# United States Patent [19]

**Friedman**

[11] **3,739,443**

[45] **June 19, 1973**


[54] **METHOD OF FORMING A SHELL-AND-TUBE HEAT EXCHANGER**


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[73] Assignee: **The Trane Company**, La Crosse, Wis.



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[21] Appl. No.: **224,868**

[52] **U.S. Cl.** ..... **29/157.3 R**, 29/447, 29/480, 29/481, 29/DIG. 48

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

[58] **Field of Search** ..... 29/157.3 R, 447, 29/471.7, 480, 481, DIG. 48



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[57] **ABSTRACT**

This specification discloses a series of steps useful in manufacturing a shell-and-tube heat exchanger in which one or more baffles are disposed. Particular emphasis is given to those steps which are used to provide a good seal between the baffle and the internal wall of the shell.


**5 Claims, 11 Drawing Figures**

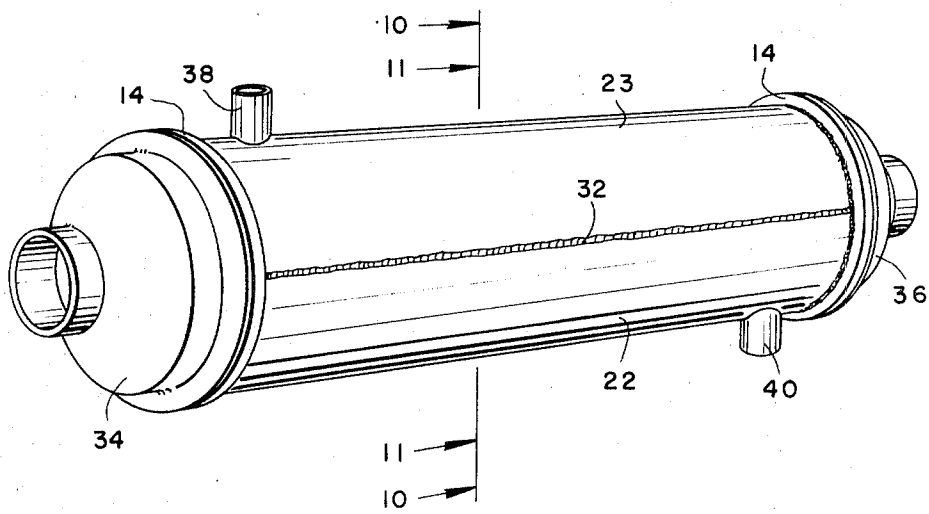


FIG. 1

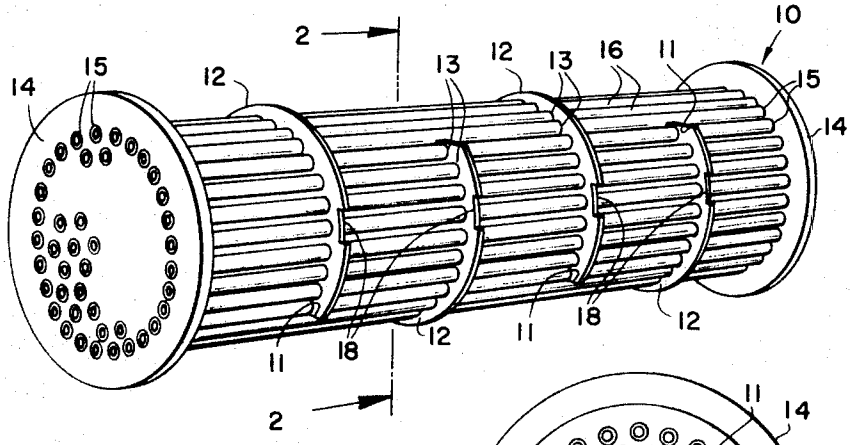
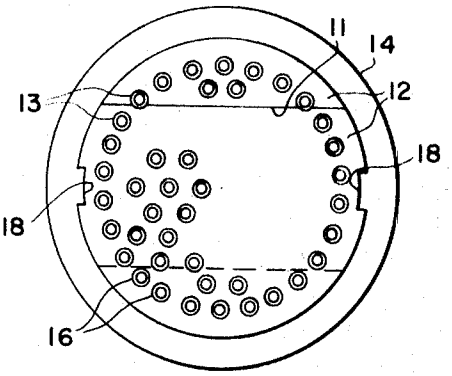



