Feb. 2, 1965 J. H. AMMON 3,168,136

SHELL AND TUBE-TYPE HEAT EXCHANGER

Filed March 17, 1955 3 Sheets-Sheet 1

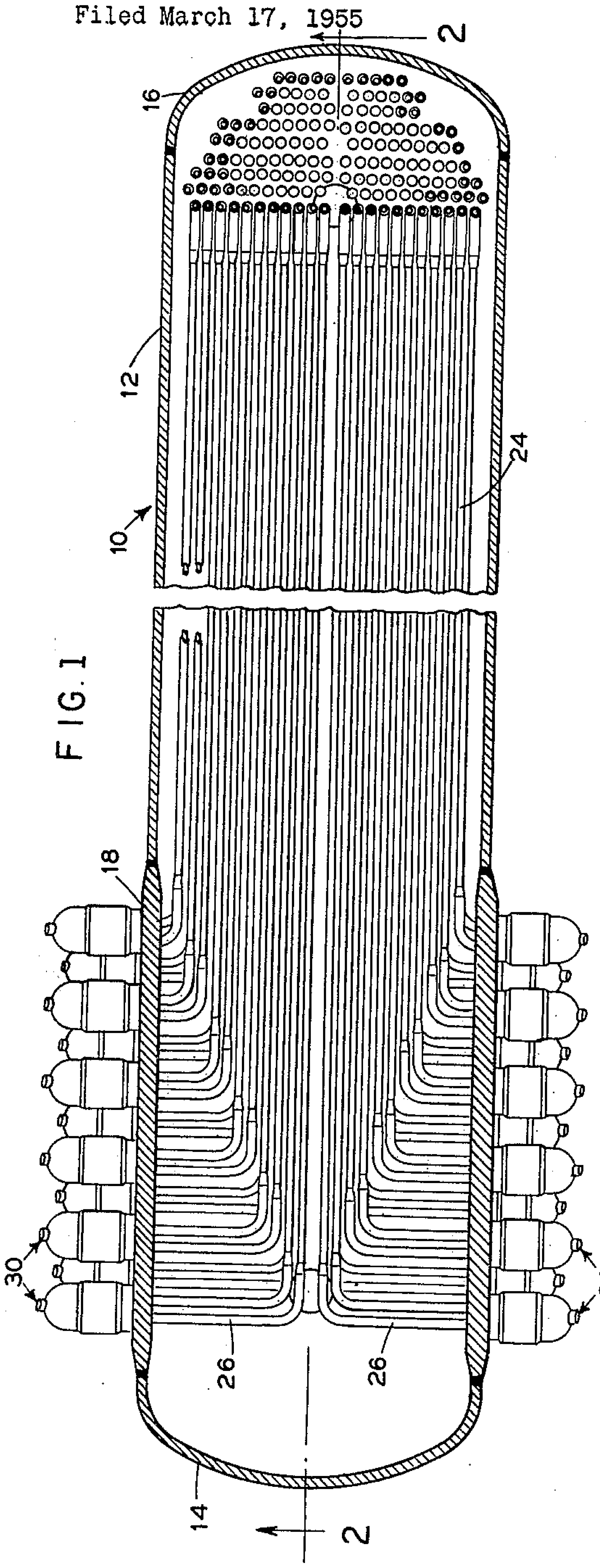

FIG. 1

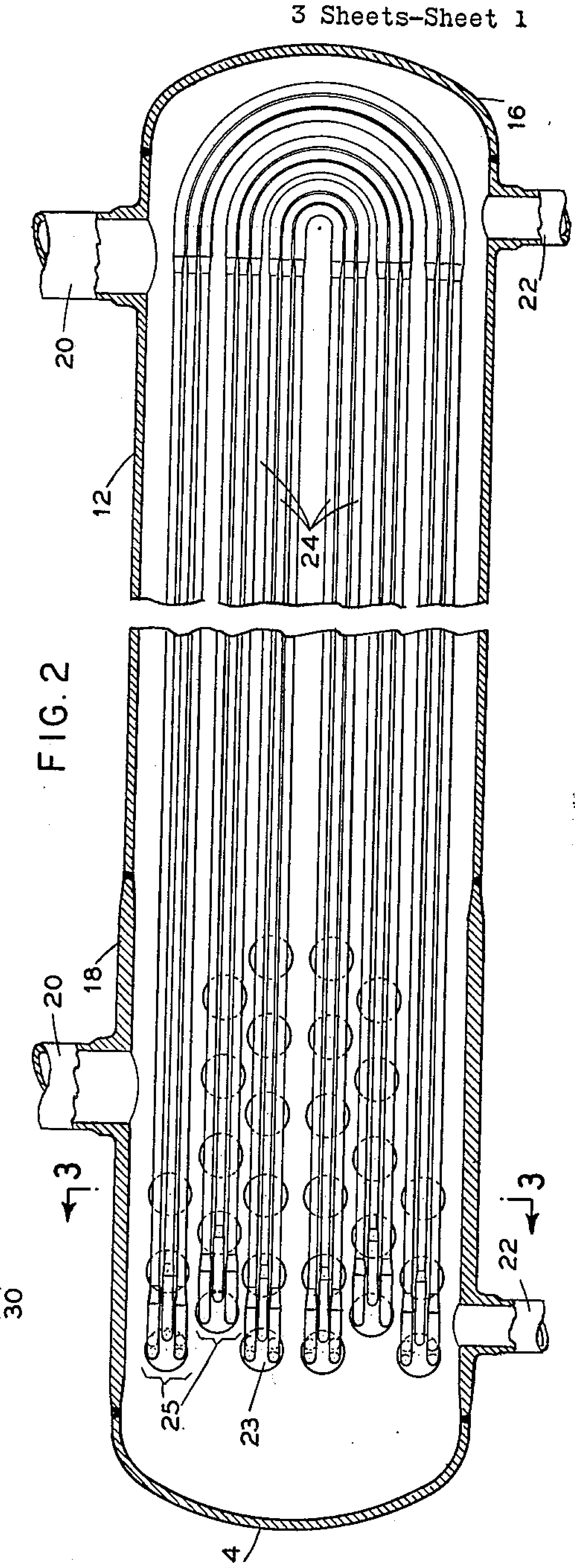

FIG. 2

INVENTOR
JOHANNES H. AMMON

BY J. P. Moran
ATTORNEY

Feb. 2, 1965 J. H. AMMON 3,168,136

SHELL AND TUBE-TYPE HEAT EXCHANGER

Filed March 17, 1955 3 Sheets-Sheet 2

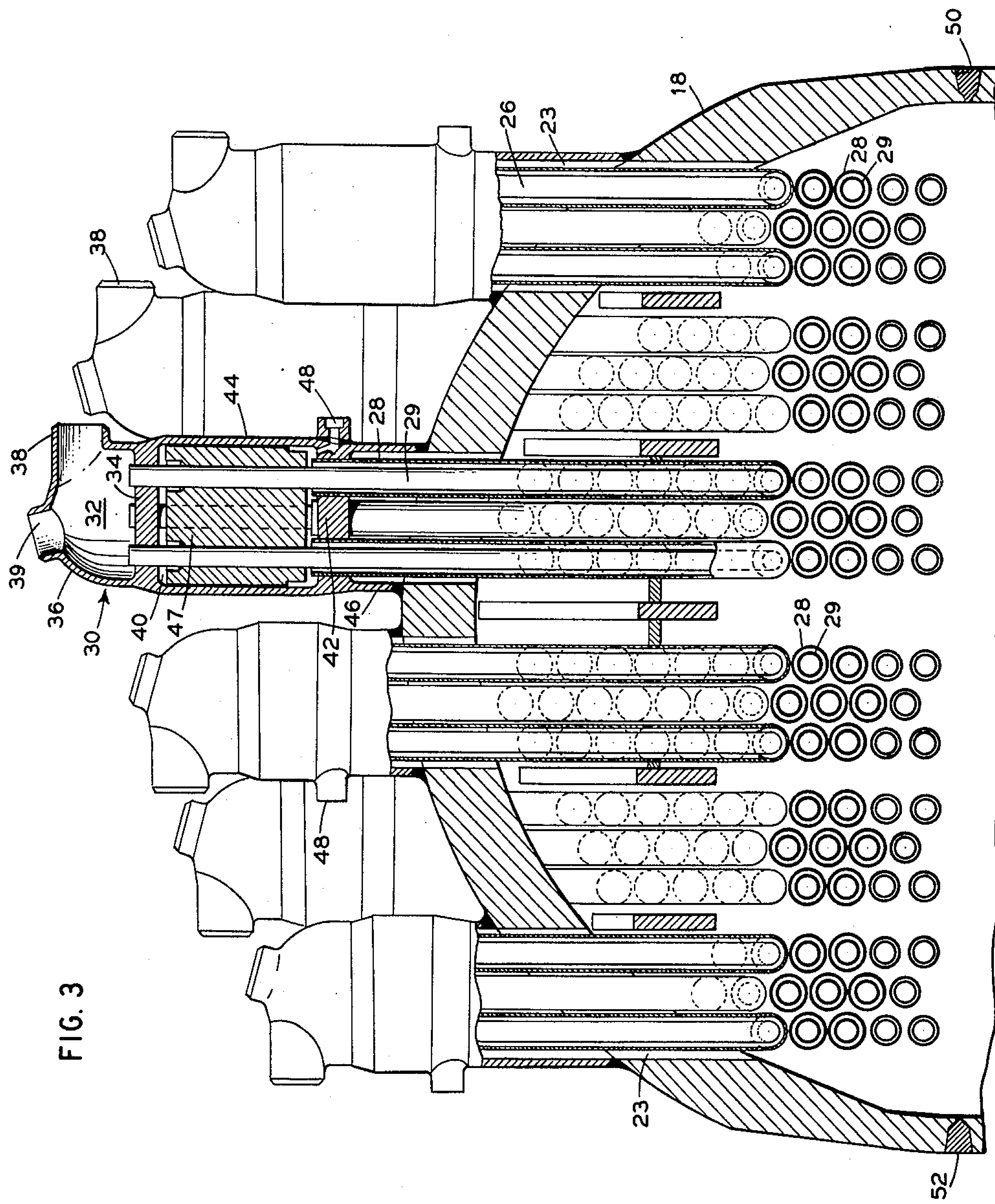

FIG. 3

INVENTOR
JOHANNES H. AMMON
BY J. P. Moran
ATTORNEY

Feb. 2, 1965 J. H. AMMON 3,168,136

SHELL AND TUBE-TYPE HEAT EXCHANGER

Filed March 17, 1955 3 Sheets-Sheet 3

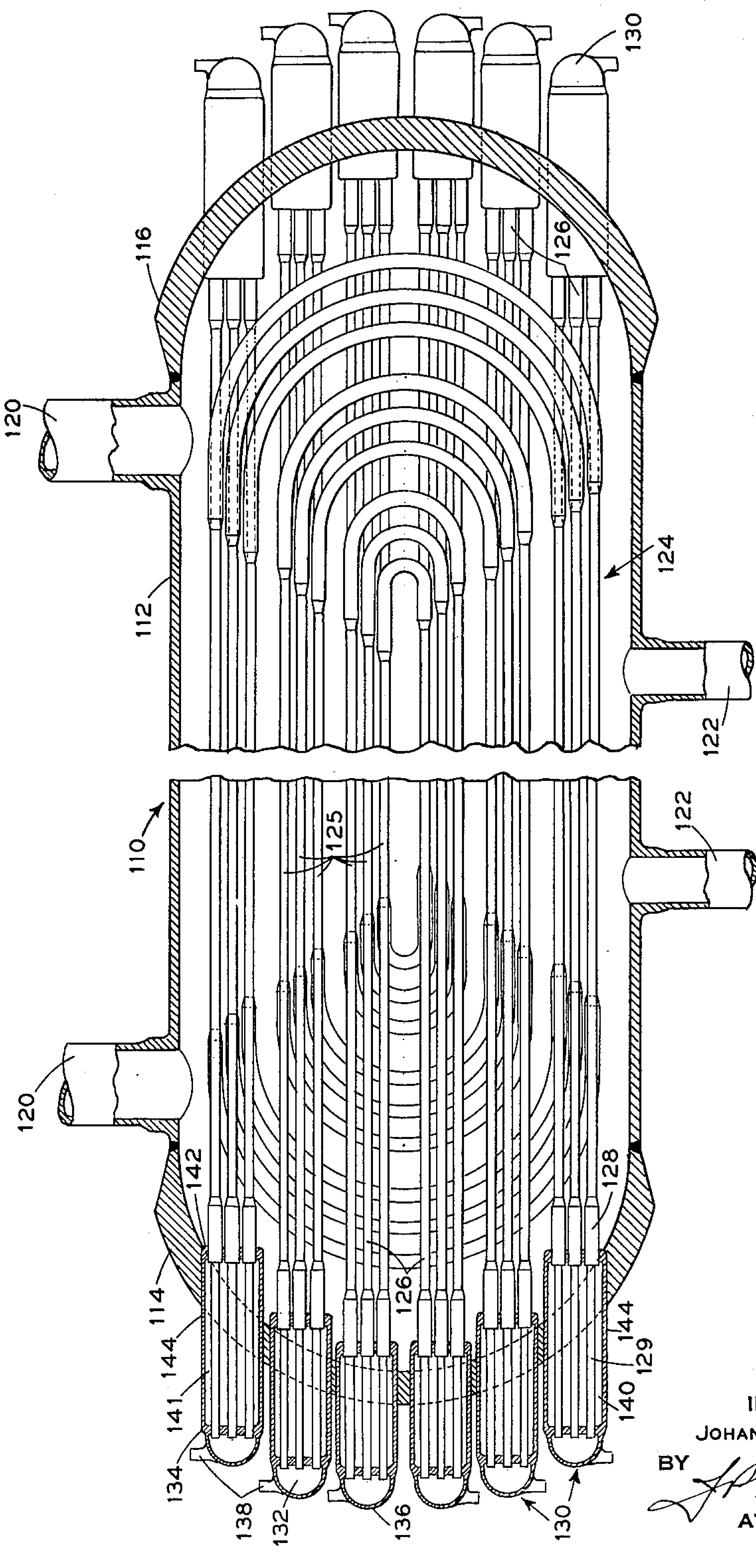

FIG. 4

INVENTOR
JOHANNES H. AMMON
BY
[signature]
ATTORNEY

United States Patent Office

3,168,136

Patented Feb. 2, 1965

1

2

3,168,136
SHELL AND TUBE-TYPE HEAT EXCHANGER

