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[11] 3,782,455

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[54] **HEAT EXCHANGER TUBE MOUNTS**

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[52] **U.S. Cl.** **165/162,** 122/510

[51] **Int. Cl.** **F28b 9/00**

[58] **Field of Search** 165/158–162, 72; 122/32

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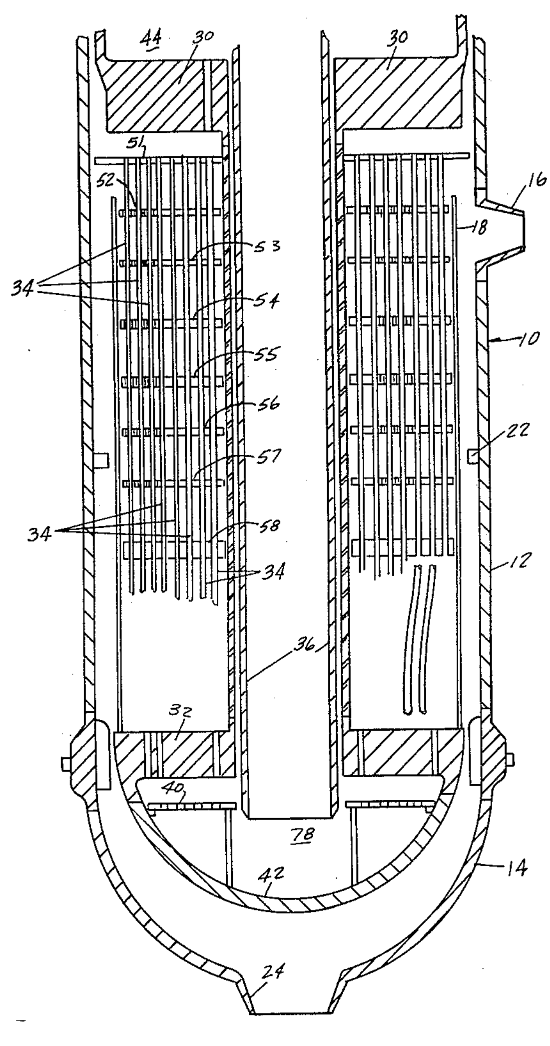
[57] **ABSTRACT**

A heat exchanger in which tubes are secured to a tube sheet by internal bore welding, which tubes may be moved into place in preparation for welding with comparatively little trouble. A number of segmented tube support plates are provided which allow a considerable portion of each of the tubes to be moved laterally after the end thereof has been positioned in preparation for internal bore welding to the tube sheet.

