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2,936,159

COMPARTMENTIZED HEAT EXCHANGER CONSTRUCTION

Filed June 21, 1957

2 Sheets-Sheet 1

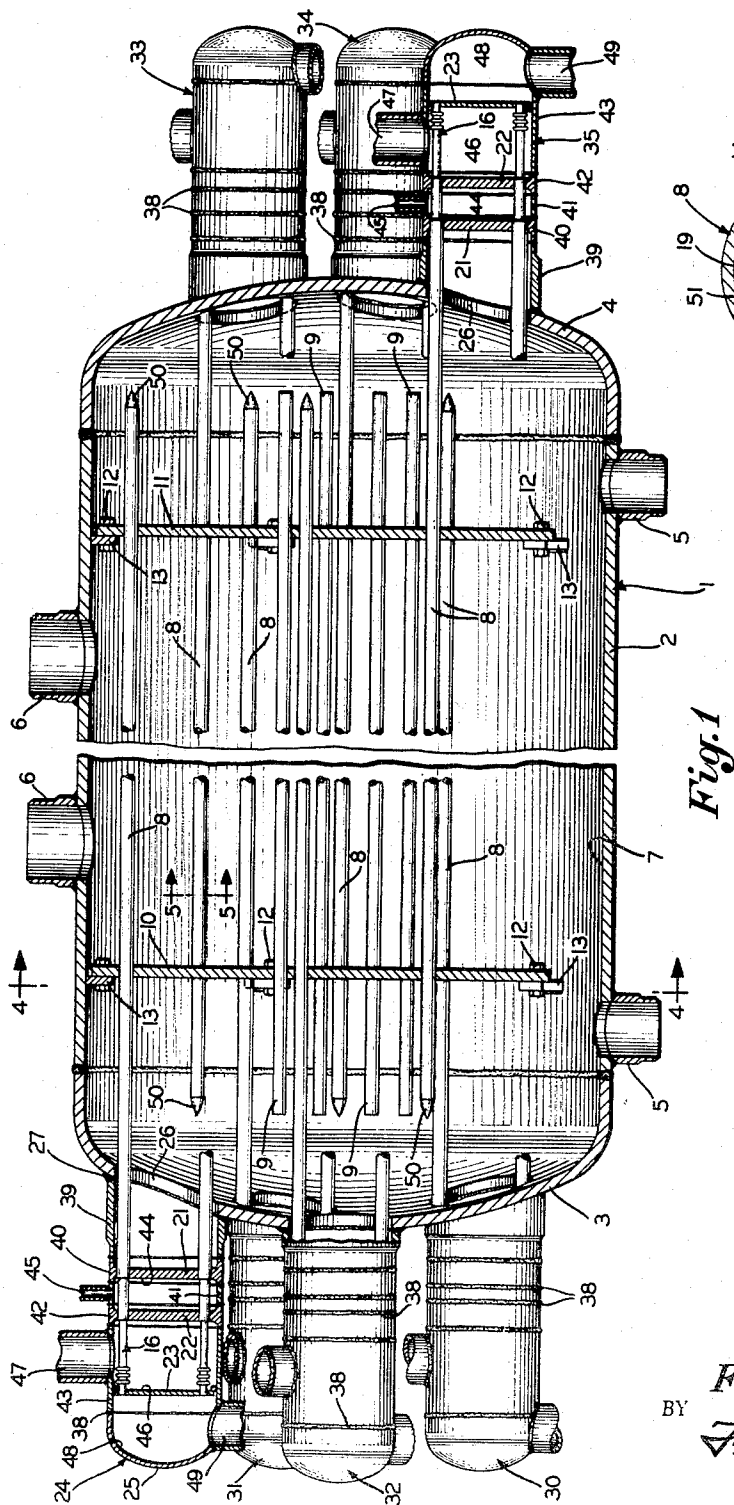


Fig. 1

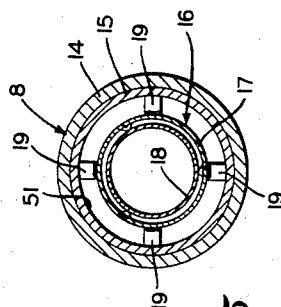


