ABSTRACT: Air cooler apparatus comprising a framework and a bundle of finned tubes supported on and extending longitudinally of the framework for shifting laterally with respect to longitudinally extending members of the framework at each side of the bundle. A strip of resilient foam material extends longitudinally between the inner side of each frame member and the adjacent outer side of the tube bundle so as to substantially close the space between the outermost tubes and the frame member.
AIR COOLER APPARATUS

This invention relates to improvements in air cooler apparatus of the type in which a bundle of finned tubes is supported between longitudinally extending frame members of a fixed framework in position to be contacted by air flowing between the frame members.

Due to thermal changes in the system in which such apparatus is disposed, the manifold connecting to the headers of each end of the tube bundle will expand and contract in a direction laterally of the framework. In order to accommodate this relative movement, the tube bundle is slidable laterally within the framework and is spaced at each side from the adjacent frame member a distance sufficient to prevent interference between them.

If left ignored, these spaces prevent proper distribution of airflow across the finned tubes of the bundle since much of the air will pass between the sides of the bundle and the frame members without contacting the outermost tubes at the sides of the bundle. Consequently, a great amount of heat transfer is lost and the entire system in which the apparatus is disposed is made less efficient.

It has been proposed to "seal" these spaces by prefabricated bodies of sheet metal. Many of these have been bent into a desired shape and secured to the inner side of the frame members for filling some of the space between the members and the sides of the tube bundle.

These prior structures present two very basic problems. For one thing, the sheet metal is expensive to fabricate, especially when it is bent to conform generally to the shape of the outboard finned tubes at the sides of the tube bundle. For this reason, the body of sheet metal usually has a flat surface facing the outboard fins, which of course renders it extremely inefficient.

Secondly, this prior structure is static and thus provides no means for accommodating to the lateral shifting of the tubes. Consequently, there is usually a fair substantial space between the outboard fins and the oppositely facing surface of the sheet metal, even when the sheet metal is bent to conform generally to the shape of the tubes. Thus, even if the facing surface of the sheet metal is close to or touches the outboard tubes at the time of installation, it is permanently deformed when the system is put into operation and the tubes press against it during lateral shifting of the bundle.

An object of this invention is to provide apparatus of this type in which the spaces are sealed in a more economical and efficient manner.

Another object is to provide such apparatus in which the spaces are maintained at least substantially closed during lateral movement of the tube bundle, and in which the means for so closing them may be formed from a relatively inexpensive material which need not be bent to any particular shape.

Still another object is to provide apparatus of the type described in which the seals are maintained despite high temperatures and fires which may occur in and around the apparatus.

These and other objects are accomplished, in accordance with the illustrated embodiment of the present invention, by apparatus of the type described in which a strip of resilient foam material is disposed within the space between each frame member and the adjacent side of tube bundle. More particularly, one side of the strip extends longitudinally along the inner side of the frame and its opposite side extends longitudinally along the outer side of the tube bundle and at least close to the fins of the outermost tubes under nominal conditions, i.e., as manufactured and before the apparatus is put in use.

Thus, when the apparatus is installed in a system in which thermal changes cause lateral shifting of the bundle toward and away from one side frame member, the seal strip will be maintained at least close to the fins inasmuch as its resiliency will enable its outer surface to conform to the fins on the outermost tubes and then return to its original shape. Also, due to this resiliency and ability to conform, the strip need not be bent to any particular shape, and instead may be merely flat on each side to thereby simplify manufacturing procedures. Furthermore, and as well known in the art, foam material of this type is economical and readily available on a commercial basis.

In a preferred embodiment of the invention, the side of the strip on at least one outer side of the bundle actually engages, and in fact is precompressed by, the fins on the outermost tubes under nominal conditions. In this manner, the space in which the strip is disposed is maintained at least substantially closed even though the bundle moves away from the frame member on which the strip is disposed, as for example, in the case of the side of the bundle nearer a fixed point of the manifold. In this latter case, of course, the other strip need not be so engaged, or at least not precompressed to the extent of the other strip, because the adjacent side of the bundle moves toward the frame member on which such other strip is disposed. As a practical matter, however, the strips on each side frame member are similarly constructed since the arrangement of the apparatus in the overall system and particularly relative to the fixed portion of the manifold, may not be predetermined. Also, of course, the tube bundle may be shifted from its nominal position while being installed, and thus even before undergoing the effects of the thermal changes in the system. In any event, this presents no problem because the great degree of flexibility of the foam material provides the apparatus with large tolerances.