8 Claims, 6 Drawing Figures



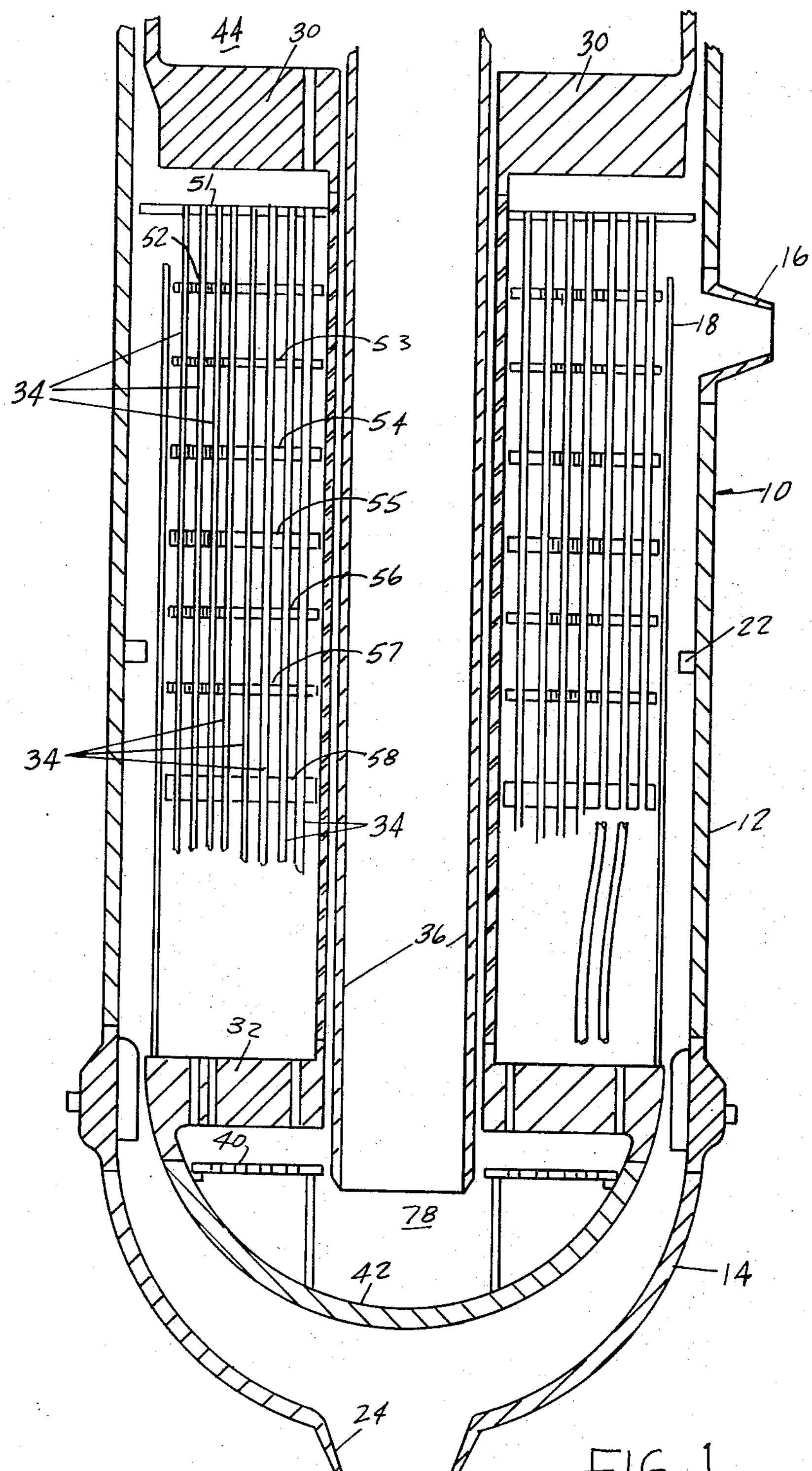

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FIG. 1

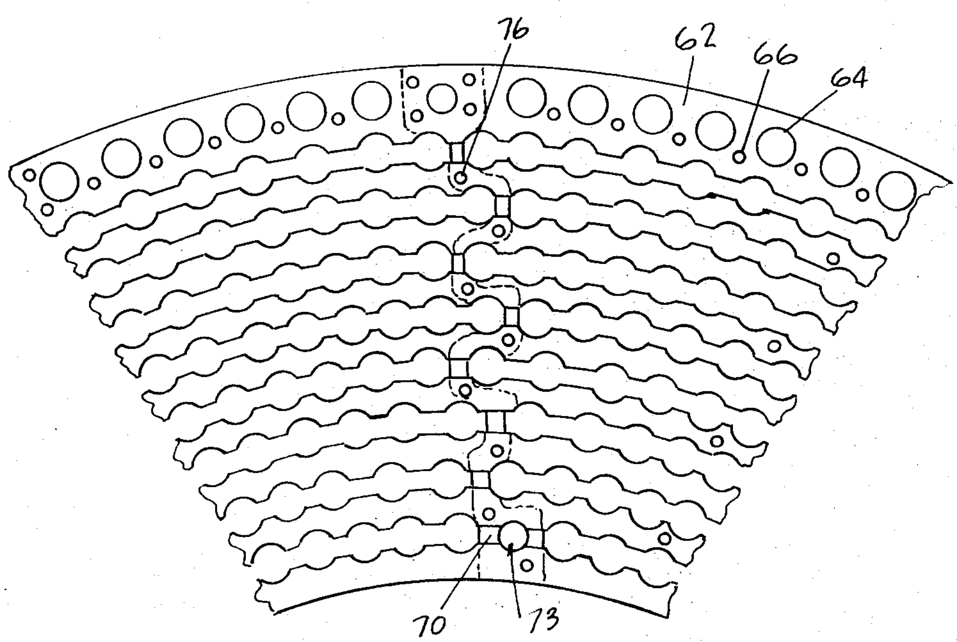


FIG. 2

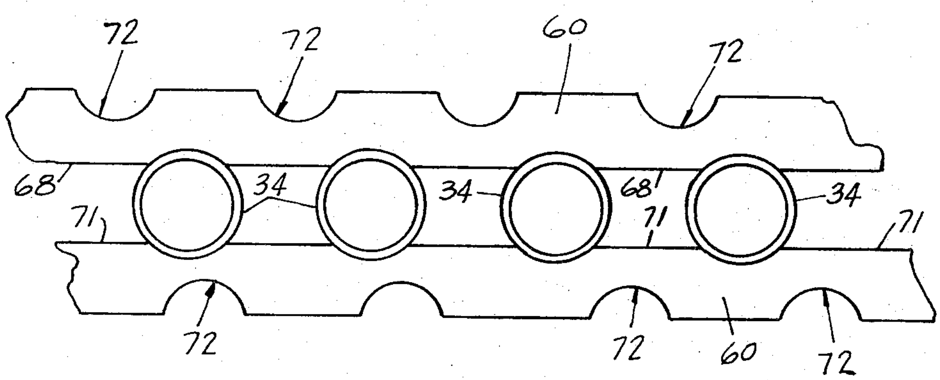


FIG. 3

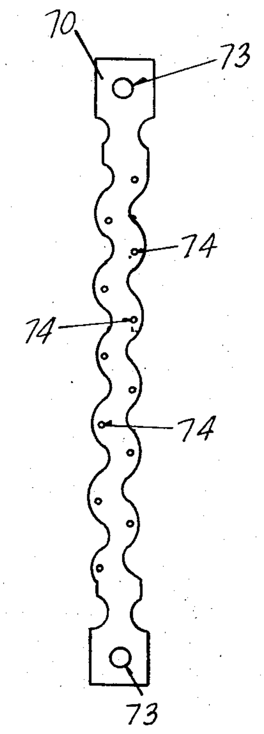


FIG. 4

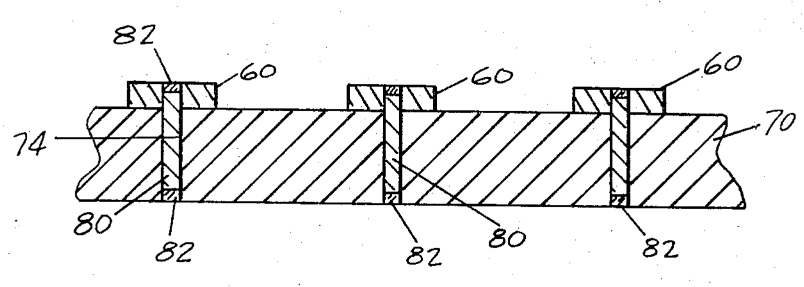
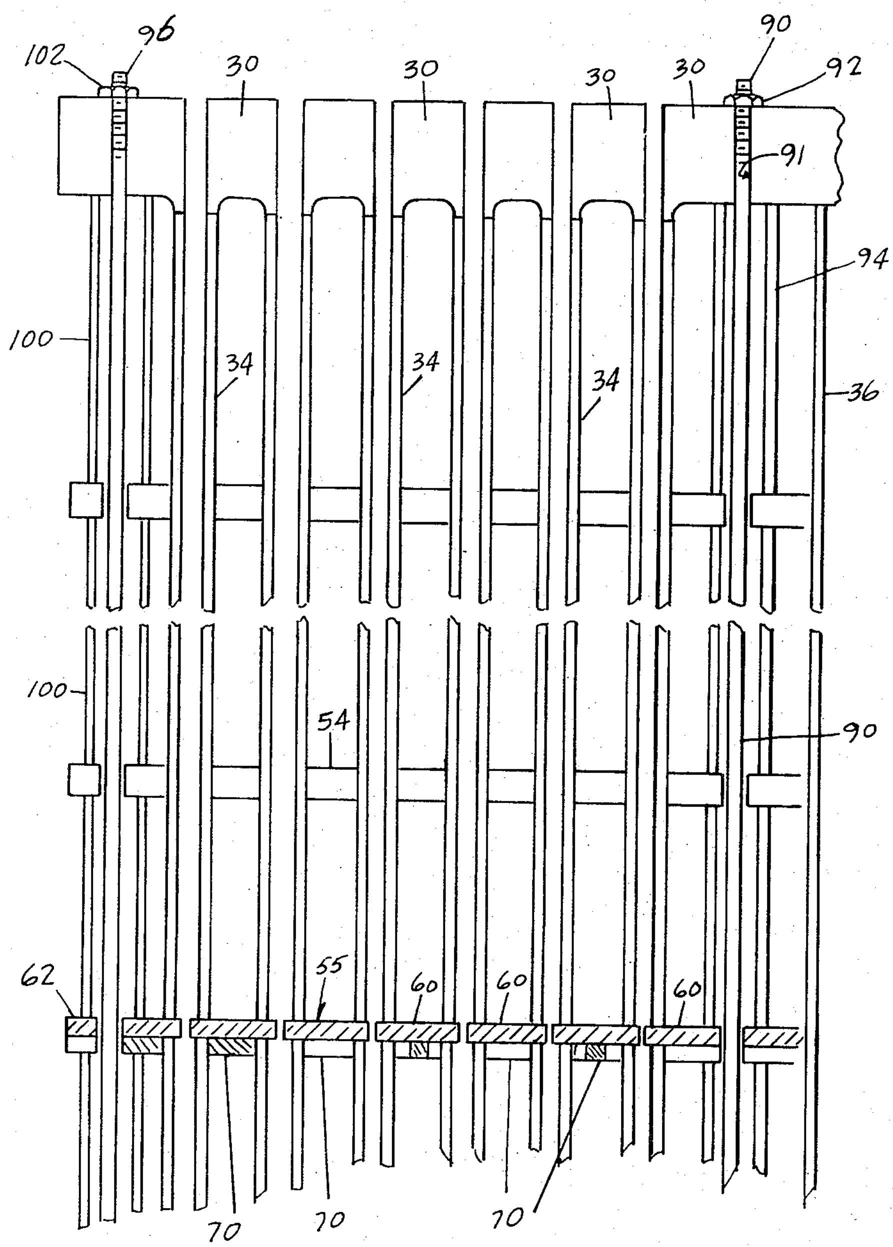


FIG. 5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96
30
30
30
30
90
92
91
94
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34
34
34
36
100
54
90
62
55
60
60
60
70
70
70

FIG. 6

HEAT EXCHANGER TUBE MOUNTS

BACKGROUND OF THE INVENTION

Most heat exchangers in which one fluid is placed in indirect heat exchange with another utilize a series of tubes to flow one fluid through, while the other fluid flows over the outside of the tubes. Tube sheets at one or both ends of the tubes are necessary to separate