Fig. 5

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2 Sheets-Sheet 2

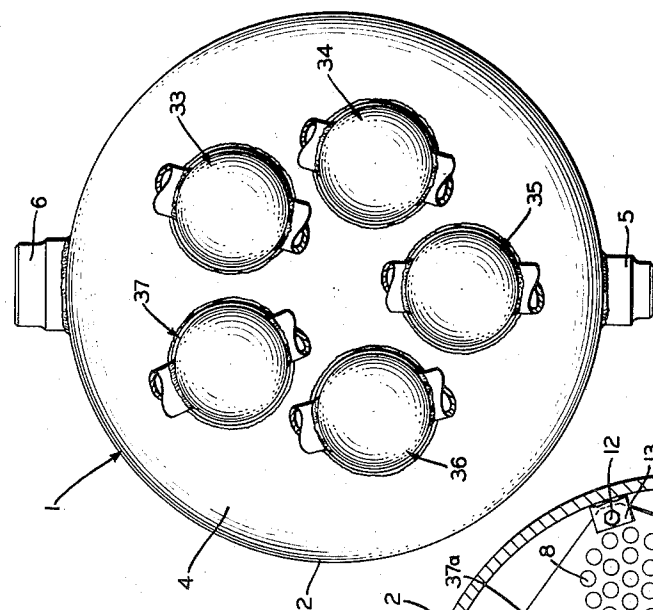
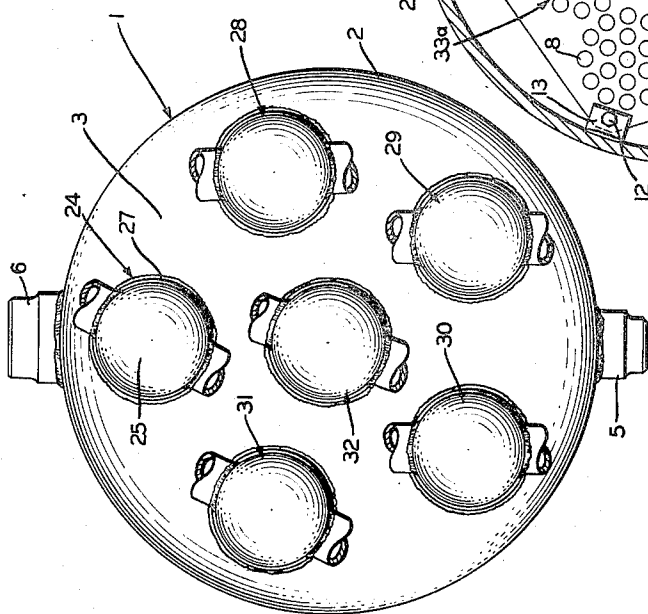
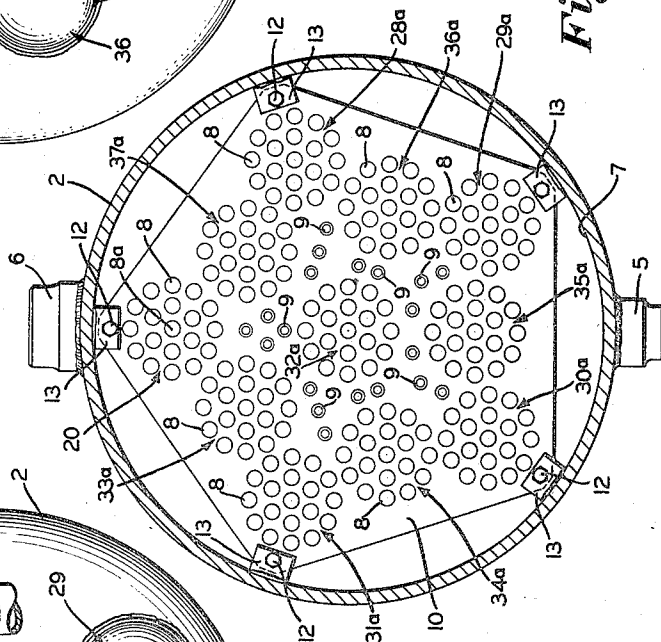


