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Kaelin

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[54] **METHOD OF MAKING A HEAT TRANSFER DEVICE**

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[73] Assignee: **Sulzer Brothers Limited,** Winterthur, Switzerland

[22] Filed: **Sept. 25, 1970**

[21] Appl. No.: **75,480**

Related U.S. Application Data

[62] Division of Ser. No. 626,453, March 28, 1967, Pat. No. 3,616,848.

[52] **U.S. Cl.** ..... **29/157.3 B,** 29/157.3 R, 29/433, 165/67, 165/162, 165/163

[51] **Int. Cl.** **B21d 53/02**

[58] **Field of Search** ..... 29/157.3 B, 157.3 R, 29/433; 165/67, 162, 163, 178; 122/249, 250; 55/269

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Assistant Examiner—D. C. Reiley, III
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[57] **ABSTRACT**

The heat transfer system includes a plurality of wound tube coils fixed within the holes of at least three plates disposed in a radiating axial manner from the axis of the system. The tube coils are wound helically or spirally and are fixed at three points about the holes through which they pass.

3 Claims, 12 Drawing Figures

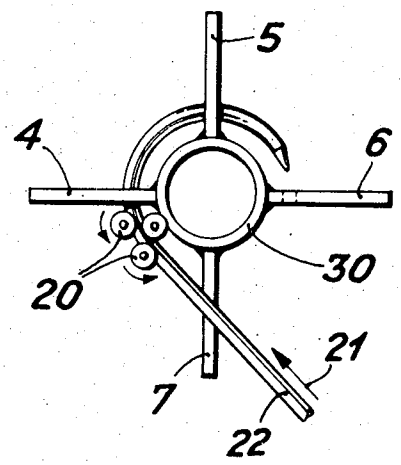


Fig. 1

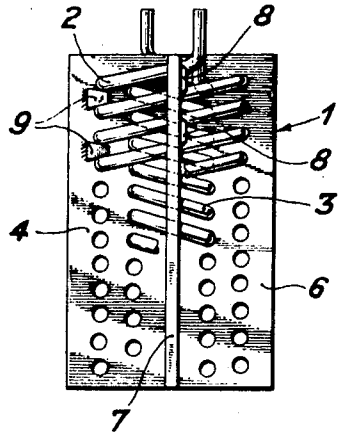


Fig. 3

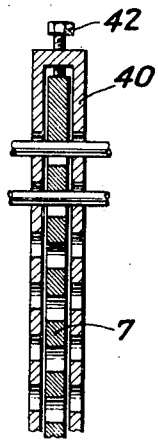


Fig. 4

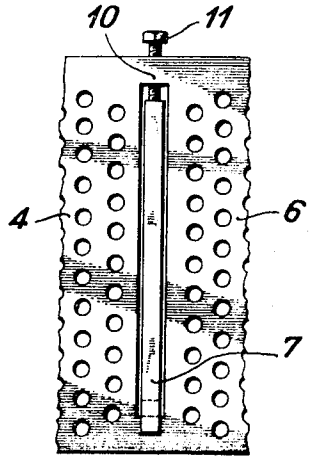


Fig. 2

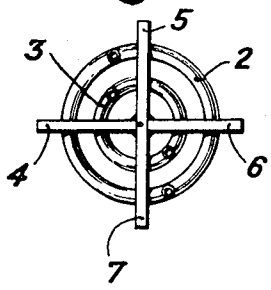


Fig. 5

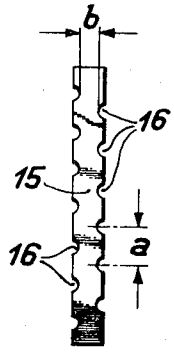


Fig. 6

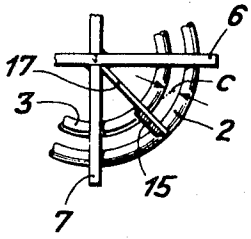


Fig. 7

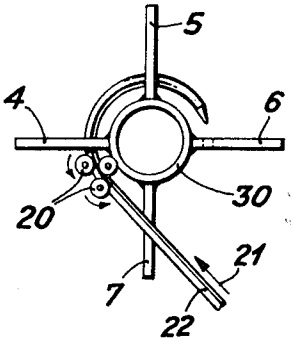
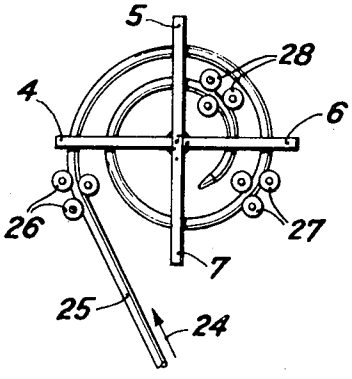