the fluid which flows through the tubes before and after their journey through the tubes from the other fluid which flows over the tubes.

This separation must be maintained and requires a hermetic seal between the outside of the tubes and the tube sheet or sheets to which the tubes are secured. The most common way to secure the tubes to a tube sheet is to drill as many holes through the tube sheet as there are tubes to be secured to it. Each tube is then positioned in one of the holes so that its end is flush with one side of the tube sheet. There are a number of well known methods of enlarging the tubes so that their outside surfaces engage against the inside surfaces of the holes. Whether or not the tubes are enlarged, they are usually welded to the tube sheet. The welds are effected at the ends of the tubes so that the end edge of the tube is welded to the adjacent tube sheet surface.

There are, however, situations where the above described construction cannot be used. For example, in heat exchangers used in nuclear power plants, it is often necessary to weld the tubes to the tube sheets by welds which are effected from within the tube sheet holes and tubes. This method of welding is often generically referred to as internal bore welding.

In internal bore welding, the tubes are each butt welded to tube sheets, usually at spigots projecting from the sheets. In the case where the tubes are internal bore welded between two tube sheets, it is impossible to move the tubes coaxially into position for welding because the tubes do not pass through the sheets. This creates a construction problem in heat exchangers where tube supporting structure is positioned between the tube sheets to prevent the tubes from being moved laterally between the sheets.