Fig. 2

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COMPARTMENTIZED HEAT EXCHANGER CONSTRUCTION

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Application June 21, 1957, Serial No. 667,246

10 Claims. (Cl. 257—236)

This invention relates to compartmentized heat exchangers and more particularly to a construction in which compartmentation is achieved by the provision of interleaved bundles of bayonet tubes extending from opposite ends of the shell of a heat exchanger such as a steam generator.

Heat exchangers have been used generally for many types of service including condensers, coolers, heaters and steam generators. In any heat exchanger it is desirable to keep the size of the shell and the tube sheets as small as possible to minimize the weight and cost of parts that do not contribute to heat transfer. A further reason for reducing the size of the equipment frequently is the lack of space available and the necessity for minimum weight. For example, on seagoing vessels space is at a premium and therefore the size and mass of the heat exchanger constitute important considerations in the design and construction of heat exchangers and other associated equipment.

However, reducing the size of a heat exchanger while maintaining its capacity and efficiency creates problems. For one thing, accessibility to the interior of the heat exchanger for assembly during manufacturing and subsequent maintenance is necessary. In addition, there is a further problem in providing a compact tube layout without creating overcrowded conditions in the arrangement of related parts.

Associated with those considerations is a requirement of providing compartmentation of heat exchange tubes by grouping the tubes into tube bundles wherein each bundle is connected to a separate header at an end of the heat exchanger. Where several headers are provided at one end of the shell and using bayonet tubes, working space between the headers must be provided for facilitating the assembly and maintenance of the individual header and tube bundle assemblies. The space between adjacent assemblies then may be occupied by other tube bundle assemblies extending from the other end of the shell.

Heretofore compartmentation in a heat exchanger has been provided by separate bundles of tubes extending from adjacent portions of one tube sheet and from adjacent individual tube sheets attached directly to the shell. Such constructions satisfied the need for compartmentation but often resulted in other problems. Hot spots in the tube sheet may develop in use of the heat exchanger which in turn create thermal stresses in the tube sheet or shell walls of the heat exchanger. Under high temperature operating conditions this problem is particularly aggravated and especially there may be critical thermal stress problems in the construction and operation of a heat exchanger where one of the fluids is a liquid metal at a temperature of from say 600° F. to 1200° F.

I have discovered that compartmentation may be achieved and excessive thermal stresses avoided in the shell and tube sheet means of a high temperature heat exchanger by providing separate tube sheets spaced from the shell for each bundle of compartmented tubes. Each

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tube sheet is separated from the end wall of the shell by a cylindrical container or thermal sleeve by which each tube bundle and tube sheet assembly is connected to the end wall of the shell in a fluid-tight manner. Each thermal sleeve is spaced from adjacent thermal sleeves for accessibility for assembly during manufacture and for maintenance. The spacing of tube sheets and thermal sleeve units at one end of the shell is dependent upon the spacing and number of similar tube sheets and thermal sleeve units at the other end of the shell.

One advantage of such compartmentation construction is that it permits the isolation of damaged components while enabling continued operation of the heat exchanger. In addition, where the tubes are bayonet tubes, such an assembly of tube bundles, thermal sleeves and tube sheets permits the disposition of tube bundles at one end between similar bundles extending from the opposite end of the heat exchanger. This so-called "interleaved" tube bundle construction, in which bundles of tubes extend from opposite ends of the shell, provides a compact arrangement of the total heat exchange surfaces, i.e. the tube walls, while achieving compartmentation.