Johannes H. Ammon, Barberton, Ohio, assignor to The Babcock & Wilcox Company, New York, N.Y., a corporation of New Jersey

Filed Mar. 17, 1955, Ser. No. 494,871
8 Claims. (Cl. 165—70)

The present invention relates in general to the construction of heat exchange apparatus and particularly to a shell and tube type of heat exchanger for effective service with a high temperature corrosive heating fluid and capable of withstanding rapid temperature variations.

Heat exchangers have been suggested having a single thick tube sheet divided by an associated partition into inlet and outlet sections, a bank of U-shaped tubes extending between and connected to the inlet and outlet sections, and a single shell encompassing the tube sheet and tube bank. When such an exchanger is subjected to rapidly varying high temperatures and pressures, the large thick tube sheet is subjected to combined thermal and pressure stresses which cause the tube sheet and shell to flex, distort and rapidly deteriorate.

Further, the temperature variations cause the connection between the tubes and tube sheet to rapidly fail and cause leakage between the two heat transfer mediums. The problem of repairing the heat exchanger is sometimes difficult and costly where an entire process has to be shut down and the system drained to make repairs possible. In the use of the prior suggested shell and tube exchangers, the entire head portion of the shell must be removed to obtain access to repair leaks and this creates a major difficulty.

The present invention is directed to a shell and tube heat exchanger in which the heat exchanger tubes are arranged in groups with each group comprising a plurality of tubes, with the groups passing through the wall of the shell at spaced positions and the tubes of each group connected to one inlet chamber or header and a corresponding outlet chamber or header.

This construction has the advantage that the shell of the unit becomes a tube sheet. The metal thicknesses are only slightly greater than an unperforated shell, and thermal stresses are considerably reduced, as compared to those of a heavy tube sheet. Further, the invention makes possible the sealing off of a leaking tube group without shutting down or draining the entire system. This advantage is obtained with a minimum reduction in capacity where the number of tube groups is large. Further, the multiple header arrangement, by reducing metal thickness in the pressure parts, reduces the cost of the exchanger correspondingly.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described preferred embodiments of the invention.

