

[54] **CLEANABLE TUBE WITHIN A TUBE
HEAT EXCHANGER AND METHOD OF
FORMING MODULAR HEADERS
THEREFOR**

[72] Inventor: **Leonard H. Schwarz**, West Hartford, Conn.

[73] Assignee: **Dunham-Bush, Inc.**, West Hartford, Conn.

[22] Filed: **July 7, 1970**

[21] Appl. No.: **52,902**

[52] U.S. Cl. **165/143**

[51] Int. Cl. **F28d 7/10**

[58] Field of Search **165/143, 151**

[56] **References Cited**

UNITED STATES PATENTS

2,658,358 11/1953 Bolling **165/143 X**

1,978,897 10/1934 Feldmeier **165/143 X**
3,310,868 3/1967 LaPorte et al. **165/151 X**

Primary Examiner—**Frederick L. Matteson**

Assistant Examiner—**Theophil W. Streule**

Attorney—**Sughrue, Rothwell, Mion, Zinn & Macpeak**

[57] **ABSTRACT**

Inner and outer headers at both ends of a tube within a tube heat exchanger are formed of a plurality of axially stacked and brazed drawn metal tubular shell segments. Segments for all headers are identical and carry axially aligned large diameter and small diameter holes on opposite sides thereof for facilitating reception of the inner tube coupling the outer headers and the outer tube coupling the inner headers as well as bushings receiving removable plugs to facilitate cleaning of the interior of the inner tubes of the heat exchanger tube assemblies.