Moreover, filler rods or dummy tubes may be provided between separate bundles of the tubes to maintain velocity of the steam within the shell and thereby prevent separation of steam and water where the heat exchanger is of the steam generator type. Thus a more uniform flow path is provided throughout the entire shell and maintains a more uniform velocity of movement of the steam.

Generally, it is an object of this invention to provide a series of tube headers with individual tube bundles in which the bundles are interleaved and extend from opposite ends of the shell and are disposed between each other to provide a compact tube layout without overlapping or overcrowding the tube headers.

It is another object of this invention to provide a heat exchanger having separate bundles of tubes attached to separate tube sheets to provide accessibility for assembly and maintenance of compartmented assemblies of tube and tube sheet units.

It is another object of this invention to provide a bundle of tubes attached to a tube sheet which may be by-passed from operation without discontinuing operation of the entire heat exchanger.

It is another object of this invention to provide an assembly including a bundle of tubes attached to a tube sheet which enables complete repair during normal shipyard overhaul periods by removal of the assembly without disturbing the shell of the heat exchanger.

Also it is an object of the present invention to provide a compartmentized heat exchanger construction including a plurality of separate tube bundles attached to separate tube sheets connected with the shell of the heat exchanger by individual tubular sleeves which enable any individual tube bundle to be by-passed from operation without subjecting the heat exchanger to harmful thermal discontinuity stresses.

It is another object of this invention to provide an assembly of bundles of tubes and a tube sheet unit connected to the end wall of the shell of a heat exchanger by thermal sleeves which accommodate excessive thermal stresses that may develop between the shell and the tube sheet units in the operation of high temperature heat exchangers.

It is another object of this invention to provide thermal sleeves that relieve differential thermal expansion between the shell cover and the separate tube sheets which may be caused by hot spots in a tube sheet within the shell of a heat exchanger.

It is another object of this invention to provide filler or dummy tubes in a high temperature heat exchanger operating as a steam generator at the interstices between

the tube bundles which prevent separation of steam and water by maintaining uniform resistance to flow of steam through the shell.

It is another object of this invention to provide replaceable compartments for ease of maintenance and for reducing metal thicknesses required for high pressure heat exchanger designs and for alleviating thermal stresses.

Finally, it is an object of this invention to provide an improved heat exchanger construction especially adapted for use as a steam generator with bayonet tubes assembled in a plurality of separate bundles which substantially eliminates the difficulties enumerated and which obtains the foregoing desiderata in a simple and effective manner.

These and other objects and advantages apparent to those skilled in the art from the following description and claims may be obtained, the stated results achieved and the described difficulties overcome by the discoveries, principles, apparatus, parts, combinations, subcombinations and elements which comprise the present invention, the nature of which is set forth in the following statement, a preferred embodiment of which—illustrative of the best mode in which applicant has contemplated applying the principles—is set forth in the following description, and which is particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

The nature of the improvements in heat exchanger construction of the present invention may be stated in general terms as including in a heat exchanger having a shell and end walls at opposite ends of the shell, a plurality of first bundles of heat exchange tubes extending into the shell from one end wall of the shell, a plurality of second bundles of heat exchange tubes extending into the shell from the other end wall of the shell in the spaces between said first bundles of tubes, all of said tubes being bayonet type tubes, each bundle of tubes being attached to a separate tube sheet spaced outwardly from the corresponding end wall of the shell, each separate tube sheet being connected to the corresponding end wall by a tubular thermal sleeve in a fluid-tight manner, and the wall of the thermal sleeve preferably having a thickness less than that of the walls of the shell and end wall, whereby the thermal sleeves control thermal discontinuity stresses that may develop in the metal tube sheet and shell walls of the heat exchanger during operation thereof under normal and abnormal operating conditions.

