easier to form the holes and radial cuts before the fins are folded, so that the holes are punched and the material removed from the future peaks on a simple flat sheet of material. It will be understood that if collars are to be formed in a flat sheet that is ultimately going to be folded into a fin assembly, adjacent collars in the flat sheet must point in opposite directions. That is, in a flat horizontal sheet one collar must protrude down from the sheet while the collars adjacent to it must protrude up. Thus, after the sheet is folded to form the parallel fins of the assembly, the collars will all be pointing in one direction, and therefore be arranged so as to accept a pipe that is pushed through the collars.
The present invention thereby furnishes a more easily manufactured and assembled cooling fin assembly on a pipe or a heat pipe than has previously been available.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will be more fully disclosed in, or rendered obvious by, the following detailed description of the preferred embodiment of the invention, which is to be considered together with the accompanying drawings wherein like numbers refer to like parts and further wherein:

FIG. 1 is a perspective view of the preferred embodiment of a corrugated fin assembly formed in accordance with the invention, penetrated by and attached to a pipe;

FIG. 2 is a layout view of a portion of a flat sheet used to form the fin assembly of the preferred embodiment of the invention; and

FIG. 3 is a perspective view of a corrugated fin assembly formed in accordance with an alternative embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

This description of preferred embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description of this invention. In the description, relative terms such as “horizontal,” “vertical,” “up,” “down,” “top” and “bottom” as well as derivatives thereof (e.g., “horizontally,” “downwardly,” “upwardly,” etc.) should be construed to refer to the orientation as then described or as shown in the drawing figure under discussion. These relative terms are for convenience of description and normally are not intended to require a particular orientation. Terms including “inwardly” versus “outwardly,” “longitudinal” versus “lateral” and the like are to be interpreted relative to one another or relative to an axis of elongation, or an axis or center of rotation, as appropriate. Terms concerning attachments, coupling and the like, such as “connected” and “interconnected,” refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as between movable or rigid attachments or relationships, unless expressly described otherwise. The term “operatively connected” is such an attachment, coupling or connection that allows the pertinent structures to operate as intended by virtue of that relationship.

FIG. 1 is a perspective view of the preferred embodiment of corrugated fin structure 10 of the invention in which pipe 12 penetrates each fin 14 and is held in thermal contact with each fin by a split collar 16. Fins 14 are formed by folding a flat sheet into the serpentine configuration shown for corrugated fin assembly 10.

Fin assembly 10 differs from conventional corrugated fin assemblies because central portions of peaks 18 of the corrugations are removed to form slots 20. Although in FIG. 1 they are substantially hidden by fins 14, slots similar to slots 20 are also removed from lower peaks 22 of fin assembly 10.

Slots 20 give fin assembly 10 the capability of developing natural convection air flow in any orientation because, unlike conventional corrugated fins, there is nothing to block the air flow in the direction of the depth of the troughs, indicated by arrows A and B. Thus, as long as fins 14 are in vertical or near vertical planes, heat transmitted to fins 14 from pipe 12 will generate natural convection, regardless of which parts of fins 14 are uppermost.

Straps or end portions 24, which are the portions of upper peaks 18 and lower peaks 22 which remain after slots 20 are formed, also serve a vital purpose. Straps 24 hold individual fins 14 together to form fin assembly 10 so that fin assembly 10 can be handled as a single unit. Furthermore, straps 24 maintain the fin to fin spacing originally designed into the assembly.

FIG. 1 also depicts one of a plurality of split collars 16, which are a preferred structure for holding fin assembly 10 onto pipe 12. Split collars 16 are formed in each fin 14, and are substantially coaxial to one another. Split collars 16 are pre-formed through the surface of each fin 14 as a central hole 32 and a cruciform slit 34. In this way, when pipe 12 is forced through holes 32, radiating cruciform slits 34 deform outwardly so as to create a plurality of gripping fingers 37. A concentric radial pattern or plurality of pre-formed score lines or thinning of the material separating the slit in cruciform slit 34, provide preferred bend-lines 38 in the material. Bend-lines 38 are positioned radially outwardly from central hole 32 so as to create a preferred and uniform bending point for the gripping fingers so that they are substantially the same length and therefore exert approximately the same gripping force on pipe 12. As shown in FIG. 2, slots 20 are cut from sheet 30 before sheet 30 is folded to form corrugated fin assembly 10. Also before the folding operation, co-linear holes 32 are formed in sheet 30, and cruciform slits 34 are cut into sheet 30 so as to radiate from holes 32. Slots 20, holes 32, and cruciform slits 34 are all located on sheet 30 so that after sheet 30 is folded, slots 20 will be at the peaks of the corrugations and collars 16 will all be aligned with one another (FIG. 1).