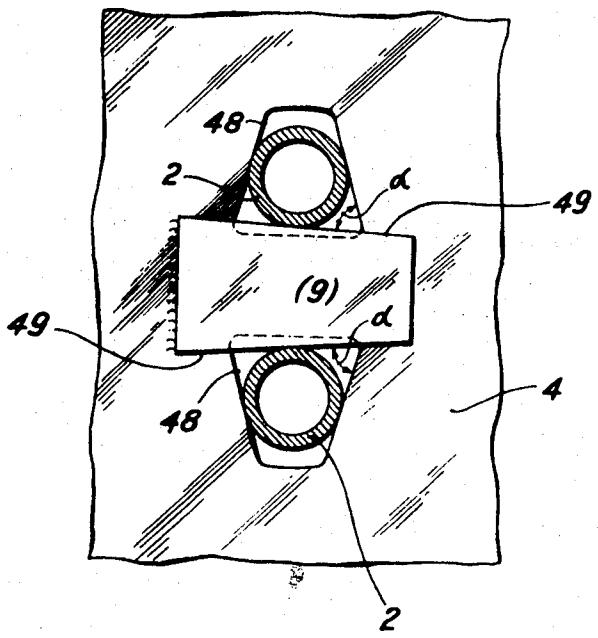
Fig. 8



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Fig. 9



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Fig.10

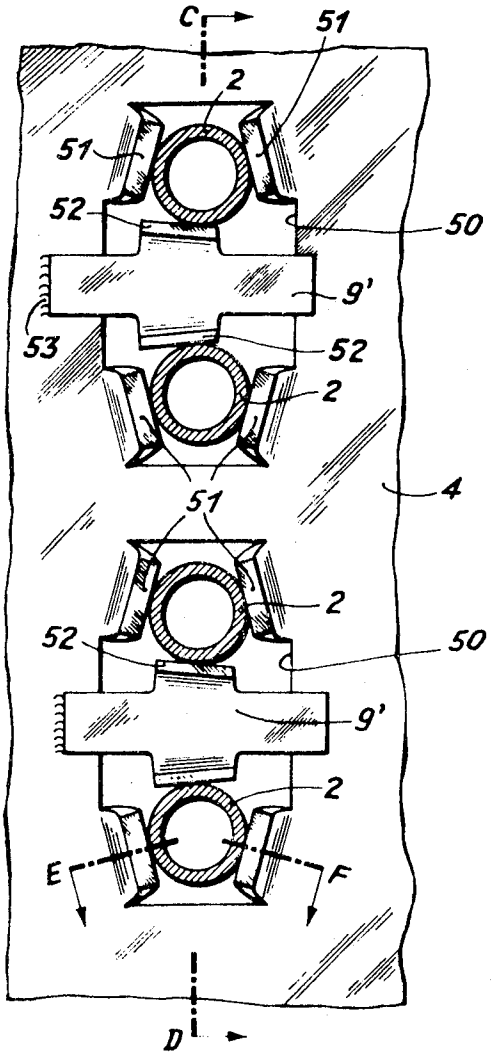
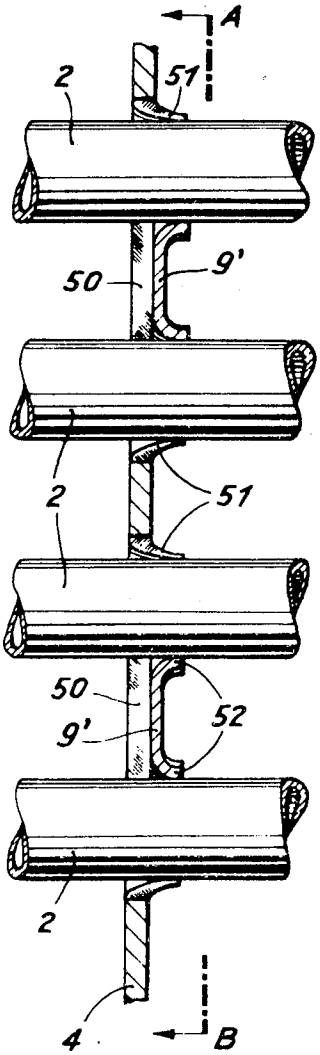


Fig.11



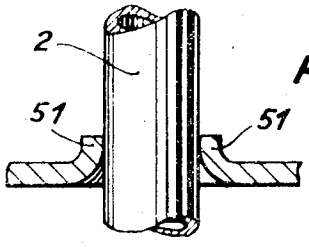


Fig.12

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METHOD OF MAKING A HEAT TRANSFER DEVICE

This is a division of application Ser. No. 626,453, filed Mar. 28, 1967, now Pat. No. 3,616,848.