5 Claims, 5 Drawing Figures

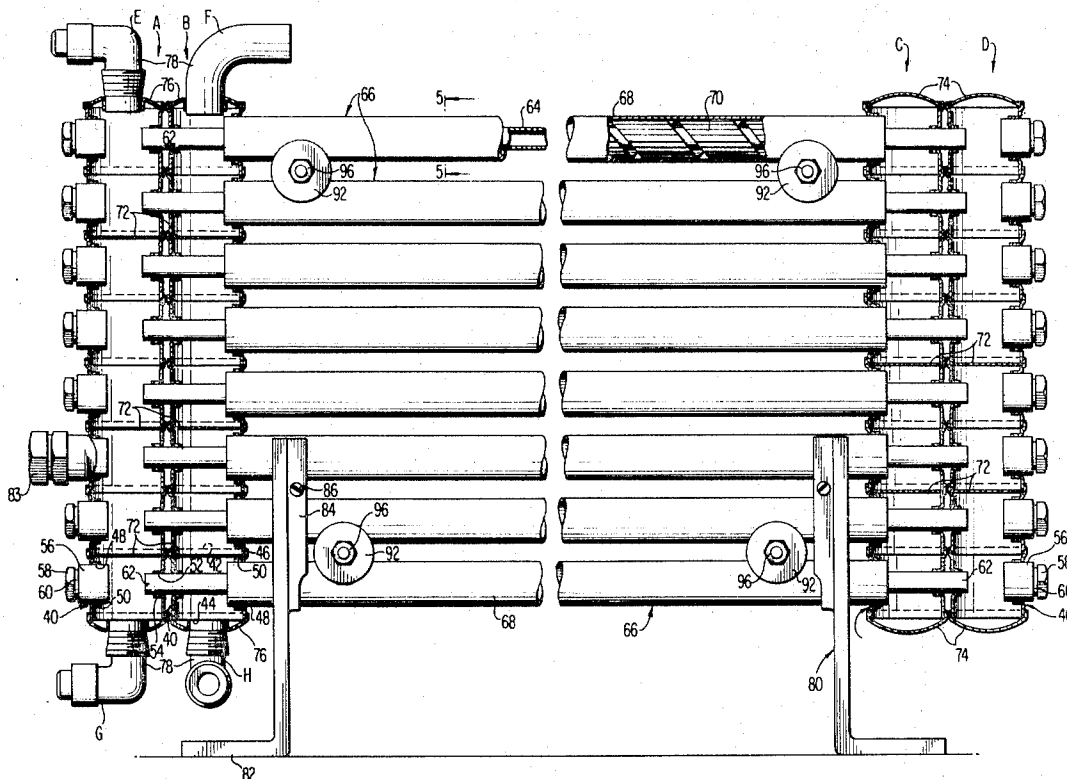


FIG. 1
PRIOR ART

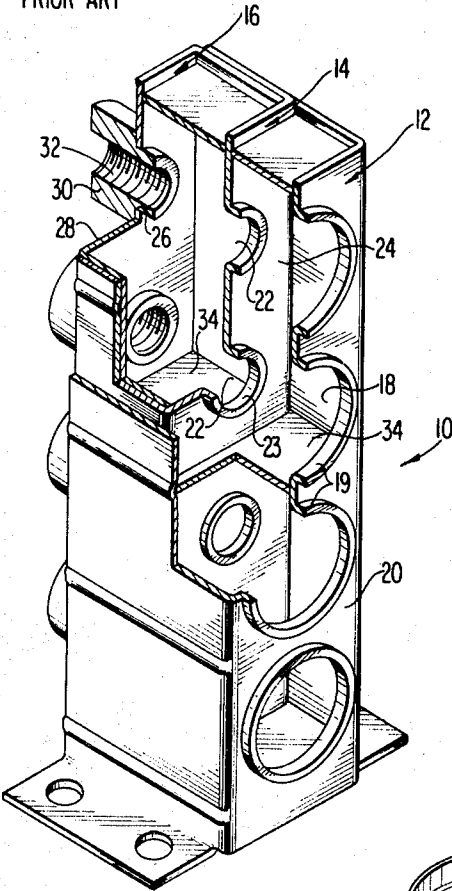


FIG. 3

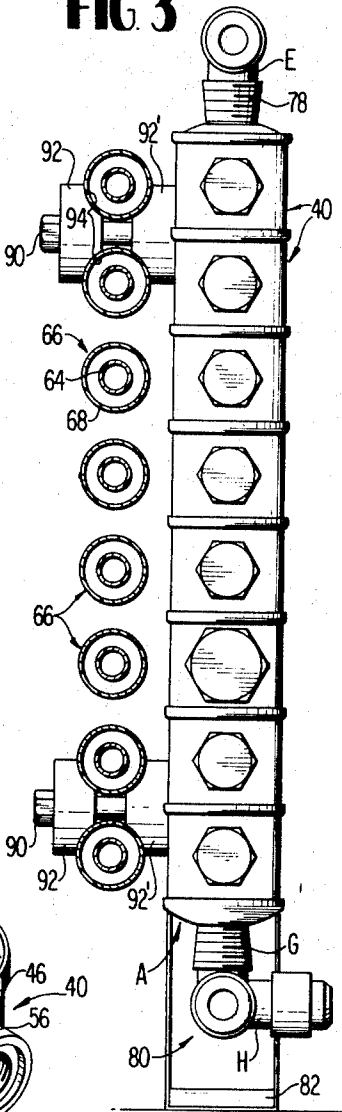
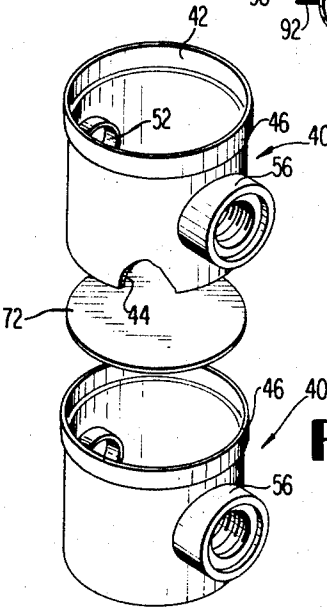