Still further, many commercial sources offer resilient foam material which is stable up to very high temperatures, and also which is self flame extinguishing, which renders strips made of it particularly well suited in the environment in which apparatus of this type is installed and used. Thus, in use, finned tubes may be raised to extremely high temperatures. Also, during installation, welding torches are often used in and around the spaces between the bundle and frame member.

In the drawings,

FIG. 1 is a perspective view of the overall apparatus of the present invention, including a tube bundle supported between longitudinally extending frame members of a framework, and further illustrating the manifolding connected to the headers of the tube bundle and struts and fan rings mounted above the framework;

FIG. 2 is an enlarged cross-sectional view of the apparatus, as seen along broken line 2—2 of FIG. 1;

FIG. 3 is a further enlarged cross-sectional view of a portion of the apparatus; and

FIG. 4 is an enlarged longitudinal sectional view of the apparatus; as

FIG. 5 is an enlarged longitudinal sectional view of the apparatus, as seen along broken line 4—4 of FIG. 1, and broken away along an intermediate portion thereof.

With reference now to the details of the above-described drawings, the overall assembly shown in FIG. 1 includes a framework 10 having longitudinally extending, laterally spaced-apart frame members 11, which conventionally interconnected by laterally extending cross frame members 12 (see FIG. 3) and thus held in fixed laterally spaced-apart relation. As well known in the art, this framework 10 is fixed in a sense that once installed, it is movable neither in a lateral nor longitudinal sense. A tube bundle 13 is supported by the framework 10 for extension longitudinally intermediate the frame members 11. More particularly, and as shown in FIGS. 2 and 3, the bundle is supported along each side by angles 14 on each frame member 11 and at spaced location along its length by the crossmembers 12. As well known in the art, this support enables the tube bundle to shift laterally between the side frame members 11.

As also well known in the art, the tube bundle is made up of longitudinally extending, parallel tubes 15 connected to headers 16 at each end and having fins 17 along their lengths for increasing their heat transfer characteristics. As is apparent from the drawings, the framework is open above and below the tubes to permit airflow, as well known in the art.
As shown in FIG. 1, manifolding 18 is connected to each of the headers 16 for circulating fluid to be cooled through the finned tubes 15, again in a manner well known in the art. Ordinarily, the manifolding connects a bank of tube bundles 13 in parallel, and, in the particular arrangement shown in FIG. 1, the bundle 13 would be at one end of the bank where the manifolding terminates. Thus, the manifolding extends outwardly from a fixed point and due to thermal changes in the system, expands and contracts with respect to that fixed point, and thus with respect to the fixed framework 10. Consequently, and as previously described, the tube bundle connected to the manifolding will be caused to shift laterally with respect to the side frame members 11, and since the tube bundle 13 is on the outer end of the bank, it will undergo even expansion and contraction than the bundles closer to the fixed point of the manifolding.

As shown in FIG. 1, each manifolding 18 includes a generally horizontally extending main conduit 19 and stubs 20 extending downwardly therefrom for connection to the headers 16. Circulation may, of course, be in either direction, i.e., from one header to the other. Also, in other arrangements the circulation may be reversed, i.e., from one header to the other and then back from the other header to the one header. However, these various arrangements are well known in the art and have no bearing on the present invention.

A pair of shrouds 21 are mounted above the open top of the framework 10 and thus over the tubes of the bundle 13. As well known in the art, these shrouds support rings 22 which conventionally surround fan 23 (not shown) for inducing airflow across the tubes 15 of the tube bundle. Again, of course, the construction of the shroud and fan rings has no bearing on the present invention, and is described merely for illustrative purposes.

As best shown in the sectional views of each of FIGS. 3 and 4, the opposite sides of the tube bundle 13 are spaced from the inner sides of the adjacent longitudinally extending frame members 11. The minimum spacing is, of course, defined by the distance between the header 16 of the bundle and the adjacent inner sides of the frame members, as shown in FIG. 2. Thus, as previously described, this spacing is required in order to accommodate the lateral shifting of the bundle which occurs, upon assembly and/or use of the apparatus, over the flanges 14 and crossframe members 12.

In any event, the outermost tubes 15 of the bundle are spaced even a greater distance from the inner side of the frame members 15 than the headers, and, as previously described, if these spacers are not “sealed” or substantially closed, there would be a considerable loss of efficiency of the apparatus. Particularly, a large part of the air flowing across the bundle does not contact the fin surface.