FIG. 2



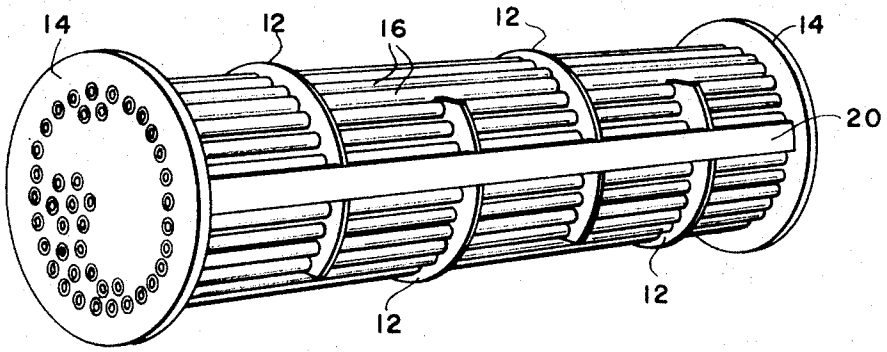




FIG. 3

FIG. 4

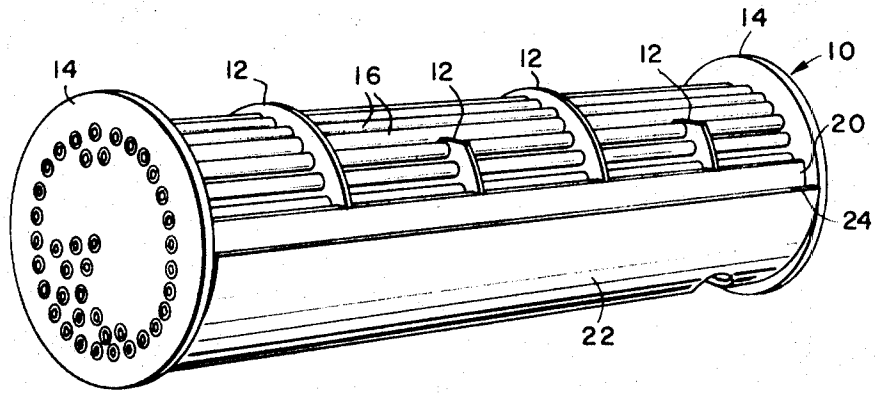



FIG. 5

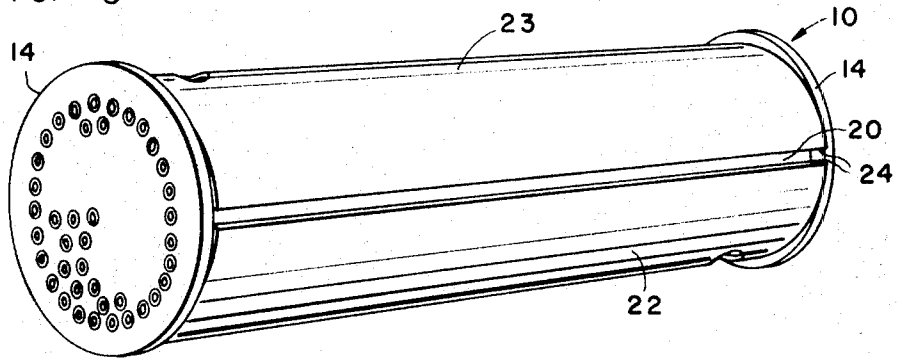
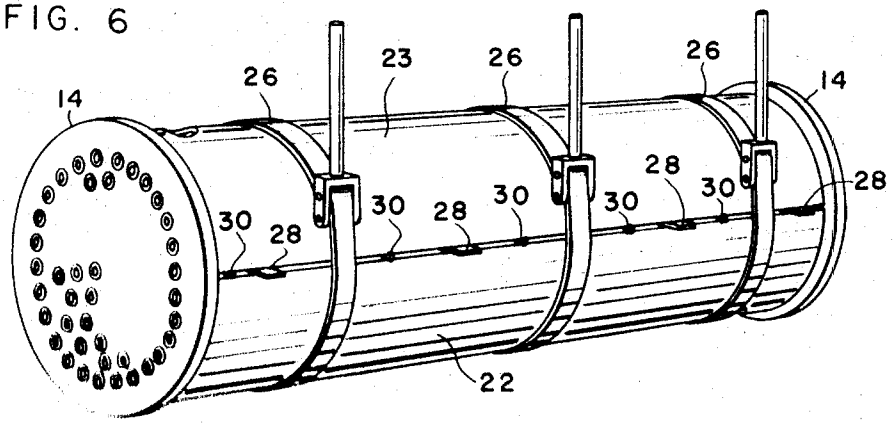