FIG. 5

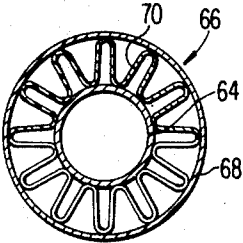


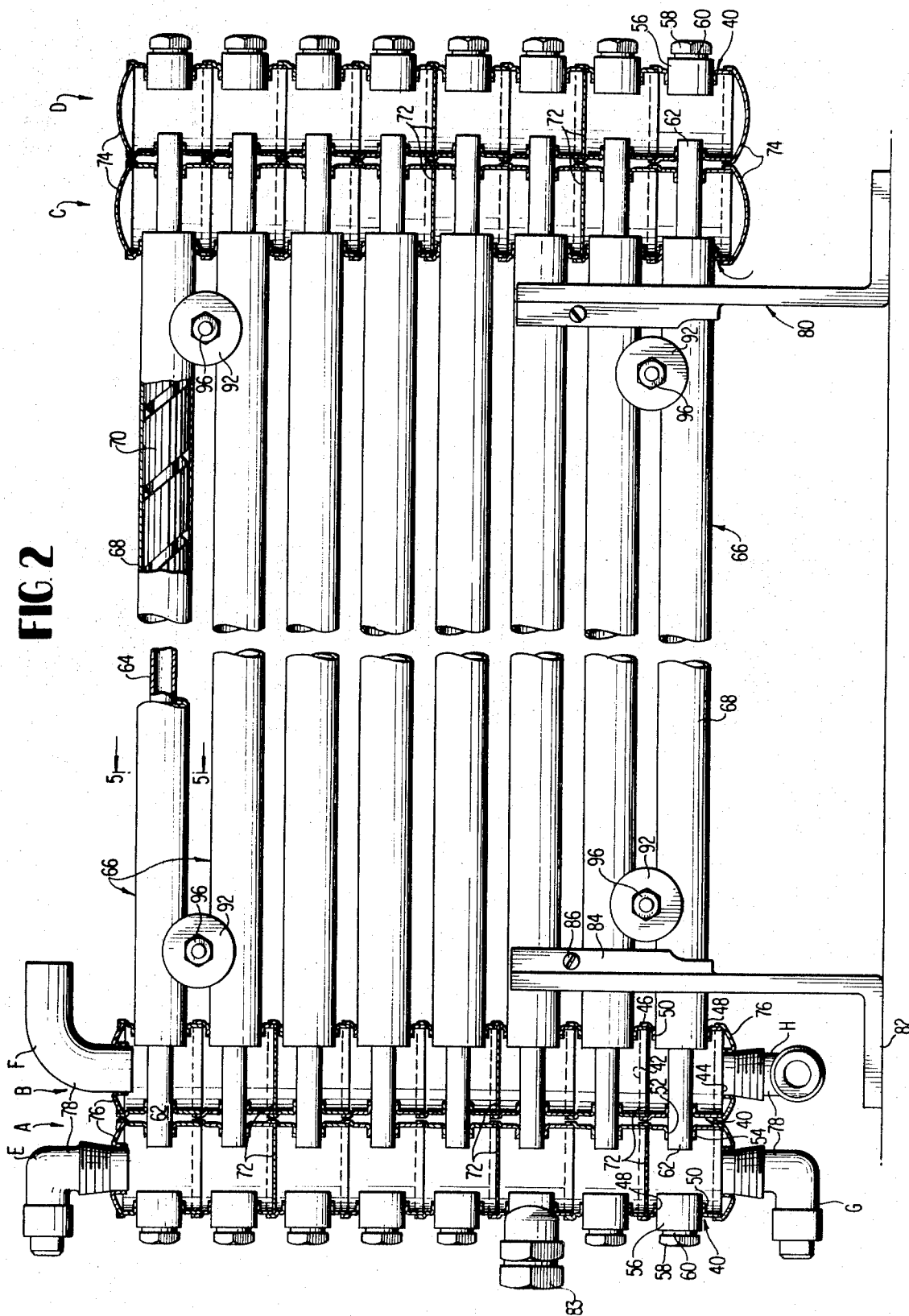
FIG. 4

INVENTOR
LEONARD H. SCHWARZ

BY *Supreme, Rottwell, Moon,
Zinn & Macpeak*

ATTORNEYS

FIG. 2



CLEANABLE TUBE WITHIN A TUBE HEAT EXCHANGER AND METHOD OF FORMING MODULAR HEADERS THEREFOR

DESCRIPTION OF THE PRIOR ART

In the past, multi-pass heat exchangers such as condensers have been manufactured by employing principally, three U-shaped interfitting brass members formed of thin plate stock to define an integral header assembly, that is, an outer header carrying the coolant and an inner head carrying refrigerant for a multi-pass refrigeration condenser or the like with header assemblies at each end of the heat exchanger. Respective headers are fluid coupled by means of the concentric tube within a tube assemblies extending between the same with the large diameter outer tube coupled to the inner wall of the inner headers and the small diameter internal tube extending axially beyond the ends of the large diameter tube and coupled to the outer header by extending through a small diameter hole formed within the intermediate wall separating the two headers.

