May 6, 1941. E. S. LEA 2,241,209

FINNED CONDENSER TUBE

Filed June 8, 1940

Fig. 1.

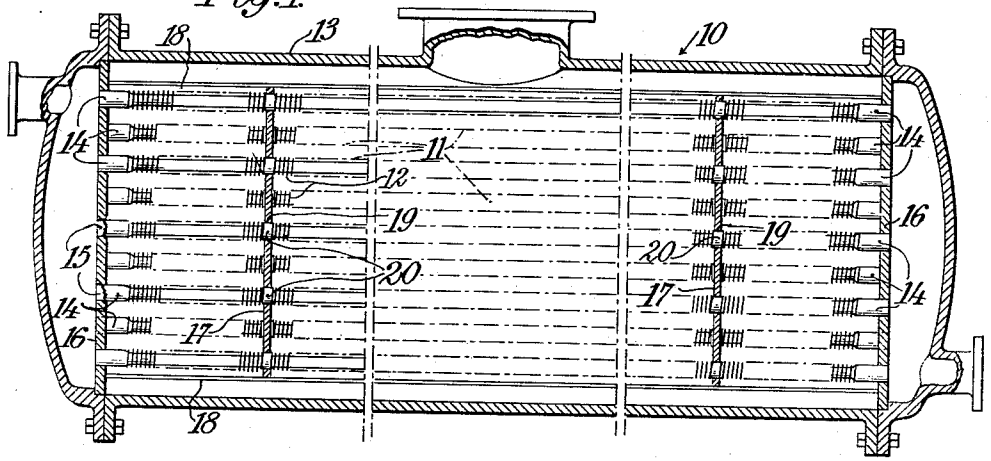


Fig. 2.

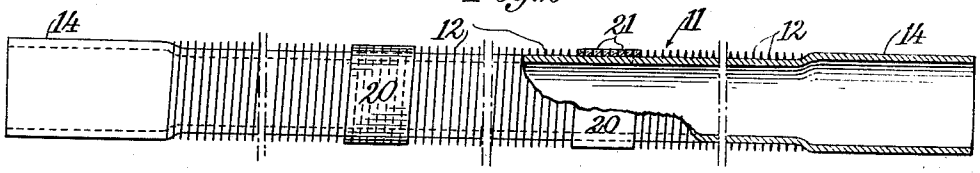


Fig. 3.

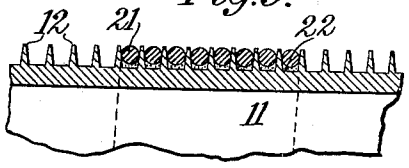


Fig. 4.

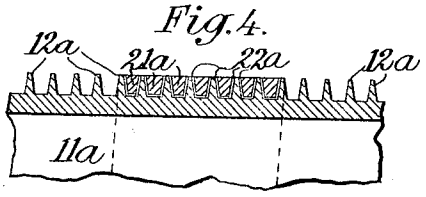


Fig. 5.

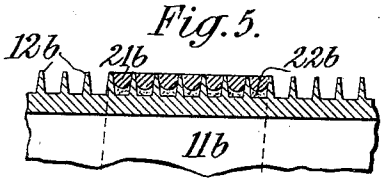
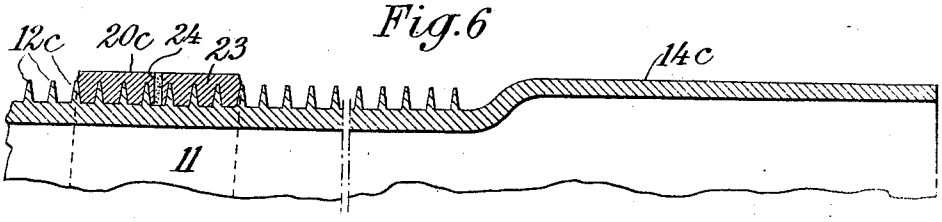


Fig. 6



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FINNED CONDENSER TUBE

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Application June 8, 1940, Serial No. 339,434

10 Claims. (Cl. 257—236)

This invention relates to heat exchangers and more particularly to the improvement of tubes employed in an exchanger of the shell and tube type.