FIG. 6



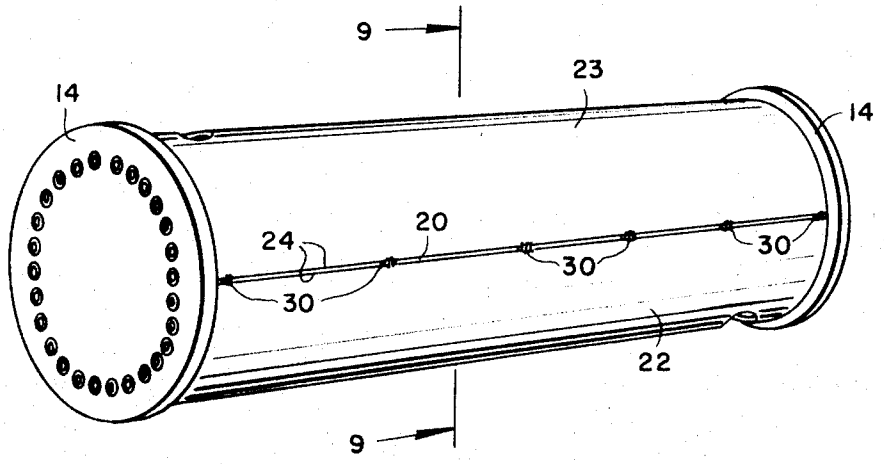



FIG. 7

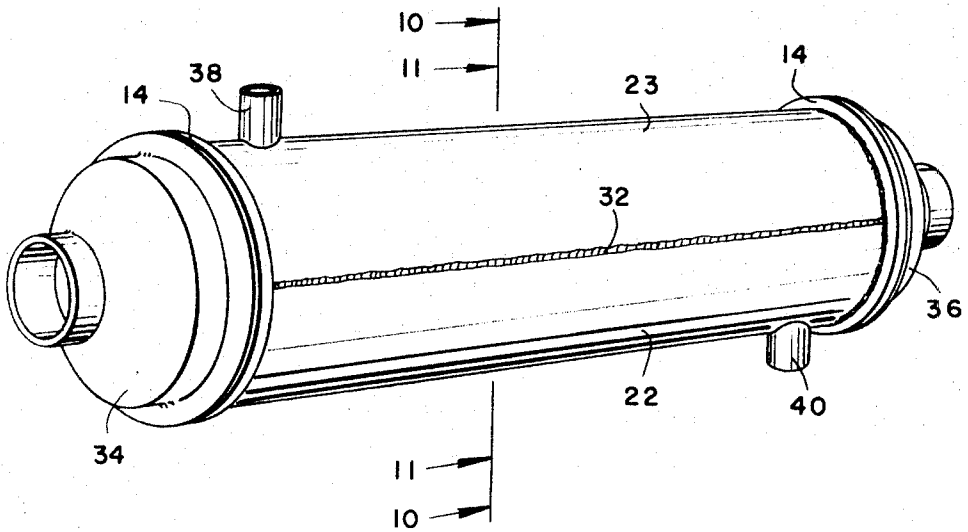



FIG. 8

FIG. 9

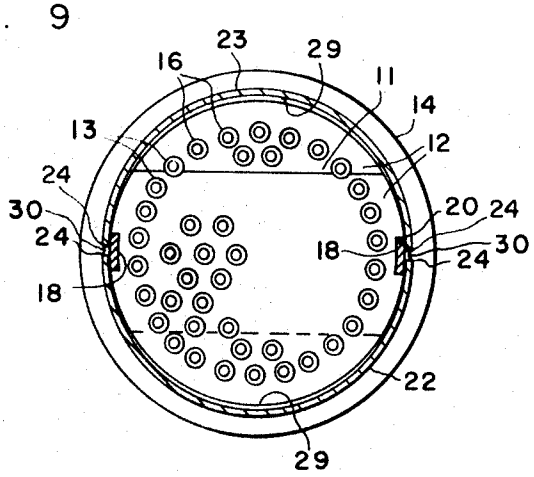
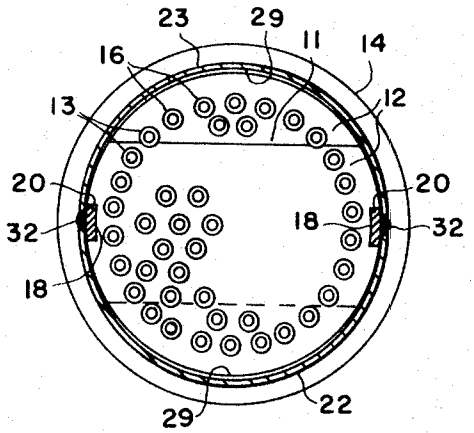



FIG. 10



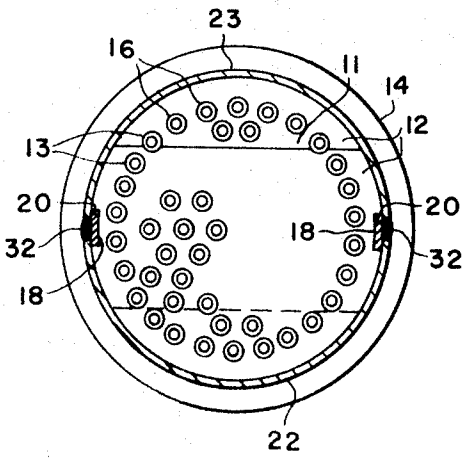




FIG. 11

# METHOD OF FORMING A SHELL-AND-TUBE HEAT EXCHANGER

This invention pertains to shell-and-tube heat exchangers. More particularly this invention relates to shell-and-tube heat exchangers in which one or more baffles are arranged inside the shell to cause a heat exchange fluid to repeatedly pass transversely through the tube bundle in a sinuous path between the inlet and outlet of the shell.

This invention provides a method of constructing such a heat exchanger which produces a good but low cost seal between the baffles and the shell so that the heat exchange fluid does not short circuit the sinuous fluid path presented by the baffles.

This method provides a series of steps which permit the shrinkage of the longitudinal welds of the shell to develop hoop tension in the shell to bring the shell into sealing engagement with the periphery of each of the baffles.