In the accompanying drawings which are illustrative of a preferred embodiment of the invention, by way of example, and in which similar numerals refer to similar parts thereof:

Figure 1 is a vertical sectional view, partly in elevation, of a heat exchanger;

Fig. 2 is an end view of the heat exchanger as seen from the left end of Fig. 1;

Fig. 3 is an end view taken from the right end of Fig. 1;

Fig. 4 is a vertical sectional view taken on the line 4—4 of Fig. 1; and

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 1.

In Fig. 1 a steam generator type of heat exchanger is generally indicated at 1. It includes a shell 2 having opposite end walls 3 and 4. The shell is provided with a pair of inlets 5 for water and a pair of outlets 6 for steam. It is to be understood, however, that the principles involved in this invention are not necessarily confined to the steam generator type of heat exchanger but may be incorporated for example in other types of heat exchangers.

The shell 2 encloses a shell chamber 7 which is filled with a plurality of heat exchange tubes 8 of the bayonet type. Each tube 8 is composed of an inner and outer tube in a manner well known in the art. In Fig. 1, only a

relatively small portion of all of the tubes 8 is shown for the purpose of description. It is understood, however, that the total number of tubes 8 is sufficient to occupy a greater part of the interior of the shell 2. The manner in which the tubes 8 are preferably disposed is shown in Fig. 4.

As shown in Figs. 1, 2 and 3, the tubes 8 are disposed in bundles of tubes, which, as shown in Fig. 4, include nineteen tubes 8 per bundle. Some of the tube bundles extend from one end wall of the shell, and some of the tube bundles extend from the other end wall of the shell in the spaces between the tube bundles which extend from the one end. Between the bundles of tubes, a plurality of dummy tubes 9 may be provided to occupy the spaces or interstices between adjacent bundles. As shown more particularly in Fig. 1, the dummy tubes 9 extend between the ends of the oppositely disposed bundles of tubes 8. Like the tubes 8, the dummy tubes or rods 9 are mounted in place between a pair of spaced mounting plates 10 and 11 which are bolted at 12 to brackets 13 attached to the inner surface of the shell 2.

As shown in Fig. 5, each bayonet tube 8 includes an outer tube 14, inner concentric double-tube 15 for the tube 14, and an inner tube unit generally indicated at 16 which may include an outer jacket tube 17 and an inner core tube 18; and the inner tube unit 16 may be spaced from double tube 15 by spacers 19. Preferably, the bayonet tube 8 may be an insulated bayonet tube construction as disclosed in the copending application of Frank Boni, Jr., and Philip S. Otten, Serial No. 667,245, filed June 21, 1957.

The uppermost bundle of tubes 8 is generally indicated in Fig. 4 at 20 which includes one center tube 8a and two outer concentric series of tubes, one of which series includes six tubes 8 and the other of which includes twelve tubes 8. As shown in Fig. 1, each bundle of tubes such as the uppermost bundle 20 is connected to a separate tube sheet unit that includes an inner tube sheet 21, an intermediate tube sheet 22, and an outer tube sheet 23, all of which tube sheets are disposed within a cylindrical shell or header generally indicated at 24, having an end cover 25 at one end and communicating with the shell chamber 7 through an aperture 26 in the end wall 3 of the shell where the header 24 is attached to the end wall 3 by an annular weld 27.

The tubes 14, 15 and 16 may be connected respectively with the tube sheets 21, 22 and 23 in any usual manner to provide a liquid-tight joint therebetween. Preferably any or all of the tube to tube sheet joints may be formed in accordance with the disclosure of the copending application of Karl A. Gardner and Frank Boni, Jr., Serial No. 649,037, filed March 28, 1957, by the method of welding tubular heat exchanger parts disclosed in the Raymond Gardner, Jr., and Anthony J. Ryder application, Serial No. 649,036, filed March 28, 1957, by using welding tools disclosed in the Gardner application, Serial No. 649,186, filed March 28, 1957, to provide internally welded joints between tube ends and tubular projections formed integrally of the tube sheet.