The principal object of the invention is to provide for the supporting of a heat exchanger tube having fins formed integrally upon its outer surface at some point intermediate its ends, and to do this in such a way as to avoid any rubbing of the tube against its support in shipment or when the exchanger of which it is a part is placed in operation.

It is a more specific object of the invention to provide a heat exchanger tube having a helical fin comprising an integral part of its outer surface, and an end portion of substantially the same diameter as the fin, with one or more bearing portions between its ends which have smooth substantially cylindrical surfaces with an outside diameter at least equal to that of the adjacent fins, whereby the tube may be passed through openings in a tube sheet and a supporting sheet, and whereby the bearing portion may be expanded to secure it firmly to that sheet.

These and other objects, as well as various features of the invention, may be better understood from a consideration of the following description in the light of the accompanying drawing in which:

Fig. 1 is a sectional view of a heat exchanger having a bank of tubes constructed in accordance with the invention.

Fig. 2 is a plan view on an enlarged scale, of one of the tubes of the exchanger of Fig. 1.

Fig. 3 is a sectional view on an even larger scale of a fragment of the tube of Fig. 2.

Figs. 4, 5 and 6 are sectional views of fragments of heat exchanger tubes similar to that shown in Figs. 2 and 3, and having bearing portions formed in different ways in accordance with the invention.

The present invention proposes to employ in a shell and tube heat exchanger 10 (Fig. 1) a plurality of heat transfer tubes 11 having finned portions 12 formed on their outer surfaces. The function of the fins to increase the area available for heat transfer between a refrigerant vapor, for example, confined within the shell 13 and in contact with the tubes, and water passing through the tubes, will be fully understood by those familiar with this art. Suffice it to say that by using the finned tubes it is possible to secure an equal heat transfer with a lesser number of them, or a much greater transfer capacity with an equal number, all as compared with an exchanger having plain surfaced tubes.

It has heretofore been the practice to form tubes of this general character by winding a strip of metal, sometimes ¼" wide, occasionally ⅜" or more, on edge about the tube with a lead between convolutions of from ¼" to ⅜"; and then to apply solder to hold the helical fin in place. In the present instance, however, the fin comprises an integral part of the tube. Thus, a seamless copper tube is rolled in such a manner as to raise the helical fin 12 upon its outer surface (Figs. 2 and 3). The integral fin has the great advantage of being perfectly bonded to the main body of the tube, and the economic advantage of avoiding the need for solder or some other bonding agent. While it is difficult to roll a fin in this fashion to a height comparable to that of the separately applied fin of the prior art, the same general effect can be obtained by forming the convolutions at closer intervals, that is to say, by reducing the lead of the helix. Thus, and as is shown very clearly in Fig. 2, the fin 12 projects about $\frac{1}{16}$" above the surface of the tube. The lead of this fin, however, is only about $\frac{1}{16}$" so that the total fin area approximates that of prior extended surface tubes having a separately applied fin.

The end portions 14 of the tube are of smooth, cylindrical form and are accordingly adapted to be expanded into circular openings 15 to join the tubes to the tube sheets, or header plates 16, which constitute the ends of a completed tube bank (see Fig. 1). It is highly desirable that at least one of these end portions 14 be of the same diameter as the adjacent fin portions so that the entire tube may be passed endwise through the openings in the tube sheets to facilitate the assembly of the tube bank, or to permit the removal and replacement of one or more of these tubes without removing a tube sheet or otherwise disassembling the bank. Accordingly, at the completion of the fin rolling operation, at least one end portion 14, and preferably both, is expanded by rolling or otherwise to the diameter of the fins.

In order to support the tubes which may be and frequently are 10 to 12 ft. long or even longer, one or more supporting plates 17 are included at points intermediate the ends of the bank, these supporting plates being welded to angle irons 18 which join the tube sheets 16 and being provided with circular openings 19 equal in diameter to the openings 15 in the tube sheets.