More specifically this invention involves a method of constructing a shell-and-tube heat exchanger comprising the steps of providing an elongated tube-and-baffle assembly; providing said tube-and-baffle assembly with a longitudinally extending weld backup strip extending substantially the full length of said assembly; providing a plurality of generally cylindrically-shaped elongated metallic shells having generally straight longitudinally extending edges; subsequently positioning said shells circumferentially about said tube-and-baffle assembly with said tube-and-baffle assembly being disposed within the bight of each of said shells and a pair of said longitudinally extending edges extending along and overlying said weld backup strip; pressing said shells against said tube-and-baffle assembly while maintaining adjacent longitudinal edges of adjacent shells in spaced abutting relationship; temporarily securing together said pair of longitudinal edges by tack welding at spaced intervals; terminating said pressing step subsequent to the tack welding step; removing portions of the material from the tack welds to reduce the heat required to replasticize the tack welds; and shrinking said shells about said tube-and-baffle assembly to produce sufficient hoop tension in said shells to draw said shells into sealing engagement with and along a major portion of the peripheral edges of the baffles of said tube-and-baffle assembly by successively plasticizing the tack welds and simultaneously longitudinally progressively fusing together said pair of longitudinal edges along substantially their full length while said tube-and-baffle assembly is disposed within the bights of said shells.

These and other aspects of the invention will become more apparent as this specification proceeds to describe the invention with reference to the drawings in which:

FIG. 1 is a perspective of a tube-and-baffle assembly including tube sheets, baffles, and tubes;

FIG. 2 is a section taken at line 2—2 of FIG. 1;

FIG. 3 is a perspective similar to FIG. 1 after the step of adding to the assembly a weld backup strip for the shells to subsequently be added;

FIG. 4 is a perspective similar to FIG. 3 after the step of adding one half shell;

FIG. 5 is a perspective similar to FIG. 4 after the step of adding the other half shell;

FIG. 6 is a perspective similar to FIG. 5 illustrating the steps of maintaining the longitudinal edges of the half shells in spaced relation and clamping the half shells tightly about the baffles while tack welding the longitudinal edges of the half shells;



FIG. 7 is a perspective similar to FIG. 6 after the step of removing the clamps and spacers from the shells and after excess material has been removed from the tack welds.

FIG. 8 is a perspective similar to FIG. 7 after the steps of welding together the longitudinal edges 24 of the half shells and after the step of adding inlet and outlet headers for both the tube and shell circuits of the heat exchanger to complete the shell and tube heat exchanger;

FIG. 9 is an exaggerated section taken at line 9—9 immediately prior to adding the continuous welds 32 along the longitudinal edges 24 of the shells illustrating the spatial relationship of the shells and the baffles;

FIG. 10 is an exaggerated section taken at line 10—10 of FIG. 8 immediately after completing the continuous welds 32 along the longitudinal edges 24 of the shells before shrinking of the weld showing the spatial relationship 29 of the shells and the baffles; and

FIG. 11 is a section taken at line 11—11 of FIG. 8 similar to FIG. 10 after the continuous welds 32 have shrunk thereby drawing the shells in sealing engagement with the baffles.

Now referring to the drawings it will be seen that FIG. 1 and 2 show a tube-and-baffle assembly 10. Assembly 10 includes a pair of spaced tube sheets 14 and a plurality of intermediate tube supporting baffles 12. Each tube sheet 14 has a plurality of tube receiving apertures 15. Each baffle 12 has a plurality of tube receiving apertures 13. Baffles 12 are generally circular except for a segment removed at 11 to provide a bypass around the baffle for the heat exchange fluid. The baffles are oriented so that the bypass area of adjacent baffles are on opposite sides of the tube-and-baffle assembly whereby the heat exchange fluid passing through the shell is directed repeatedly transversely through the assembly in a sinuous path.

The tube-and-baffle assembly may be assembled by supporting the two tube sheets and baffles in a fixed relation as shown with an appropriate jig and by inserting the tubes 16 into the aligned apertures 15 and 13 of the tube sheets and baffles. For purposes of simplifying the disclosure not all of the tubes and apertures have been illustrated. Each of the baffles has a notch 18 on opposite sides of its rim spaced from the removed segment. The notches are shaped and aligned to receive a weld backup strip 20. In FIG. 3 the backup strip 20 has been inserted in the notches.