The cylindrical shell or header 24 is shown in Fig. 2 along with other similar shells or headers generally indicated at 28, 29, 30, 31 and 32. The headers 28, 29, 30, 31 and 32 are connected to the particular tube bundles generally indicated at 28a, 29a, 30a, 31a and 32a, respectively, as shown in Fig. 4.

Likewise, the opposite end wall 4 of the shell 2 is provided with a plurality of headers generally indicated at 33, 34, 35, 36 and 37 as shown in Figs. 1 and 3. The headers 33 to 37 are preferably symmetrically disposed and their longitudinal axes are disposed on a circle, the radius of which is substantially equal to one-half the radius of a similar circle on which the headers 24 and 28 to 31 are disposed. Thus, the longitudinal axes of the headers 32 to 37 are located between the axis of the

central header 32 and the axes of the outer headers 24 and 28 to 31.

Moreover, the axes of the headers 33 to 37 are out of alignment with a line between the axis of the inner header 32 and each axis of the outer headers 24 and 28 to 31. For example, the longitudinal axis of the header 33 is preferably disposed on a line bisecting the angle between the lines extending from the headers 24 and 31 to the center of the header 32. In a similar manner, the longitudinal axes of the other headers 34 to 37 are disposed substantially halfway between the other headers in the outer circle as shown in Fig. 2.

The headers 33, 34, 35, 36 and 37 are provided with tube bundles 33a, 34a, 35a, 36a and 37a, respectively, the pattern for the arrangement of which is more particularly shown in Fig. 4. Thus the filler rods or dummy tubes 9 are provided between the interstices or zones between the tube bundles where spaces of no tubes 8 would otherwise exist.

Each header is composed of a plurality of longitudinally disposed annular sleeve portions which are welded together end-to-end in a fluid-tight manner such as welds 38. For example, the header 24 includes a thermal sleeve 39 adjacent to and welded at 27 to the shell end wall 3. In addition, the header 24 includes annular sleeve portions 40, 41, 42 and 43, to the latter of which is connected the dome-shaped cover 25. The annular header sleeve portions 40 and 42 include the inner and intermediate tube sheets 21 and 22, respectively, and the annular sleeve portion 41 encircles a chamber 44 between the tube sheets 21 and 22. In addition, a monitoring port 45 is provided in the annular sleeve 41 for communication with the chamber 44. The outer tube sheet 23 is detachably connected to the inner surface of the annular sleeve portion 43 and thereby provides a header chamber 46 which communicates with a fluid outlet port 47 in the annular portion 43. Likewise a chamber 48 is provided between the outer tube sheet 23 and the cover 25 with which chamber 48 a fluid inlet 49 communicates.

All of the headers are similar in construction, and as shown in Fig. 1, the walls of all of the annular sleeve portions 39-43 and cover 25 are of less thickness than the walls of the shell 2 and the end members 3 and 4.

When the heat exchanger 1 is operated, water enters the inlets 5, passes through the shell chamber 7 in heat exchange contact with the tubes 8 and leaves the shell through the outlet 6 as steam. The tubes 8 are heated by a hot fluid such as liquid metal which enters the heat exchanger 1 through the many fluid inlets similar to the inlet 49 in the header 24, and passes into the inner tube 18 (Fig. 5) of the inner tube unit 16, and then flows to the opposite end of the tube 8 which is sealed by an end cap or cover 50, and then flows in the opposite direction in an annular space 51 (Fig. 5) between the tubes 15 and 17 to the chamber 46 between the tube sheets 22 and 23, and then out of the header through the outlet 47. During the return flow of the hot fluid, heat is transmitted through the walls of the tubes 15 and 14 to the shell fluid surrounding the tubes 8.

Each tube 8 includes the pair of tubes 14 and 15 having end portions seated within the spaced tube sheets 21 and 22 respectively. The double-tube construction 14-15 provides leak-detection means for the hot fluid flowing through the tubes and any failure of such tubes. The double-tube construction may be that shown in the co-pending application of Bruegger and Otten, Serial No. 380,214, filed September 15, 1953, now Patent No. 2,864,404, dated December 16, 1958.