Collars 16 are formed from holes 32 and slits 34. Collars 16 can either be pre-formed into sheet 30 by drawing the collars before sheet 30 is folded or, with properly selected materials and dimensions, after folding. If formed after folding, a mandrel or pipe can be pushed through holes 32 to form collars 16 by deforming gripping fingers 37 outwardly, in the same direction as the movement of the mandrel or pipe. In either case, holes 32 are sized so that when pipe 12 is installed it will merely require being pushed through collars 16. Preferably, when pushing pipe 12 through holes 32, tooling is positioned in the troughs between adjacent fins (e.g., a comb-like fixture) to provide support for the fin during the insertion and movement of pipe 12 through the fin. Significantly, with pipe 12 installed, split collars 16, via gripping fingers 37, will retain enough elasticity to hold pipe 12 with sufficient contact force to provide adequate, thermally conductive contact.

Referring to FIG. 3, an alternative fin structure 40 comprises a plurality of fins 14 comprising an open-ended slot 44 and an opening 46 defined through each fin. Open-ended slots 44 and openings 46 are preferably centrally located within each fin 14, and are arranged in substantially aligned relationship to one another from fin to fin. In this
way, plurality of open-ended slots 44 and openings 46 form a receptacle-passageway through fin structure 40. Open-ended slots 44 are sized so as to be the same or somewhat larger than the outer diameter of a pipe 42, and openings 46 are sized so as to be the same or somewhat narrower than the outer diameter of a pipe 42. Thus, when pipe 42 is inserted into the receptacle-passageway formed by open-ended slots 44, it is retained in fin structure 40 via a press fit in openings 46. Alternatively, pipe 42 may be maintained within open-ended slots 44 by soldering, brazing, or thermal adhesives. Also, more than one pipe 42 may be positioned within open-ended slots 44.

[0024] Of course, open-ended slots 44 and openings 46 may have a variety of shapes, sizes and locations in fin structure 40. For example, open-ended slots 44 may be defined by tapering edges of each fin 14. Openings 46 may be defined by substantially circular, elliptical, polygonal or rectilinear edges of each fin 14. The location within fins 14 of openings 46, and the length, width, and orientation of open-ended slots 44 may also vary as required for a particular application without departing from the scope of the invention. Furthermore, fin structure 40 may comprise only open-ended slots 44.

[0025] The present invention provides a versatile cooling fin structure which is not restricted in its orientation for convection cooling, and which can easily be

What is claimed is:

1. A fin assembly comprising a corrugated sheet having alternating peaks and troughs in which portions of said peaks are removed to permit air flow in the direction of the depths of the troughs.

2. The fin assembly according to claim 1 wherein said fins include at least one hole to hold a pipe.

3. The fin assembly according to claim 1 wherein said portions of said peaks are removed from a flat sheet before said flat sheet is folded so as to form said corrugated sheet.

4. A fin assembly comprising a corrugated fin assembly including a plurality of fins with a split collar formed on each fin, said collar being expanded by and holding a pipe which passes through said fins.

5. The fin assembly according to claim 4 wherein said split collars are formed in a flat sheet before said flat sheet is folded to form said corrugated fin assembly.

6. The fin assembly according to claim 5 wherein said split collars include a central hole and at least two radially extending slots so that said split collars are formed by pushing a pipe through said central holes so as to expand that portion of said flat sheet extending between said slit adjacent to said hole.

7. A method for fabricating a fin assembly, comprising:

   (A) providing a length of fin material, the fin material capable of being formed into a corrugated assembly of parallel spaced fins defining peaks at a top surface and defining corresponding troughs at a bottom surface with air channels created by the parallel spaced fins, the peaks and troughs each including a central section bounded by a pair of end sections;

   (B) removing a portion of said central section of at least some of said peaks so as to form top surface slots in said corrugated fin material;

   (C) removing a part of said central section of at least some of said troughs so as to form bottom surface slots in said corrugated fin material; and

   (D) permitting airflow through said top and bottom surface slots in a direction substantially perpendicular to existing air flow through said air channels when said fin material is formed into said corrugated assembly of parallel spaced fins.