The invention relates to a method of making a heat transfer device. More particularly, the invention relates to a method of making a heat transfer assembly including a cluster of at least one helically or spirally wound tube.

Heretofore, heat transfer systems of the above kind have had the tube coils fixed spatially by bands and screws. However, this construction as well as the methods for attaching such has been complicated and very time consuming and as a result has been expensive.

Briefly, this invention provides a heat transfer system having a cluster or plurality of tubes at least one of which is helically or spirally wound into a tube coil and a plurality of plates which mount the coils of the tube coils and which are disposed radially of the coils and axially of the tube cluster. The plates are provided with holes through which the coils of a tube coil pass and are provided with locking means for fixing the coils within the plates.

In one embodiment of the invention, a wedge is inserted at the locations where the coils pass through the plates between a pair of adjacent tube coils in wedging relation to the coils and rigidly connected, as by tack welding, to the adjacent plate. Similar wedges are secured to each plate between each pair of tube coils so that only one wedge on a plate is used or each pair of tube coils thereby reducing the number of wedges.

In another embodiment of the invention, the tube coils pass through wedge-shaped holes in the plates and contact with two spaced points around the hole. Also, a wedge is secured at one end to a plate and disposed in wedging relation to a tube coil passing through the holes of the plate. This effects a three point support for each tube passing through a plate while maintaining the initial stress between the wedge and tube. In the event that a tube coil should become loosened the play between the tube and any of the three points of support is slight.

In another embodiment, each of two adjacent wedge-shaped holes are disposed with the board ends in facing relation and a wedge is wedged between the tube coils passing through these holes. This enables two adjacent tubes to be fixed by a single wedge so that each tube has a three point support. This embodiment can be further modified by enlarging each pair of facing wedge-shaped holes so as to form a single slot and by wedging a single wedge between the pair of tube coils passing through the slot. This modification allows a reduction in weight of the plates without affecting the securement of the tube coils in the plates.

In still another embodiment, the sides of the holes or slots which contact the tube coils are formed with outwardly bent flaps which are disposed out of the plate plane and bear resiliently on a tube coil to prevent loosening of the tubes. These flaps bear against the tube coil even during variations in temperature. Likewise, the wedges are formed with resilient flaps which extend transversely to the plane of the wedges to bear resiliently on the tube coils.

Preferably, the angle between the bearing surface of a wedge and the wedge side of the hole adjacent to the narrow end of the wedge is more than twice the angle of friction.

In still another embodiment, the relative positions of the plates are altered with respect to each other after insertion of the tube coils either by altering the angular positions of the plates or the axial positions through the use of the fixing means. In this embodiment, the whole tube cluster is fixed in the plates with one adjusting movement. Alternatively, the relative positions of the tube coils can be altered after insertion in the plates to resiliently fix the tube coils in place. This is accomplished by positioning a bar axially of the tube cluster between radially adjacent tube coils in resilient engagement with the coils. Advantageously, the bar can have recesses into which each coil fits. The bar is secured in place by being welded to a cross-bar which is fixed to the plates at their point of intersection.

The method provided by the invention includes the steps of securing a plurality of apertured plates together to form a radiating plate structure, coiling at least one straight tube into a helical winding, and inserting the coiled portions of the tube through the apertures of the plates in a helical manner. A further method of the invention includes a simultaneous coiling and insertion through the apertures of the plates of the tube in a single operation.

Accordingly, it is an object of the invention to provide a heat transfer system having tube coils which are fixed in place in a single inexpensive manner.

It is another object of the invention to provide a wound tube coil in a plurality of radiating plates.

It is another object of the invention to support a tube coil in a plurality of plates with a three point support in each plate.

It is another object of the invention to position a wound tube coil in a plurality of radiating plates in a resilient manner.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates an elevational view of a heat transfer system according to the invention,

FIG. 2 illustrates a plan view of the system of FIG. 1;

FIG. 3 illustrates a section through a means for fixing the tubes of a heat transfer system of the invention in place;

FIG. 4 illustrates a fragmentary section through a modified means for fixing the tubes in place;

FIG. 5 illustrates a bar which is used in fixing tubes in place according to the invention;

FIG. 6 illustrates a fragmentary view of a heat transfer system using the bar of FIG. 5 to fix the tubes in place;

FIG. 7 schematically illustrates a method of making a heat transfer system according to the invention;

FIG. 8 schematically illustrates another method of making a heat transfer system according to the invention;

FIG. 9 illustrates an enlarged view of a pair of holes within a plate and a wedge wedging a pair of tubes into three point contact according to the invention;

FIG. 10 illustrates a view taken on line A-B of FIG. 11 of a modified heat transfer system of the invention;

FIG. 11 illustrates a view taken on line C-D of FIG. 10; and

FIG. 12 illustrates a view taken on line E-F of FIG. 10.