A particular bundle in which the failing tube 8 is located may be by-passed to enable continued operation of the heat exchanger, if some failure of any of the tubes 8 or the component parts thereof occurs during operation of the heat exchanger. Such failure may be of one of the double tubes 14 and 15, which could ultimately result in interleakage between the shell and tube

fluids. This failure would be detected by the leak-detection means monitored through port 45 communicating with the leakage detection chamber 44. The by-passing may be accomplished, for instance in connection with tube bundle 20, by cutting off passage of tube fluid through the tube fluid inlet and outlet ports 49 and 47 by closing valves, not shown. Thereafter, the tube failure may be repaired during normal shipyard overhaul periods by removing the particular tube bundle, such as the tube bundle 20, from the heat exchanger without disturbing the shell of the heat exchanger, as by cutting through the welded joint 38 between the adjoining thermal sleeve 39 and header wall portion 40 and by severing the connections with the inlet and outlet ports 49 and 47. After the necessary repairs have been made, the bundle 20 may be replaced by rejoining the parts which had been separated for removal of the tube bundle.

As compared to other designs, the bayonet tube arrangement utilized in the construction of the present invention offers complete freedom from all tube stresses other than those due to temperature gradient through the tube walls or to hydrostatic pressure. All stresses due to differential expansion between the shell and tubes, between individual tubes, or between legs of the same tube are completely eliminated with the exception of those moderate stresses in the span between the tube sheets 21 and 22.

That is to say, every tube in every component is free to expand and contract individually without restraint excepting the portion of the inner tube 15 of the double tube 14 and 15 extending between the tube sheets 21 and 22. This span is under compression during normal operation and upward change in temperature and in momentary tension during downward change of temperature. However, the strength of the tube may be so designed that the severest stresses to which the tube may be subjected fall well within normal acceptable limits. Failure, however, of the tube 15 at this location can be detected through leakage detection chamber 45, and the outer wall 14 of the double tube 14 and 15 still provides a barrier to interleakage between shell and tube fluids until the particular tube bundle can be by-passed and taken out of operation.

Both temperature level and gradient, and attendant stress in the tube sheets and tube joints of the improved construction are reduced as a result of the bayonet tube design, since sharp temperature changes in the incoming stream of hot tube fluid are not imposed directly upon the main tube sheet 21, but rather upon the thin flexibly supported core tube sheet 23. By the time that the hot tube fluid stream element in which the transient sharp temperature change occurred reaches a critical strength part, the severity of the transient temperature change has been considerably reduced.

Again, as compared to other designs of heat exchangers in which the tube sheets span and are connected directly with the shell walls, the separation of the individual tube sheets 21, 22 and 23 from the shell walls 3 and 4 by the thermal sleeves 39 provides outstanding advantages.

Thus the separation of the tube sheets 21, 22 and 23 from the shell walls 3, 4 and 2 reduces thermal discontinuity stresses in these parts to a minimum during steady operation, as well as operation where sharp transient temperature changes may occur. Further, the improved construction utilizing the thermal sleeve connection between the shell and tube sheets eliminates entirely any discontinuity stresses between adjacent compartments in the event that any particular compartment is taken out of operation.

In other words, a sharp or substantial temperature change, for example, in any tube sheet 21 of any one of the bundles 20, 28a, 29a, etc. with respect to the tube sheet 21 in any of the other bundles either by a transient temperature increase or by a reduced temperature incident to taking a particular bundle out of operation is

accommodated by the improved construction. The thermal sleeves 39 accommodate the differential radial expansion which may occur in such instances between the tube sheets and the shell cover walls 3 or 4 and thus remove the shell cover walls from excessive thermal stresses to which they would be subjected in the absence of separation of the tube sheets from the shell by means of thermal sleeves.