Reference to FIG. 1 discloses a typical multi-pass condenser header assembly for a condenser of the tube within a tube type construction. As such, the prior art header assembly 10 is formed principally of three U-shaped brass members stamped from thin metal flat stock and consisting of a large outside U-shaped member 12, an intermediate U-shaped member 14 and an inner U-shaped member 16, members 12 and 14 being nested and facing in the same direction while member 16 is nested within member 14, but facing in the opposite direction. Brazed rings 19 defining large diameter openings 18 within end wall 20 of member 12 are then brazed to the ends of the large diameter tubes (not shown), and further small rings 23 defining smaller diameter holes 22 within the end wall 24 are brazed to the small diameter tubes (not shown). Similar diameter holes 26 within end wall 28 of the reversely oriented U-shaped member 16, carry the internally threaded fittings 30 which receive removable end plugs (not shown). This allows the passage of cleaning elements within the threaded bore 32 of the same for entry into the small diameter tubes of the tube assemblies (not shown) connecting headers at respective ends of the heat exchanger. In addition, in such an assembly it is necessary to provide baffle plates 34 at various positions within both the outer header created by plates 16 and 14 and the inner header created by plates 12 and 14 to cause the fluid within the same to move along desired flow paths from a header at one end of the heat exchanger to the header at the opposite end and thence return to the same header but within another area separated by the baffle plates 34. In the case of FIG. 1, the return fluid would exit from the chambers on the upper side of plates 34, pass to the other end of the heat exchanger and return to enter the chambers defined by the lower side of the same baffle plates 34.

In the manufacture of such heat exchangers, it is necessary to build up the header by brazing the three primary plates together, that is, 12, 14 and 16, and braze rings 19 and 23 thereto to define openings 18 and 22, and further braze the baffle plates 34 in proper position to define the number of passes for the heat exchanger. Since the joints existing between all of these components must be sealed to create sealed compartments, it is very difficult to complete a sealed brazed

assembly except by a series of subassembly, brazing and leak testing steps and, perhaps more importantly, upon completion of the heat exchanger, including the brazing of the inner and outer tubes to respective openings 18 and 22, it is impossible to repair any internal leaks between rise or header chambers or in the vicinity of the baffle plates 34, nor in fact is it possible to determine just where the leaks have occurred, since a great number of the joints are hidden, in this type of construction.

SUMMARY OF THE INVENTION

The present invention is directed to the production of a readily cleanable, "tube within a tube" heat exchanger in which all brazed joints are exposed to the outside and in which the completion of the brazed assembly may be achieved by only a few separate brazing steps and with greatly increased reliability. The invention allows ready use of identical components to form a modular heat exchanger of variable height and in which identically formed assemblies may be stacked back to back, and fluid coupled to effect a compact, large capacity heat exchanger.

The present invention resides primarily in the creation of four identically configured headers, each comprising a plurality of axially stacked and brazed drawn metal, tubular shell segments with each segment constituting a tubular body having open ends and diametrically opposed large diameter and small diameter holes defined by integral rims. Inner and outer headers are formed at each end of the heat exchanger by placing the stacked shell segments with their small diameter holes facing each other. Concentric tube assemblies with the inner tube extending beyond the end of the outer tubes, are inserted therein, such that the ends of the large diameter tube are brazed to the shell segment where the large diameter hole of the inner header faces the same and wherein the small diameter inner tubes of each tube assembly extend through both small diameter holes of the inner and outer header and are brazed to the integral rims defining the same. The large diameter holes of the outer header segments at each end of the assembly carry brazed thereto a threaded bushing receiving a threaded removable end plug allowing access of cleaning equipment to the inner tube of the tube assembly to facilitate cleaning of the same.