It has always been a problem in this art to

join the tubes firmly to these supporting plates. It has not been unusual, even with exchangers employing plain surfaced tubes, to find that tubes which left the factory in perfect condition, rubbed against their supports during shipment to such an extent as to cause leaks. In many other instances the vibration of the equipment in operation produced similar accidents within unreasonably short times. This problem becomes even more acute when finned tubes are employed. The edges of the fins do not present enough area to give a firm bearing with the supporting sheet, nor is it possible to strip away a section of the fin to leave a plain surface for engagement with the supporting plane. If the latter were attempted, it is evident that the tube could not be passed through the openings 18 in the supporting plates and then be firmly engaged with that support. In the illustrative case there would be about ⅛" between the surface of the tube from which the fin had been removed, and the adjacent surface of the support, a space which it would be all but impossible to fill.

In order to solve this problem the tubes 11 of the present invention are provided with definite bearing areas 20 raised to the full height of the fin 12 or higher and having smooth substantially cylindrical surfaces adapted to be engaged firmly in the openings 19 in the supporting sheets. It is evident that a tube of the described kind may readily be passed through the openings in the tube sheets 16, and through the openings in the supporting plates 17, during the assembly of the bank, or in the event that a tube must be replaced; and that the end portions 14 of the tubes may then be expanded to secure them to the tube sheets, and that the smooth bearing portions 20 may likewise be expanded to fill the openings 19 and thereby to secure them to their supporting plates. In the completed bank these tubes will be fully supported. There can be no relative movement between them and their supports, and accordingly, there can be no destructive rubbing between the parts.

According to one modification, as is shown in Figs. 2 and 3, each bearing area is formed by winding a piece of wire 21 around the tube between the convolutions of the helical fin, and by applying solder 22 to hold the wire in place. In this modification (Fig. 3) the wire is of circular cross-section having a diameter approximately equal to the spacing between adjacent fin convolutions. The solder thus serves not only to hold the wire in place but also to fill the space between the tube and the wire.

Various forms of shaped wire may be employed in the building up of the bearing portions in place of the circular wire illustrated in Figs. 2 and 3. Thus, as shown in Fig. 4, the wire 21*a* may have the exact cross-sectional shape of the space between the fins 12*a*, and in such a case only a very small amount of solder 22*a* will be needed, just enough to bond the wire to the tube 11*a*. In Fig. 5 a wire 21*b* of "half round" section is employed, solder 22*b* again being applied to bond the wire to the tube 11*b* and to fill the space between that wire and the fin 12*b*.

In another modification of the invention (Fig. 6) a solid nut 23 having a smooth cylindrical outer surface, and an internal thread of a shape corresponding to that of the space between adjacent convolutions of the fin 12*c* and a lead corresponding to that of the helix which the fin describes, is used to form the bearing portion 20*c*. After the nut has been applied to the tube, it may be fixed in place by the application of solder through the hole 24. It will be recognized that in applying this modification of the invention to the tube of Fig. 2, it will be necessary to thread the nut on that tube before its end portions 14*c* are expanded. If, however, and as is entirely possible, but one end portion is to be expanded to the full diameter of the fin, the other being of cylindrical form but of smaller diameter, then the nut 22 may be applied at any time. There is a further point to be noted in connection with this modification of the invention. Where a tube having a nut 23 as its bearing portion is to be included in an exchanger from which it must be withdrawn in an endwise direction, and without removing either of the tube sheets, then it is essential that the end portions 14*c* of the tube be expanded to such an extent that their outside diameter corresponds to that of the nut which, as is readily evident, is of somewhat greater diameter than the adjacent fin of 13*c*.