Compartmentation of the surface in the improved construction into small diameter tube bundles extending lengthwise from both ends of the shell from individual tube sheets connected by thermal sleeves with the shell affords many other advantages. The use of a multiplicity of small tube sheets, such as the tube sheet 21, permits the use of smaller and thinner parts as structural elements which results in great economy in the use of material and in the manufacture thereof, and many advantages in ease of handling, fabrication time, etc.

Stocking of spare parts is simplified because spare tube bundles are relatively small and can be carried in stock on shipboard or at shipyards when the heat exchanger is designed for installation on shipboard.

Removal of a tube bundle for repair aboard ship is feasible by cutting the thin-walled thermal sleeves and the inlet and outlet connections therefor. No dismantling of the shell proper is required. Damaged tube bundles can be repaired easily because of their small size and consequent general accessibility.

In essence, the various described advantages of the present invention are achieved by the interleaved bayonet tube bundle construction in which the bayonet tubes are mounted and extend into the shell from tube sheets separated from the shell walls proper by thermal sleeves. In this manner, not only is compartmentation provided, but thermal discontinuity stresses are controlled.

Accordingly, the construction of the present invention provides compartmentation with a compact tube layout without overcrowding or overlapping the headers; provides simplicity of manufacture and accessibility for maintenance; provides for by-passing any one of the tube bundles without creating a thermal stress problem; provides a plurality of relatively small tube sheets remote from the end wall of the shell of the heat exchanger; provides thin-walled parts for the tube sheets and thermal sleeves which may be readily fabricated; provides small-sized spare parts which simplifies the problem of stocking spare parts when carried on shipboard; provides a compartmented construction in which tube bundles may be replaced aboard ship without dismantling the shell; and provides a construction overcoming the difficulties and achieving the advantages indicated.

In the foregoing description certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Moreover, the embodiment of the improved construction illustrated and described herein is by way of example, and the scope of the present invention is not limited to the exact details of construction shown.

Having now described the features, constructions and principles of the invention, the characteristics of the new compartmentized heat exchanger construction, and the advantageous, new and useful results provided; the new and useful discoveries, principles, parts, elements, combinations, subcombinations, structures and arrangements, and mechanical equivalents obvious to those skilled in the art are set forth in the appended claims.

I claim:

1. 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 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 tube sheet means in each sleeve and the sleeve and closure means therefor form a series of separate chambers in each sleeve, and in which the tube bundles include bayonet tubes having inner and outer tube members, and in which the inner and outer tube members communicate respectively with separate chambers in the sleeve.

4. The heat exchanger construction defined in claim 3 in which the inner bayonet tube member is insulated.

5. The heat exchanger construction defined in claim 3 in which the outer bayonet tube member comprises telescoped double tubes, and in which each of the double tubes communicates with a separate chamber in the sleeve.

6. 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.

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

8. The heat exchanger construction defined in claim 1 in which the tube sheet means in each sleeve and the sleeve and closure means therefor form a series of separate chambers in each sleeve, and in which each sleeve is provided with tube fluid inlet and outlet means communicating respectively with separate chambers in the sleeve.

9. 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.

10. The heat exchanger construction defined in claim 9 in which the tube bundles include bayonet tubes having inner and outer tube members.

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Notice of Adverse Decision in Interference

In Interference No. 91,886, involving Patent No. 2,936,159, F. Boni, Jr.,
Compartmentized heat exchanger construction, final judgment adverse to the
patentee was rendered June 12, 1962, as to claims 1, 2, 6, 7, and 9.
[*Official Gazette July 10, 1962.*]

Disclaimer

2,936,159.—*Frank Boni, Jr.*, Massillon, Ohio. COMPARTMENTIZED HEAT EXCHANGER CONSTRUCTION. Patent dated May 10, 1960. Disclaimer filed Oct. 3, 1962, by the assignee, *Baldwin-Lima-Hamilton Corporation*.

Hereby enters this disclaimer to claims 1, 2, 6, 7, and 9 of said patent.
[*Official Gazette November 6, 1962.*]