Domed end caps are readily brazed to the upper and lower ends of each of the headers to complete the same with some of the caps being provided with conventional fluid coupling fittings allowing delivery and removal of the heat exchange fluids to respective headers. Disc shaped baffle plates are brazed between selected tubular shell segments to define the passes for the fluids passing through the concentric tube assemblies coupling headers at the opposite ends of the heat exchanger. Preferably, the cup-shaped drawn metal shell segments have enlarged diameter lips at one end to both receive the opposite end of the adjacent segment and also to facilitate the holding of the disc-shaped baffle plates which are slightly larger in diameter than the major portion of the shell segments to facilitate placement and brazing of the same. Since all joints are exposed to view, any seal failures are readily ascertainable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partially in section, of a prior art header assembly for use in forming a "tube within a tube" heat exchanger.

FIG. 2 is a side elevational view, partially in section, of the improved "tube within a tube" heat exchanger of the present invention employing stacked drawn metal tubular shell segments to define inner and outer headers at both ends of the heat exchanger.

FIG. 3 is an end view, partially in section, of the heat exchanger shown in FIG. 2.

FIG. 4 is an exploded, perspective view of a portion of one header of the heat exchanger of FIG. 2, illustrating the use of the drawn metal shell segments of the present invention.

FIG. 5 is a sectional view of a "tube within a tube" heat exchanger tube assembly coupling the headers at respective ends of the heat exchanger.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In contrast to the heat exchange header assembly of the prior art illustrated in FIG. 1, the present invention makes use of a plurality of stacked, drawn metal tubular shell segments 40 as seen in FIG. 4, which are formed from flat metal stock and drawn by conventional methods.

In FIG. 2, for each segment 40, an open top 42 and an open bottom 44 is shown. It is noted that the open top 42 is defined by an enlarged diameter lip 46 which allows the seating of the bottom edge of the adjacent cup within the same so as to define a stacked array for the individual headers identified at A, B, C, and D, headers A and D being the outer headers while headers B and C are the inner headers of the heat exchanger. The open bottom, cup-shaped segments 40 for all headers A, B, C, and D, are identical in size and configuration and are also identically formed with a large diameter hole 48, FIG. 2, punched into the side thereof with some of the material defining an integral internal rim 50, while in similar fashion, small diameter holes 52 are formed by punching the side wall inwardly and forming a small diameter rim 54. The large diameter holes 48 receive cylindrical bushings 56 which are brazed thereto and carry, in turn, removable threaded plugs 58 and washers 60 so as to effect a ready seal of the end plugs 58 when seated within the threaded bushing 56.

The bushing and plugs are carried in all of the large diameter holes of the segments of the exterior headers, since removal of the plugs allows ready access to the interior of the outer header A and D and insertion of a cleaning tool (not shown) within the same. Inner headers B and C are oppositely oriented to outer headers A and D, that is, the smaller diameter holes 52 for these headers lie side by side and in axial alignment. It is by this arrangement, that each small diameter hole 52 receives the axially extending end 62 of the small diameter tube 64, forming a portion of a "tube within a tube" heat exchanger tube assembly 66. The outer tube 68 is formed of suitable metal, and the refrigerant is carried by the outer passage defined by the large diameter tube 68 and the small diameter tube 64. A corrugated metal fin 70 is wrapped in spiral fashion

about the small diameter inner tube 64, and facilitates heat exchange between the fluid flowing through small diameter tube 64 and the counterflow fluid between this tube and the large diameter tube 68. The protruding ends 62 of the small diameter tube are brazed to the annular rims 52. The length of the large diameter tube 68 is such that it extends within headers B and C and is brazed to the periphery of rim 50 defining opening 48 of the inner headers B and C.

It is, therefore, apparent that if incomplete brazing occurs at the joints between the large diameter tube 68 and rim 50 receiving the same, or the small diameter tubes and rims 52 for all four headers, or if there is incomplete brazing and a lack of seal between bushing 56 and rim 50 of the outer headers A and D, the exact spot where leakage occurs, being exposed, may be ascertained for prompt repair of the heat exchanger at the specific area requiring the same.