Of the drawings:

FIG. 1 is a plan section of a heat exchanger constructed in accordance with the present invention;

FIG. 2 is a side elevation of the heat exchanger taken on line 2—2 of FIG. 1;

FIG. 3 is an enlarged partial elevation through the heat exchanger at line 3—3 of FIG. 2; and

FIG. 4 is a section of another embodiment of the invention.

In FIGS. 1 to 3 there is shown an embodiment of the heat exchanger 10 of the present invention which comprises an outer elongated pressure vessel or shell 12 of circular cross-section having dished end portions 14, 16. The shell 12 is constructed with a portion 18 of its cylindrical wall of a greater metal thickness than the remaining portions of the shell. Suitable nozzles 20, 22, are provided for passing a heat transfer fluid through the shell 12.

Disposed within the shell there is a bundle 24 of U-shaped tubes with each tube having end portions 26 laterally extending in a vertical plane perpendicular to the vertical plane of its U-bend as the tube ends pass through the wall of the shell 12.

In FIGS. 2 and 3 the tubes of the bundle 24 are shown divided into a number of groups 25, each group consisting of three or six tubes. The ends of the tubes of each group pass through an opening 23 in the wall of the shell 12 and are connected to fluid chambers 30 which are integrally attached to the shell 12 at spaced positions along the thick portion 18 of the shell. Further, each heat transfer element is a double tube and is composed of an outer tube 28 and inner tube 29.

The double tubes are constructed so that the outer tubes 28 have an increased diameter at the 90 degree and 180 degree bends to provide for differential thermal expansion of the inner tubes 29.

FIG. 3 being a partial sectional elevation shows the construction of the fluid chambers 30 and the arrangement of tubes therein. Each chamber when arranged for a double tube connection has a fluid space 32 formed by the outer tube sheet 34 and closure head 36. Arranged in each head 36 are the fluid nozzle 38 and the inspection fitting 39. A second fluid chamber 40 is formed by the outer tube sheet 34, the inner tube sheet 42, and a cylindrical portion 44. The inner tube sheet 42 is integrally attached to the shell 12 by the extension tube 46.

The tubes are arranged so that the tubes of each group pass through the inner tube sheet 42. Each outer tube 28 is attached to an inner tube sheet 42 while the inner tube 29 extends through the fluid chamber 40 and through the outer tube sheet 34, each inner tube being secured to the tube sheet 34 in pressure tight relationship. To reduce the volume of the fluid chamber 40, a fill block 47 is fitted over the inner tubes 29. Thus there is an annular space between the inner and outer tubes in communication with the fluid chamber 40. This space is normally filled with a heat exchange medium so as to increase the heat transfer conductance of the double tube. This medium is introduced and/or drained by a connection 48 (see FIG. 3) for each group of tubes.

The arrangement of the tubes is such that the inlet and outlet chambers for each group of tubes are on the same side of the shell and that one half of the total number of tube groups are attached to one half of the shell 12 and the remainng tube groups are attached to the other half of the shell. Thus one half of the total tube bundle is fitted into each one half of the shell and then the two halves are secured together by longitudinal seam welds 50, 52. The end portions 14, 16 are then attached to complete the assembly.

The heat exchanger 110 of FIG. 4 also employs multiple inlet and outlet chambers for the fluid flowing through the bent tubes. The outer elongated pressure shell or vessel 112 is composed of a long cylindrical section and two hemispherically shaped end portions 114, 116. Suitable nozzles 120, 122 are provided for passing a heat transfer fluid through the shell.

Disposed within the shell are separate groups 125 of U-shaped heat exchange tubes with each group of tubes arranged in vertical rows and each adjacent row having their tube ends 126 oppositely extending to form an interlaced tube bundle 124 uniformly filling the pressure shell 112. Further, each tube is a double tube and is composed of an outer tube 128 and an inner tube 129.

The double tubes are constructed so that the outer tubes **128** have an increased diameter at the 180 degree bends to provide for differential thermal expansion of the inner tubes **129**.

Each double tube is secured in one of the chambers **130** in the same manner as the tubes shown in FIGS. 1 to 3.

Each end portion **114**, **116** of the shell **112** has a number of spaced holes therein and into which there is fitted and attached a number of fluid chambers **130**. The outer end of the chamber **130** having a fluid space **132** formed by the outer tube sheet **134** and the hemispherical head **136**. The fluid nozzles **138** provide entry to the fluid space **132**.