Referring to FIGS. 1 and 2, heat transfer system 1 consists essentially of pairs of tube coils 2, 3 of different radii and plates, for example, four plates 4, 5, 6, 7 which are disposed substantially at right angles to each other to mount the tube coils. The plates 4, 5, 6, 7 are welded together at the center of the heat transfer system 1 and radiate therefrom axially of the system. Each plate 4, 5, 6, 7 has a plurality of fully encompassed apertures or holes in the plane of the plate which are of radii corresponding to the radii of the tube coils 2, 3 so as to permit passage of a tube coil with a relatively clost fit. In addition, these holes are spaced in accordance with the coil intervals of the tube coils 2, 3. Wedges are secured to all the plates 4, 5, 6, 7 to wedge between the coils not only of the outer tube coil 2 but also the inner concentric tube coils 3 to fix the tube coils 2, 3 in the plates. For example, wedges 9 are inserted between each pair of coils of tube coil 2 near to the locations of the passage of the coils through the plate 4 and are secured, as by tack welds, to the plate 4 so as to fix the tube coil 2 in the plate 4. Similarly, wedges 8 are secured at one end to plate 7 and pass between the coils of the tube coil 2.

Referring to FIG. 3, instead of using wedges, the tube coils (only two of which are shown for clarity) pass through holes in the plate 7 as well as through a pair of aligned holes in a fork 40 which is slidably mounted over plate 7. The fork 40 has a threaded screw 42 which pass through the top into abutment with the top surface of plate 7 for moving the fork 40 up and down relative to plate 7. The fork 40 and screw 42 are dimensioned so that when the screw 42 is threaded outwardly of the fork 40 so as to permit the fork 40 to rest directly on the plate 7, the holes in the fork 40 and the holes in the plate 7 are coincidental. The coils of the tube coils can then be passed through these holes. However, when the screw 42 is threaded inwardly of the fork, the fork 40 moves upwardly of the plate 7 causing a misalignment of the respective holes. Thus, with the coils passing through the holes in the plate 7 and fork 40 and the screw being tightened to raise the fork, the walls of the holes in the fork and the wall of the hole in the plate bear against the coils to fix the tube coils in place. Similar fork-type fixing means are mounted on each plate over each vertical set of holes therein and each screw of a fork is screwed simultaneously into the fork when the coils of the tube coils are passing through the plates. Alternatively, a fork can be dimensioned to pass over a number of vertical sets of holes in the plates to grip and fix several radially juxtaposed coils.

Referring to FIG. 4, the plates instead of being fixed together at a common intersection point are constructed to pass one through the other. In such a case, a screw 11 is threaded into a threaded bore in a portion 10 connecting the opposite plates 4, 6 to contact the upper surface of the connecting portion between the remaining plates 5, 7. Upon insertion of the tube coils in the aligned holes of the respective plates, the screw 11 is tightened to shift plates 4 and 6 angularly relative to the remaining plates 5 and 7 as well as axially so as to fix the tube coils within the holes of the plates 4, 5, 6, 7.

Referring to FIG. 5, another means for fixing the tube coils in the plates consists of a bar 15, which has recesses 16 along its length on two opposite sides. These recesses are adapted to the radii of the tubes of the tube coils, and the distance a between them corresponds to the tube coil intervals. The distance b between the recesses 16 is greater than the radial distance c between the tube coils 2 and 3. The tube coils are fixed by first inserting the bar 15 between the coils 2 and 3, so that it is at right angles to the position shown in FIG. 6. When the bar 15 is situated at the correct height, it is turned 90° about its longitudinal axis, so that the recesses 16 bear on the tube coils 2 and 3. Because the distance *b* is greater than the distance *c*, the tube coils 2 and 3 are braced resiliently in a radial direction, and pressed firmly against the hole walls in the plates 6 and 7. The bar 15 is secured in the position shown in FIG. 6 by welding to it a cross-bar 17, which is welded to the plates 6 and 7 at the point where these plates meet.