Of course, the heat exchanger has the further advantages, since it employs thin metal baffle discs or plates 72 which define the number and extent of passes of both coolant and refrigerant within respective tubes 64 and 68, of each tube assembly 66. Since the diameter of the baffle disc 72 is larger than the internal diameter of the major portion of the shell segment, but is slightly less than the diameter of the enlarged rim portion 46 of the segments, they may be merely dropped in place along with suitable brazing material at the proper position in the vertical stack. When brazed, they effect a sealed joint while at the same time adjacent segments are sealingly coupled to facilitate both ease in assembly and time required to effect brazing of the components into multi-pass modular headers. During manufacture, the complete header assembly may be formed by properly stacking shell segments upon each other with spacers or baffles 72 at predetermined locations. After brazing the four headers A, B, C, and D, a vertical assembly may be formed much in the manner of that of the completed unit shown in FIG. 2. Dome-shaped end caps 74 or perforated end caps 76 which carry elbow fitting 78 and allowing fluid connection to the supply of coolant and refrigerant for a condenser use, and discharge of the same at the opposite ends of respective headers, are brazed to the ends of each header to achieve, respectively, a sealed connection and a completely sealed assembly. The heat exchanger of FIG. 2 is shown with an enlarged fitting adapter and an enlarged pipe plug 83 carried by the same, providing an enlarged diameter opening for coupling to an additional coolant supply from a water tower.

It is important to note that when metal drawing the cup-shaped elements therefrom to define segments which are open both at the top and the bottom, the holes through the cylindrical wall as at 48 and 52 and the rims 50 and 54 defining the same may be readily formed since the end of the short tubular segment allows insertion of a forming tool internally of the same, while the other open end allows the waste material to be discharged therefrom during forming of the punched holes 48 and 52. With the shell segments being drawn from sheet metal stock, all connections to fittings and the tubes of the heat exchanger assembly 66 may be readily brazed by a conventional fluxed or fluxless brazing alloy which is compatible both to the water forming the coolant and a conventional

refrigerant carried by the large diameter outer tube 68 and inner headers B and C, respectively. The heat exchanger is formed of a single or multiple layers of vertically stacked arrays of tube assemblies 66 fluid coupled to inner and outer headers A, D, and B, C. It may be readily supported by L-shaped heat exchangers supports 80 having a common base 82 and a pair of side walls 84 coupled together by screws 86 which pass between adjacent tube assemblies 66. In a sample arrangement, FIG. 3, more than one vertical stack of tube assemblies 66 and headers are provided. Thus, in addition to the tube assemblies 66 making up the first row of the heat exchanger, one or more additional rows of tube assemblies 66, constitutes a multiple series of heat exchange passages defined by inner tubes 64 and outer tubes 68.

The present invention contemplates unique mechanical connection means for supporting additional vertical stacked arrays of tubes just to the rear of the first stack. The mechanical means consists of a series of threaded bolts 90 which carry modified spacer discs 92 having curved recessed inner surface portions 94 which abut the outside surfaces of the outer tube 66 with a modified disc 92' captured between the tube assemblies 66 for each vertical stack and having two cylindrical recesses within each end face abutting respective tubes of the adjacent rows. As seen in FIG. 2, on the opposite side of the heat exchanger, similar discs 92 are provided, and a threaded nut 96 completes the mechanical connection. Thus, with four such bolts and a series of spacer discs, at respective corners of the heat exchanger, multiple vertical arrays of heat exchange tube assemblies, may be mechanically coupled together for fluid connection by various connecting means (not shown) so that fluid may flow either in series through these tubes, or in parallel, as desired.

In operation, refrigerant gas passes through fitting 78 identified at F, FIG. 2, and enters header B where, due to the presence of the first baffle disc 72, the refrigerant passes through the upper two, large diameter tubes 68, where it enters the larger volume chamber within inner header C, as defined by uppermost baffle disc 72 carried thereby. The refrigerant continues to pass in a reverse direction through the next two tubes assemblies 66 and re-enters a chamber defined by the two upper discs 72, in header B. At this point, the gas returns to the right side of the assembly, that is, the inner header C through a single tube only, and flow continues in this manner until the condensed refrigerant is discharged through fitting H at the lower left hand side of header B. The coolant, employed to achieve condensation of the refrigerant, preferably enters fitting G at the bottom end of header A and passes within small diameter tube 64 of the lowermost tube assembly 66 and enters the right hand header D, where it reverses direction along a pass defined by the lowermost baffle discs 72 carried by header D. Flow continues as determined by baffle discs 72. The heated coolant liquid, such as water, is discharged from the heat exchanger through elbow fitting E at the upper end of header A. Of course, for the next array of heat exchanger tubes to the rear of the illustrated array, FIG. 2, fluid may be passing in parallel or in series as desired.