As previously described, in accordance with the present invention, this space is at least substantially closed or sealed by a strip 23 of resilient foam material extending longitudinally along the inner side of the frame member 11 from one header 16 to the other and for a height substantially equal to that of the headers. Moreover, and as also shown in these figures, one side of the strip 23 extends along the inner side of the frame member, and its opposite side is at least close to, and preferably engaged with, the fins of the outermost tubes of the tube bundle so that under nominal conditions, the strip is precompressed, as best shown in the detailed view of FIG. 3, to about 20 percent of the outside diameter of the fins 17 of the tube. As will be apparent from FIG. 3, even when so precompressed, the strip does not prevent airflow about the outer sides of the outermost tubes itself.

In any event, the precompression is ideally designed to allow for the maximum expected movement of the outermost finned tubes, in the position they occupy under nominal conditions, away from the adjacent strip without losing contact with the strip, or at least without becoming spaced from the strip more than a small amount. In the case of the system illustrated in FIG. 1, the movement or lateral shifting of the tube bundle would, upon an increase in thermal conditions, be expected to be from left to right as the temperature of the system increases above nominal conditions. In this case, with the strip on the right-hand side of the tube bundle precompressed under nominal conditions, the fins of the outermost tubes of the right side of the bundle will further compress the strip. However, the low density, resilient foam material contemplated by the present invention will easily permit such further compression without permanent deformation. Consequently, upon cooling of the system and thus shifting of the bundle from right to left, the strip 23 on the right side of the apparatus will follow the leftward movement of the fins and thus return to the position shown in FIG. 3.

At the same time, precompression of the strip on the left side of the bundle, which would be similar to that illustrated by the right side strip 23 of FIG. 3, would permit this lateral shifting of the bundle to the right without losing more than a very small amount of contact with the fins, as previously mentioned. Then, of course, upon cooling of the system, the outermost tubes on the left side of the bundle would return to strip-precompressed position.

As previously described, this invention contemplates that the strip 23 may be flat on each side, thereby avoiding any complicated and expensive prefabricating procedures. Ordinarily, the outer side of each strip will be secured to the inner side of the mesh frame member 11 by means of a suitable adhesive. Due to the compressibility of the resilient foam material, the preassembly of the strips along the length of the frame members presents no problem in the later assembly of the tubes of the tube bundle between frame members.

As also previously indicated, resilient foam materials suitable for use with the present invention, preferably polyurethane or polyether, are available from many commercial sources. Common materials of this latter type are of low density and thus permit a great degree of flexibility. They are also conventionally stable under the high temperatures which make them especially well suited for the present invention. For example, it has been determined that strips of such material will remain stable when precompressed by finned tubes raised to a temperature as high as 450° F. For a sustained period of two weeks.

A still further desirable characteristic of some of these resilient foam materials is their ability to extinguish flame, which, as previously indicated, may be encountered during installation or repair of the assembly. This characteristic results from the incorporation in the material of chlorine, which is released by the heat of the flame.

From the foregoing description of one embodiment of this invention by way of example, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinafore set forth, together with other advantages which are obvious and which are inherent to the apparatus and structure.

The invention having been described, what is claimed is:

1. A fire cooler apparatus, comprising a framework including longitudinally extending, laterally spaced-apart frame members, a tube bundle including a plurality of parallel, finned tubes and a header at each end of the tubes, means on the framework supporting the tube bundle between the frame members and with the tubes extending longitudinally of the frame members in position to be contacted by air flowing between said members, said tube bundle being slidable laterally of the supporting means to compensate for differential lateral movement between the framework and tube bundle, and a strip of resilient foam material having the side extending longitudinally along the inner side of each frame member and its opposite side extending longitudinally along the adjacent outer side of the bundle and continuously for substantially the entire length of the outermost tubes, said opposite side of the strip being at least close to the fins of the outermost tubes on said side of the tube bundle under nominal conditions and thus positioned for being directly engaged by said fins.
2. Apparatus of the character defined in claim 1, wherein the side of the strip along at least one outer side of the bundle engages the fins of said outermost tubes.

3. Apparatus of the character defined in claim 2, wherein said side of the strip is precompressed at its engagement with said fins.

4. Apparatus of the character defined in claim 1, wherein the side of each strip engages the fins of the outermost tubes of the adjacent outer side of the bundle.

5. Apparatus of the character defined in claim 4, wherein the side of each strip is precompressed at its engagement with said fins.

6. Apparatus of the character defined in claim 1, wherein said strip material is stable up to a temperature of at least 450°F.

7. Apparatus of the character defined in claim 6, wherein said strip material is self flame extinguishing.