Another situation in which conventional contruction techniques cannot be used without problems is where the tubes must be bent over a portion of their length to allow for thermal expansion and contraction and supported along their length by tube supports. It is impossible to move these tubes axially into position to be welded once the bent portions come in contact with tube supports.

The several situations discussed above are examples where it is desirable to construct a heat exchanger by moving tubes laterally into position to be welded to a tube sheet.

SUMMARY OF THE PRESENT INVENTION

It is an object of the present invention to overcome drawbacks found in the prior art such as those discussed above. Accordingly, a heat exchanger with at least one tube sheet and a plurality of tubes which are supported along their length is provided with tube supports which have a number of circumferential bars which extend on each side of each tube and which are supported by a plurality of radial support bars and which can be secured to the radial bars after tubes have been moved radially into position to permanently support the tubes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a portion of a tube and tube sheet heat exchanger employing the tube supports of the present invention;

FIG. 2 is a view in perspective showing a portion of one of the tube supports of FIG. 1;

FIG. 3 is a view, partly in section, showing how the circumferential bars of the present invention support the heat exchanger tubes;

FIG. 4 is a plan view of one of the radial support bars shown in FIG. 2;

FIG. 5 is a view, partly in section, showing how the circumferential support bars are secured to the radial bars; and

FIG. 6 is an enlarged view showing the tube supports and their securement to the tube sheet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a portion of a heat exchanger made in accordance with the present invention. The heat exchanger designated generally as **10** has an outer shell **12** which is generally cylindrical, being tapered inward at the bottom **14** so that it is essentially closed at the bottom. The primary fluid enters at the primary inlet **16** to flow inward until it impinges against an annular shroud **18** to flow upward and over the top of the shroud **18** and then downward through a tube section **20** within the shroud **18** until it is below a seal **22** which is between the shroud **18** and shell **12** at a location below the intake **16.** The primary fluid then flows radially outward through openings in the shroud **18** to the space between the shroud **18** and the outer shell **12** to flow downward between them and out of the heat exchanger through the primary outlet **24.** The seal **22** creates a stagnant annular layer of primary fluid above it and between the shroud **18** and the shell **12.**

The tube section **20** includes two tube sheets, specifically an upper tube sheet **30** and a lower tube sheet **32** and a plurality of tubes **34** extending between the two tube sheets. The tube sheets are annular and encircle a central conduit **36** which feeds secondary fluid downward to a lower chamber **38** which is defined by an annular perforated distribution ring **40** and an inverted dome **42** below the ring **40.** The secondary fluid then flows upward through the ring **40** and then through the tube sheet **32** and the tubes **34.** The tubes **34** are distributed in the annular space between the central conduit **36** and the cylindrical shroud **18.** After leaving the tubes **34,** the secondary fluid flows through the annular upper tube sheet **30** to an upper chamber **44,** where it is collected and led out of the heat exchanger **10.**

The tubes **34** are supported along their length by a series of annular tube supports **51, 52, 53, 54, 55, 56, 57** and **58.** These supports allow the primary fluid to flow downward through them and at the same time, support and properly space the tubes **34.**

Because the primary fluid flows radially outward through the shroud **18** below the seal **22** to flow downward between the shroud **18** and shell **12,** the central conduit **36,** shroud **18,** tube sheet **32** and tube support **58** define an annular body of stagnant primary fluid. In passing between the tube support **58** and the tube sheet **32,** each of the tubes are bent. The bends allow for thermal expansion and contraction of each of the tubes **34** without tube failure. The bent portions are each situated in an area of stagnant primary fluid so that no vibration will be created by the flow of the primary fluid over the bent portions of the tubes **34**.

It has already been explained why it is necessary in many heat exchangers to be able to install the tubes **34** by moving them sideways into position so that they can be welded to the tube sheets **30** and **32**. In the heat exchanger **10**, it would not be possible to move the tubes **34** axially through one of the tube sheets and the tube supports toward the other of the tube sheets **30** and **32** over the distance between the tube sheets. It would not be possible to move the bent portions through the tube supports.