Each chamber **130** has the inner tube sheet **142** with the inner tube sheet face disposed completely within the walls of the shell **110**. A thermal conducting fluid chamber **140** is formed by the inner tube sheet **142**, the outer tube sheet **134** and cylindrical portion **144**. The cylinder **144** being integrally attached to the shell end portions **114**, **116**.

The embodiments herein described involve double tube heat exchangers which are so constructed to provide a great margin of safety against the leakage of one heat transfer medium into the other heat transfer medium, where the two mediums are incompatible. Additionally, the invention contemplates the use of single wall tubes in place of the double wall tubes.

While in accordance with the provisions of the statutes, there is illustrated and described herein specific forms of the invention, those skilled in the art will understand that changes may be made in the form of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of the other features.

What is claimed is:

1. Conpartmentized heat exchanger construction including tubular side walls and end walls forming a shell chamber, a series of openings formed in each end wall, a series of spaced tubular sleeves connected to each end wall and projecting outwardly from the openings formed therein, closure means for the outer end of each sleeve, the axes of the sleeves projecting from one end wall being located intermediate the axes of the sleeves projecting from the other end wall, tube sheet means mounted within each sleeve, said tube sheet means in each sleeve being spaced outwardly of the sleeve connection with the end wall from which the sleeve projects, a tube bundle mounted on the tube sheet means in each sleeve and extending from the tube sheet means through the sleeve into the shell chamber, and the mounting of tube bundles in sleeves projecting from one end wall on axes intermediate the axes of sleeves mounting tube bundles projecting from the other end wall providing an interleaved arrangement between the series of tube bundles extending into the shell chamber from the sleeves projecting outwardly from one end wall and the series of tube bundles extending into the shell chamber from the sleeves projecting outward from the other end wall.

2. The heat exchanger construction defined in claim 1 in which the axes of the tubular sleeves are parallel with each other and with the axis of the tubular shell side walls.

3. The heat exchanger construction defined in claim 1 in which the tubes of each bundle extend from the sleeves projecting outwardly from one end wall into the shell chamber to a point near the opposite end wall.

4. The heat exchanger construction defined in claim 1 in which the sleeve walls have a thickness less than that of the shell end walls.

5. Compartmentized heat exchanger construction including tubular side walls and end walls forming a shell chamber, a series of openings formed in each end wall, a series of spaced tubular headers connected to each end wall and projecting outwardly from the openings formed therein, closure means for the outer end of each header, the axes of the headers projecting from one end wall being located intermediate the axes of the headers projecting from the other end wall, tube sheet means mounted within each header, each header including a thermal sleeve portion extending from the shell end wall from which the header projects to the tube sheet means thereby spacing said tube sheet means outwardly of the header connection with the end wall from which the header projects, a tube bundle mounted on the tube sheet means in each header and extending from the tube sheet means through the thermal sleeve portion into the shell chamber, and the mounting of tube bundles in headers projecting from one end wall on axes intermediate the axes of headers mounting tube bundles projecting from the other end wall providing an interleaved arrangement between the series of tube bundles extending into the shell chamber from the headers projecting outwardly from one end wall and the series of tube bundles extending into the shell chamber from the headers projecting outwardly from the other end wall.

6. The heat exchanger construction defined in claim 1 in which the tube sheet means in each sleeve is of less thickness than said shell chamber walls.

7. The heat exchanger construction defined in claim 1 in which U-shaped double tubes extend between said spaced tubular sleeves.

8. The heat exchanger construction defined in claim 7 in which the outer tube of each double tube is of an increased diameter in the bend to provide for longitudinal expansion of the straight legs of the inner tube.

References Cited in the file of this patent

UNITED STATES PATENTS

686,313	Mann	Nov. 12, 1901
1,397,282	Hanley et al.	Nov. 15, 1921
1,743,451	Hartmann	Jan. 14, 1930
1,802,413	Engler	Apr. 28, 1931
1,823,800	Hartmann et al.	Sept. 15, 1931
1,964,051	Gordon et al.	June 26, 1934
2,063,490	Davis	Dec. 8, 1936
2,060,078	Hobbs	Nov. 10, 1936
2,187,555	Flindt	Jan. 16, 1940
2,243,593	Zallea	May 27, 1941
2,643,862	Stelling	June 30, 1953
2,658,728	Evans	Nov. 10, 1953