Further, while the heat exchanger is advantageously manufactured by the use of the drawn, modified cup-like shell segments 40, which are identically formed but oppositely oriented insofar as the inner and outer headers are concerned, it is envisioned that long metal tubes defining each header may be severed at various locations to facilitate placement of the baffle 72 into position, and then brazed, and likewise may have a series of large diameter and small diameter holes drilled or otherwise formed therein before or after severing, but the arrangement of the same allows unimpeded inspection of all brazed joints between the baffle plates and the header tubes, and the tube assemblies of the heat exchanger coupling the headers at opposite ends of the same.

What is claimed is:

1. In a "tube within a tube" heat exchanger including inner and outer fluid headers sealingly coupled, respectively, to opposite ends of inner and outer tubes defining a heat exchange tube assembly, the improvement wherein:

each header comprises a plurality of open ended, identical, axially stacked, tubular segments in module form, each segment including opposed small and large diameter holes within its side wall, respective headers at each end of said tube assembly being oriented with their small diameter holes facing each other, each small diameter tube extending beyond the ends of said large diameter tube for each tube assembly and passing through both small diameter holes for each header, and sealed thereto, each large diameter tube being sealed within a large diameter hole of said inner header and removable end plugs sealingly carried by said large diameter holes within said outer header to facilitate cleaning of said small diameter tubes while allowing easy location of any loss of seal between the sealed components of said heat exchanger.

2. The "tube within a tube" heat exchanger, as defined in claim 1, wherein each tubular segment comprises a cylindrical drawn metal body having an enlarged rim on one end to facilitate stacking and an imperforate baffle disc within said enlarged annular lip of selected segments as well as the end of the adjacent shell segment to facilitate seal coupling of these elements while forming the flow paths of said heat exchange fluids through said heat exchanger.

3. The "tube within a tube" heat exchanger, as claimed in claim 1, wherein said tubular segments are drawn from thin metal material, and said small and large diameter holes are formed by punching in portions of said tubular segment side wall to define an annular rim coaxial with each hole.

4. The "tube within a tube" heat exchanger, as claimed in claim 3, wherein the axial ends of said headers are closed off by domed-shaped end caps sealed thereto.

5. A multiple row, readily cleanable, tube within a tube heat exchanger assembly characterized by completely exposed brazed joints throughout the assembly, comprising: pairs of inner and outer substantially tubular fluid headers brazed to opposite ends of inner and outer tubes defining heat exchange tube assemblies for each vertical array, each of said headers

7

constituting a plurality of identical open ended, cup-shaped, axially stacked drawn shell segments, each segment including opposed small and large diameter holes within its sidewall, respective headers at each end of said tube assemblies being oriented with their small diameter holes facing each other to commonly receive an end of said small diameter tube extending beyond said large diameter tube and being brazed thereto, the large diameter tubes extending within the large diameter hole within said inner headers and brazed thereto, said large diameter holes within said outer header carrying removable threaded end plugs for facilitating cleaning of the inner tubes of said heat exchanger, and a plurality of mechanical coupling means for coupling

8

at least two vertical stacked arrays, said coupling members comprising a threaded bolt extending between adjacent large tubes of the heat exchanger tube assemblies for all vertical stacked arrays the width of said heat exchanger assembly, and a plurality of spacer discs carried on said threaded bolt with at least one spacer disc between each vertical stacked array and having arcuate grooves corresponding to the periphery of the outer tube of said tube assembly and being of a thickness to space said vertical stacked array of tube assemblies from each other and a nut for mechanically locking said spacers to said tube assemblies.

* * * * *

15

20

25

30

35

40

45

50

55

60

65