If it were attempted to move the straight portions of the tubes axially through all of the tube supports into engagement with the tube sheet **30**, the tubes would have to be distorted extremely before being passed through the tube support **58**. The problem is solved by designing several of the tube supports so that they can be assembled as the tubes are moved laterally inward to be engaged by those tube supports.

The tube supports **51, 52, 53** and **54**, which can be referred to as solid tube supports, plates with holes drilled in them to accommodate the tubes **34** and the tie rods which will be described hereinafter. The other tube supports, namely, **55, 56, 57** and **58** which can be referred to as segmental tube supports are constructed in sections as the tubes **34** are placed in position and welded. The tubes closest to the central conduit **36** are first welded in place and the tubes immediately outward of those are welded and then the tube outward of those are welded in place. The tubes are thus progressively welded until all are in place. The segmental tube supports thus allow the tubes to be positioned while being distorted only slightly below the lower most solid support **54** so that the upper end of the tubes can be moved axially through the supports **54, 53, 52** and **51** until the end of the tube abutts against the tube sheet **30**. Thereafter, the lower portion of the tube is moved laterally inward until the lower end is positioned against the lower tube sheet **32** for welding.

A section of a segmented tube support is shown in FIG. **2**. Essentially, it consists of a series of parallel curvilinear circumferential bars **60**, each of which makes up a portion of one of a number of concentric circles. The outermost circumferential bar **62** is slightly different in that it has a series of round holes through it so that it encircles the tubes which pass through the holes. The circumferential bar **64** also has a series of smaller holes **66** which allow primary fluid to pass easily through.

FIG. **3** shows two adjacent circumferential bars **60** grasping several of the tubes **34**. Notice that the inner side **68** of the upper circumferential bar **60** does not engage against the outer side **69** of the lower bar **60** as they appear in FIG. **3**. Each of the circumferential bars **60** has along each side a number of spaced indentations **72** which conform to a portion of the outer surface of each of the engaged tubes **34**. Since the sides of adjacent circumferential bars **60** do not touch, primary fluid passing parallel to the tubes **34** can pass downward through the circumferential bars **60**.

Notice in FIG. **2** that each of the circumferential bars **60** and **62** passes over several radial bars **70**. The radial bars **70**, one of which is shown by itself in FIG. **4**, each have at their ends a hole **73** through which the tie rod (which will presently be described) pass. The bars **70** also have a plurality of smaller holes **74** which are used to securely fasten the circumferential bars **60** and **62** to it.

FIG. **5** shows in cross section a bar **70** supporting several of the circumferential bars **60**. The circumferential bars **60** have holes **76**, each of which is aligned with one of the holes **74** in the radial bars **70**. A pin **80** is inserted in each of the holes **74** and projects upward into one of the holes **74**. The pins do not extend upward to the upper surface of the bars **60** and do not extend downward to the lower surface of the radial bars **70**. The spaces above and below the pins **80** are filled with weld material **82** to secure the pins **80** in the bars **70** and the bars **60**. The result, of course, is to firmly secure the circumferential bars **60** to the radial bars **70**.

When it is desired to weld the tubes **34** in place, the radial bars **70** are secured to the central conduit **36**. The tubes **34** are then positioned with inner most tubes being positioned first. They are each bent slightly at their lower portion and moved axially through the supports **54, 53, 52** and **51** and into engagement with the tube sheet **30** where they are welded. The lower portions are then allowed to flex inward and as circumferential rows of tubes **34** are positioned, circumferential bars **60** are secured to the radial bars **70** to secure the tubes **34** in place.

The securement of the circumferential bars **60** to the radial bars **70** involves no more than aligning those bars so that the holes **74** are aligned with the holes **76**. The pins **80** are inserted into each of the aligned pair of holes **74** and **76** and the weld material **82** is added.