FIG. 4 illustrates the step of placing the tube-and-baffle assembly and one half shell 22 together. FIG. 5 illustrates the step of placing the tube-and-baffle assembly and the other half shell 23 together. The half shells 22 and 23 are elongated cylindrical plates ⅛ inch thick having an arcuate cross-section of a diameter slightly larger than the tube baffles 12. The straight or longitudinal edges 24 of the half shells are arranged to overlie backup strips 20 as clearly seen in FIG. 5, 9, 10, and 11.

The shells 22 and 23 are then clamped or pressed firmly to the tube-and-baffle assembly as illustrated in FIG. 6 as by clamping strips 26. Simultaneously spacers 28 are disposed between the adjacent longitudinal edges 24 of the half shells 22 and 23 to maintain edges 24 in spaced relationship. This space should be on the order of about ⅛ inch for shell diameters of about 8

inches to 18 inches. This spatial relationship is illustrated in FIG. 9. FIG. 9 also illustrates by way of exaggeration the presence of some clearances 29 between the half shells and the periphery of the baffles. This clearance results from manufacturing variations and is not desirable as it permits the heat exchange fluid to short circuit the prescribed sinuous heat exchange fluid path within the heat exchanger shell which results in substantial loss of efficiency.

The edges of the half shells are then tack welded together at intervals 30 to maintain the shells in the prescribed position and the clamp devices 26 are then removed. The spacer members 28 may also be removed at this time. For purposes of this invention it is preferred that any excess material be removed from tack welds 30 as for example by snag grinding. The purpose of this is so that a subsequent weld made over the tack weld will sufficiently heat and plasticize the tack welds and permit the half shells to be drawn closer together as described hereinafter. At this point the structure now appears as illustrated in FIGS. 7 and 9. It is evident that clearance 29 still exists between half shells 22 and 23 and the baffle edges even after tack welds 30 have cooled.

The shells are then brought to bear firmly against the baffle peripheral edges or rims to substantially eliminate clearances 29 by establishing sufficient hoop tension within shells 22 and 23. This is accomplished by extending a deep continuous welding bead 32 along the backup strips 20 to thoroughly join edges 24. This is preferably done by arc welding although gas welding will also be satisfactory. In either event sufficient heat must be used to adequately plasticize the tack welds 30. While the continuous weld 32 is still hot and fluid, the joint between the half shells and the clearance 29 will be as illustrated in FIG. 10. However, as the weld bead 32 solidifies and cools, it will shrink and draw the half shells 22 and 23 together, establishing sufficient hoop tension therein to substantially eliminate clearance 29 as illustrated in FIG. 11. The heat exchanger is then completed by the addition of tube headers 34 and 36 and shell header 38 and 40 as shown in FIG. 8.

This reduction and elimination of the clearances between baffles 12 and shells 22 and 23 eliminates fluid leakage short circuiting the prescribed sinuous path for heat exchange fluid thereby substantially increasing the efficiency of the heat exchanger. This increase in efficiency may be as high as 30%.

Having now described in detail the preferred embodiment of my invention, I contemplate that many changes may be made without departing from the scope or spirit of my invention and as such desire to be limited only by the claims.

I claim:

1. A method of constructing a shell-and-tube heat exchanger comprising the steps of: providing an elongated tube-and-baffle assembly; providing said tube-and-baffle assembly with a longitudinally extending weld backup strip extending substantially the full length of said assembly; providing a plurality of generally cylindrically-shaped elongated metallic shells having generally straight longitudinally extending edges; subsequently positioning said shells circumferentially about said tube-and-baffle assembly with said tube-and-baffle assembly being disposed within the bight of each of said shells and a pair of said longitudinally extending edges extending along and overlying said weld backup strip; pressing said shells against said tube-and-baffle assembly while maintaining adjacent longitudinal edges of adjacent shells in spaced abutting relationship; temporarily securing together said pair of longitudinal edges by tack welding at spaced intervals; terminating said pressing step subsequent to the tack welding step; removing portions of the material from the tack welds to reduce the heat required to replasticize the tack welds; and shrinking said shells about said tube-and-baffle assembly to produce sufficient hoop tension in said shells to draw said shells into sealing engagement with and along a major portion of the peripheral edges of the baffles of said tube-and-baffle assembly by successively plasticizing the tack welds and simultaneously longitudinally progressively welding together said pair of longitudinal edges along substantially their full length while said tube-and-baffle assembly is disposed within the bights of said shells.

2. A method of constructing a shell-and-tube heat exchanger comprising the steps of: providing an elongated tube-and-baffle assembly; providing a plurality of generally cylindrically-shaped elongated metallic arcuate shells having generally straight longitudinally extending edges; subsequently positioning said shells circumferentially about said tube-and-baffle assembly with said tube-and-baffle assembly being disposed within the bight of each of said shells; tightening said shells against said tube-and-baffle assembly while maintaining adjacent longitudinal edges of adjacent shells in spaced abutting relationship; and shrinking said shells about said tube-and-baffle assembly to produce sufficient hoop tension in said shells to draw said shells into sealing engagement with and along a major portion of the edges of the baffles of said tube-and-baffle assembly by longitudinally progressively welding adjacent longitudinal edges of adjacent shells along substantially their full lengths while said tube-and-baffle assembly is disposed within the bights of said shells.

3. A method of constructing a shell-and-tube heat exchanger comprising the steps of: providing an elongated tube-and-baffle assembly; providing a plurality of generally cylindrically-shaped elongated metallic arcuate shells having generally straight longitudinally extending edges; subsequently positioning said shells circumferentially about said tube-and-baffle assembly with said tube-and-baffle assembly being disposed within the bight of each of said shells; and shrinking said shells about said tube-and-baffle assembly to produce sufficient hoop tension in said shells to draw said shells into sealing engagement with and along a major portion of the edges of the baffles of said tube-and-baffle assembly by welding adjacent longitudinal edges of adjacent shells along substantially their full lengths while siad tube-and-baffle assembly is disposed within the bights of said shells.

4. A method of constructing a shell-and-tube heat exchanger comprising the steps of: providing a tube-and-baffle assembly; providing a generally cylindrically shaped elongated arcuate shell having generally straight longitudinally extending edges; disposing said tube-and-baffle assembly with the bight of said shell; and while said tube-and-baffle assembly is disposed within the bight of said shell, shrinking said shell about said tube-and-baffle assembly to produce sufficient hoop tension in said shell to draw said shell into sealing engagement with and along a major portion of the edges of the baffles of the tube-and-baffle assembly by

fusing the longitudinal edges of said shell substantially along their full length.

5. A method of constructing a shell-and-tube heat exchanger comprising the steps of: providing an elongated tube-and-baffle assembly; providing a plurality of generally cylindrically shaped elongated metallic arcuate shells having generally straight longitudinally extending edges; subsequently positioning said shells circumferentially about said tube-and-baffle assembly with said tube-and-baffle assembly being disposed within the bight of each of said shells; tightening said shells against said tube-and-baffle assembly while maintaining adjacent longitudinal edges of adjacent shells in spaced abutting relationship; temporarily securing together said adjacent longitudinal edges of said adjacent shells by tack welding at spaced intervals; terminating said tightening step subsequent to the step of tack welding; and shrinking said shells about said tube-and-baffle assembly to produce sufficient hoop tension in said shells to draw said shells into sealing engagement with and along a major portion of the edges of the baffles of said tube-and-baffle assembly by longitudinally progressively welding adjacent longitudinal edges of adjacent shells along substantially their full lengths while said tube-and-baffle assembly is disposed within the bights of said shells.



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