Each of the various tubes which are here illustrated has a helical fin portion. That type of fin is preferred because it is the easiest to form integrally with the tube, and because it makes possible the use of a simple piece of wire in the building up of a bearing portion or the application of a nut to form the bearing portion. Literally, the tube has but a single fin. It is conventional in the art, however, to refer to it as a finned tube or as a tube having a plurality of fins formed on its surface. Where these terms are used, they will be understood to refer to a tube having a helical fin, or to one having a series of fins of circular or other form.

Since certain changes may be made in carrying out the invention, all within the skill of the mechanic in the art, it is intended that the foregoing shall be construed in a descriptive rather than in a limiting sense.

What I claim is:

1. In a heat exchanger, a metal tube having a plurality of fins extending radially from its outer surface and a substantially firm bearing portion formed between its ends; and a supporting sheet having an opening therein of a diameter at least equal to that of said fins through which opening said tube extends; said bearing portion comprising metallic means engaging said tube and providing it with a substantially smooth cylindrical outer surface of a diameter which is at least substantially equal to the outside diameter of said fins, and said tube being supported by said sheet by having its bearing portion snugly fitting the opening in said sheet.

2. In a shell and tube heat exchanger, a plurality of metal tubes disposed in closely spaced parallel relation, each such tube having fins extending radially from its outer surface and a substantially firm bearing portion formed between its ends, said bearing portion comprising metallic means engaging said tube between adjacent fins and providing it with a smooth surface having an outside diameter at least equal to that of said fins; oppositely disposed header plates and an intermediate supporting plate, said plates having aligned openings therein through which said tubes extend; said tubes having their ends secured in the openings in said header plates, and their bearing portions expanded into and filling the openings in said intermediate supporting plate.

3. In a shell and tube heat exchanger, a metal tube having a helical fin extending radially from its outer surface and a substantially firm bearing

portion formed between its ends, said bearing portion comprising metallic means substantially filling the spaces between adjacent convolutions of said helical fin and forming a smooth cylindrical surface having an outside diameter at least equal to the diameter of said fin; and a supporting sheet having an opening therein of a diameter at least equal to that of said fin through which opening said tube extends; said tube being secured to said sheet by having its bearing portion expanded into the opening in that sheet.

4. In a heat exchanger according to claim 3, further characterized in that said metallic means comprises a piece of wire wound around said tube between the convolutions of said helical fin, and means securing said wire to said tube, and in that said wire engages said tube and substantially fills the space between adjacent convolutions of said fin.

5. In a heat exchanger according to claim 3, further characterized in that said metallic means comprises a piece of wire wound around and engaging said tube between adjacent convolutions of said fin, said wire having a flat outer surface substantially aligned with the outer edges of said fin portion and substantially bridging the space between the adjacent convolutions, and means for bonding said wire to said tube.

6. In a tube for a heat exchanger according to claim 3, further characterized in that said metallic means comprises a piece of wire wound around said tube between the convolutions of said fin portion, said wire having a cross-sectional shape such as substantially to fill the space between adjacent convolutions of the fin and a flat outer surface substantially aligned with the outer edges of such fins, and means for holding said wire upon said tube.

7. In a tube for a heat exchanger according to claim 3, further characterized in that said metallic means comprises a nut threaded upon the helical fin portion of said tube, said nut having internal threads of a shape such as substantially to fill the space between adjacent convolutions of the fin portion and a cylindrical outer surface.

8. In a heat exchanger according to claim 3, further characterized in that said metallic means comprises a piece of wire wound around said tube between the convolutions of said helical fin and in that said wire engages said tube and substantially fills the space between adjacent convolutions of said fin.

9. In a heat exchanger according to claim 3, further characterized in that said metallic means comprises a piece of wire wound around said tube between the convolutions of said helical fin and solder securing said wire to said tube and in that said wire and said solder form a cylindrical surface substantially aligned with and including the outer edges of said fin.

10. In a heat exchanger according to claim 1, further characterized in that said tube has a helical fin, in that said means comprises a piece of wire wound around said tube between the convolutions of said helical fin, and means securing said wire to said tube, and in that said wire engages said tube and substantially fills the space between adjacent convolutions of said fin.

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