FIG. **6** shows the radial bars **70** mounted in position. Rods **90** threaded at their ends are passed through holes **91** in the tube sheet **30** which holes lie on a circle adjacent to the conduit **36**. The rod **90** is secured from downward movement by bolts **92**. Vertical sleeves **94** are passed over the rods **90** until they abutt against the lower side of the tube sheet **30**. Thereafter, the uppermost solid support **51** is moved upwardly into place with the rods **94** passing through holes provided therein. When the support **51** is in place, other sleeves **94** are moved upward over the rods **94** and the next lower solid support can be placed in position. The outer end of each support is held up by a temporary rigging. This procedure is followed until all of the solid supports are in place and the segmented supports are ready for positioning.

Sleeves **94** are then passed upward over the rods **90** until they abutt against the lower surface of the solid support immediately above, in this case **54**. Each of the radial bars **70** has at its inner end a hole **73** which will accommodate tie rods **90** as the radial bar **70** is passed upward so that it engages the bottoms of the sleeve **94**. As rows are subsequently added, the degree to which the tubes **34** must be distorted at their lower portions becomes less and less. In the preferred embodiment, the outermost circumferential bar **62** has holes **64** rather than recessions **72** in the side thereof so it cannot be moved sideways to clamp the outermost circumferential row of tubes. This is no problem because the tubes can be moved axially through the outermost circumferential bars **62** because very little flexing is necessary. Until all of the circumferential bars are in place, the radial bars **70** are supported at their outer ends by a temporary rig (not shown) until outer tie rods **98** and their associated sleeves **100** are in place. This is accomplished by aligning all of the sleeves **100** between all of the tube supports and then moving the tie rods **98** axially through the sleeves and the holes **73** at the outer ends of the radial bars **70.** The rods are secured by bolts **102** from movement with respect to the tube sheets and the rigging at the outer ends of the radial bars is removed.

The foregoing describes but one specific embodiment of the present invention. Other embodiments being possible without exceeding the scope of the present invention as defined in the following claims.

What is claimed is:

1. A tube support for a heat exchanger having a plurality of tubes for conveying fluid in heat exchange with fluid flowing outside of said tubes comprising:

a plurality of radial bars extending outward along the radii of a circle;

a plurality of circumferential bars supported on said radial bars, said circumferential bars each being on the circumference of one of a plurality of concentric circles and each having a plurality of recessions spaced along the sides thereof so that facing recessions on adjacent circumferential bars can grasp a cooling tube between them.

2. The tube support defined in claim **1** wherein the sides of adjacent circumferential bars do not abutt to thereby provide a flow space for said fluid flowing outside of said bars.

3. The tube support defined in claim **1** wherein said radial bars have spaced recessions along the sides thereof to engage said tubes.

4. The tube support defined in claim **3** wherein said recessions on one side of each of said radial bars are at different locations along the lengths than the recessions at the other side of said bar so that said radial bars can accommodate tubes lying along one of said radii.

5. A heat exchanger having a plurality of tubes for conveying fluid in heat exchange with fluid flowing outside of said tubes comprising:

a tube sheet;

a plurality of tube supports, each of said tube supports comprising:

a plurality of radial bars extending outward along the radii of a circle, the plane of said circle being generally parallel to said tube sheet;

a plurality of circumferential bars supported on said radial bars, said circumferential bars each being on the circumference of one of a plurality of circles concentric to said first defined circle, each of said circumferential bars having a plurality of recessions spaced along the sides thereof so that facing recessions on adjacent circumferential bars can grasp a cooling tube between them;

said heat exchanger further comprising:

a plurality of tie rods extending through and bolted to said tube sheet and extending through and supporting said radial bars.

6. The heat exchanger defined in claim **5** further comprising a plurality of sleeves, each of said sleeves encircling one of said tie rods, some of said sleeves being positioned between and spacing said tube supports.

7. The heat exchanger defined in claim **6** further comprising a second tube sheet, said tie rods extending through and bolted to said second tube sheet, further comprising additional sleeves encircling said tie rods and positioned between said second tube sheet and the support closest thereto.

8. The heat exchanger defined in claim **6** further comprising other tube supports, said other tube supports comprising solid plates with holes through which said tubes and said tie rods pass, said other supports being positioned between said first defined tube supports and said tube sheet, additional sleeves encircling said tie rods, some of said additional sleeves being positioned between said other tube supports, some of said additional sleeves being positioned between the other tube support closest to said tube sheet and said tube sheet.

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