8. A method according to claim 7 further comprising forming a plurality of uniformly spaced apertures in the length of said fin material.

9. A method according to claim 8 further comprising spacing said plurality of uniformly spaced apertures to define a straight aperture alignment capable of receiving a pipe through said apertures in said fin material when said fin material is formed into said corrugated assembly.

10. A fin assembly comprising:

   a length of fin material, said fin material being capable of being formed into a corrugated assembly of parallel spaced fins defining peaks at a top surface and defining corresponding troughs at a bottom surface with air channels created by the parallel spaced fins, said peaks and troughs each including a central section bounded by a pair of end sections;

   means for removing a part of said central section of at least some of said peaks to form top surface slots in said corrugated fin material;

   means for removing a part of said central section of at least some of said troughs to form bottom surface slots in said corrugated fin material, whereby air flow is permitted through said top and bottom surface slots in a direction substantially perpendicular to existing air flow through said air channels when said fin material is formed into said corrugated assembly.

11. A fin assembly according to claim 10 further comprising a plurality of uniformly spaced apertures in said length of fin material.

12. A fin assembly according to claim 11 further comprising means for spacing said plurality of uniformly spaced apertures to define a straight aperture alignment capable of receiving a pipe device through said apertures in said fin material when said fin material is formed into said corrugated assembly.

13. A fin assembly according to claim 10 wherein said top surface slots and said bottom surface slots are formed in said fin material before said fin material is corrugated.

14. A process for transferring heat which comprises incorporating into a heated structure the fin assembly of claim 10 and transferring heat from the heated structure by inserting the heated structure through said plurality of uniformly spaced apertures to generate natural convection in said fin assembly.

15. A fin assembly comprising:

   a sheet of metal folded so as to form a plurality of alternating peaks and troughs with a wall extending between each of said peaks and troughs so as to define a plurality of fins wherein a central portion of each of said peaks is removed to form a through-opening that is bounded by spaced-apart straps of said sheet metal so as to permit air flow parallel to said troughs; and wherein each of said fins define a hole and at least two
slits extending radially from said hole and through a portion of said fin so that when a pipe is inserted through said hole a portion of said fin projects outwardly in the direction of movement of said pipe.

16. A fin assembly according to claim 15 wherein said pipe penetrates each said fin and is held in thermal contact with each fin by a that portion of said fin that projects outwardly in the direction of movement of said pipe.

17. A fin assembly according to claim 15 wherein said straps are portions of said peaks and maintain a selected fin to fin spacing.

18. A fin assembly according to claim 15 wherein said holes are substantially coaxial to one another.

19. A fin assembly according to claim 18 wherein said hole is centrally located in each fin and said slit comprises a cruciform shape.

20. A fin assembly according to claim 19 wherein when said pipe penetrates said holes, the material of said fin that defines said cruciform slits deforms outwardly so as to create a plurality of gripping fingers that engage said pipe.

21. A fin assembly according to claim 19 wherein said holes and slits form a split collar.

22. A fin assembly according to claim 15 wherein said straps are substantially flat.

23. A fin assembly according to claim 15 wherein said straps are substantially rounded.

24. A fin assembly comprising:

a sheet of metal folded so as to form a plurality of alternating peaks and troughs with a wall extending between each of said peaks and troughs so as to define a plurality of fins wherein a central portion of each of said peaks is removed to form a through-opening that is bounded by spaced-apart straps of said sheet metal so as to permit air flow parallel to said troughs; and wherein each of said fins define a hole and at least two slits extending radially from said hole and through a portion of said fin and having a plurality of concentric preformed bend-lines positioned radially outwardly from said hole so that when a pipe is inserted through said hole a portion of said fin bends along at least one of said concentric bend-lines and projects outwardly in the direction of movement of said pipe.

25. A fin assembly comprising:

a sheet of metal folded so as to form a plurality of alternating peaks and troughs with a wall extending between each of said peaks and troughs so as to define a plurality of fins wherein a central portion of each of said peaks is removed to form a through-opening that is bounded by spaced-apart straps of said sheet metal so as to permit air flow parallel to said troughs; and wherein each of said fins defines an open ended slot extending through a portion of said fin and sized so as to accept a pipe.

26. A fin assembly according to claim 25 comprising an opening defined within each of said fins and located at an end of said slot.

27. A fin assembly according to claim 25 wherein said plurality of fins define a plurality of axially aligned slots so as to form a receptacle-passageway through said fin assembly.