Referring to FIG. 7, one method of making a heat transfer system, for example, having a plurality of apertured plates 4, 5, 6, 7 (as described above) secured in a radiating manner from a displacement cylindrical body 30 and disposed in spaced circumferential relation to each other, starts with the feeding of a straight tube 22 in the direction indicated by arrow 21 through a series of three rollers 20. As the tube 22 is shaped into a coil of constant diameter and constant coil interval by the rollers 20 it is fed perpendicularly (as shown) into the plates through the apertures in the respective plates 4, 5, 6, 7. Upon filling the innermost series of apertures in the plates, the next series of apertures is filled in the same manner; the distance between the rollers of the series of rollers 20 being adjusted in accordance with the different radius of curvature of the outer tube coil.

Referring to FIG. 8, where the tube coils are of a spiral configuration, a straight tube 25 is initially fed in the direction of arrow 24 through a roller system 26 positioned between adjacent apertured plates 4 and 7 to be bent into a curvature enabling it to pass through these consecutive plates 4, 5 and 6. Next, the curve tube is passed through second roller system 27 positioned between plates 6 and 7 to be bent into a curvature enabling it to be passed through the following three plates 7, 4 and 5. Finally, the curved tube is passed through a roller system 28 positioned between plates 5 and 6 to be bent into a curvature enabling it to pass through plates 6, 7 and 4. This method enable a heat transfer system to be constructed with spiral tube coils which may either extend in a plane parallel to the plane of the drawings or lie on a conical surface.

Referring to FIG. 9, the plates of the system, for example, plate 4, is provided with holes 48 of wedge-shaped outline for the passage of the coils of the tube coils 2. Each pair of adjacent holes 48 are disposed with the broad ends of the wedge-shape in facing relation. Each pair of holes 48 cooperates with a wedge 9 which is secured at its broad end, as by welding, to the plate 4 and is disposed between adjacent coils of pipe coil 2 to fix the coils to the plate 4. The wedge 9 is sized to press the coils through the wedge surfaces 49 toward and against the wedge sides of the holes 48 so that each coil is supported reliably at three points. The angle α between the wedge surface 49 and the wedge side of a hole 48 adjacent the narrow end of wedge 9 is larger than twice the angle of friction.

Referring to FIGS. 10 to 12, the means to fix the coils of tube coil 2 in the plates can also utilize slots 50 which have been formed from pairs of adjacent wedge-shaped holes which are interconnected through removal of the separating piece of the plate between them. In this case, each slot 50 has two pairs of flaps 51

bent from the plate 4 into the passage bounded by the slot and out of the plane of the plate 4 to resiliently bear against the two coils passing through the slot. Each pair of flaps 51 engage a single coil at two spaced points. A wedge 9' is disposed to extend over each slot 50 between the pairs of flaps 51 and coils and is secured as by a tack weld 53 to the plate 4 at one end. The wedge 9' has transversely extending flaps 52 along opposite sides which bear resiliently against the coils and cooperates with flaps 51 to support each coil at three points. This three point support fixes the coils in the plate 4 in a manner to flexibly receive any heat expansion between the coils and plate 4. In addition, this resilient fixing means prevents the occurrence of pitting which is of particular advantage where the heat transfer systems are used in nuclear reactors since the wear resulting from pitting could jeopardize the operation of the reactor.

In use, a heat conveying medium flows substantially axially around the cluster of tubes of the heat transfer systems of FIG. 1, 2, 7 and 9 to 12 whereas, the medium flows substantially radially through the clusters of tubes of the systems of FIG. 8.

It is noted that the coils of the pipe coils which carry known heat transfer mediums can be fixed to the plates of the heat transfer systems of the invention by welding, for example, by tack welds. Further, the number of radiating plates used in accordance with the invention may include three or more plates and may be uniformly or non-uniformly spaced from each other around the circumference of the system.

Having thus described the invention, it is not intended that it be so limited as changes may be readily made therein without departing from the scope of the invention. Accordingly, it is intended that the foregoing Abstract of the Disclosure, and the subject matter described above and shown in the drawings be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A method of making a heat transfer system having a plurality of wound tube coils fixed in a plurality of plates having fully encompassed apertures in the plane of the plates comprising the steps of

mounting the radiating plates in a secured radiating manner with the plates disposed in spaced circumferential relation,

bending a straight tube to impart a curvature therein,

coiling the curved tube about itself to form a tube coil, and

inserting the tube coil perpendicularly into the plates into and through the apertures of the apertured plates.

2. A method as set forth in claim 1 wherein the curved tube is coiled into a helical configuration and the helical tube coil is inserted into the apertured plates in a helical manner.

3. A method as set forth in claim 1 wherein said steps of coiling and inserting are performed simultaneously.

* * * * *