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1,884,209

HEAT EXCHANGE APPARATUS

Original Filed Sept. 18, 1930 2 Sheets-Sheet 1

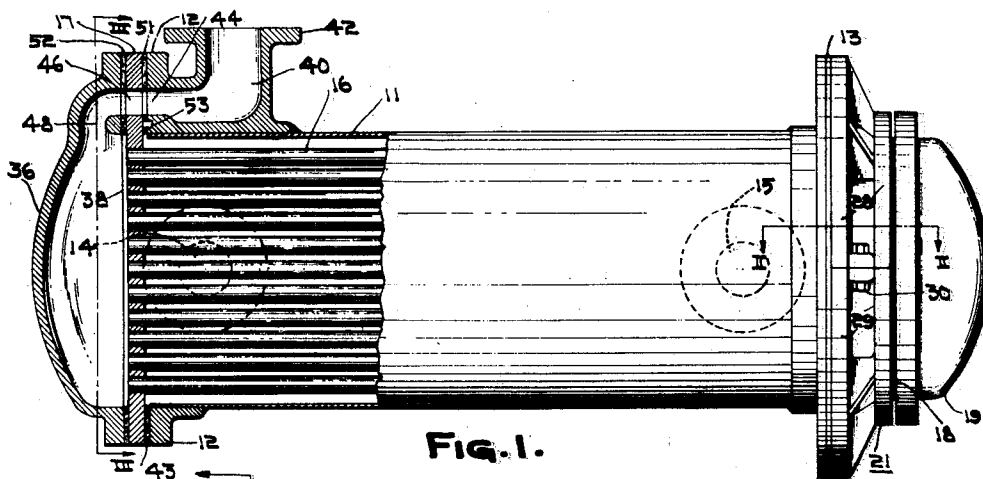


FIG. 1.

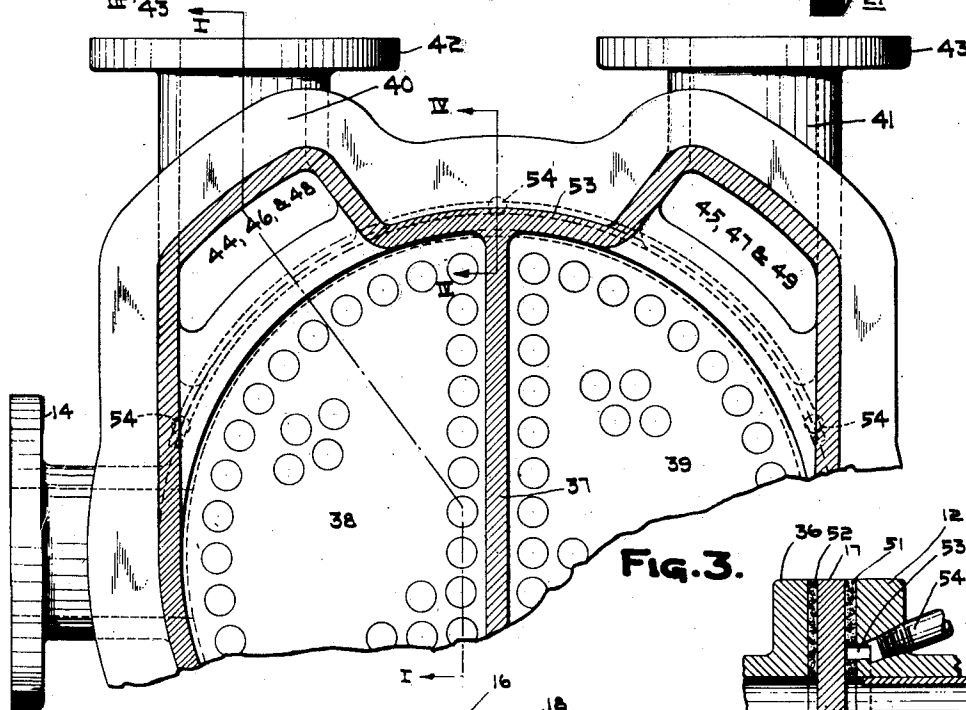


FIG. 3.

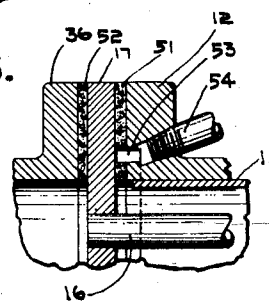


FIG. 4.

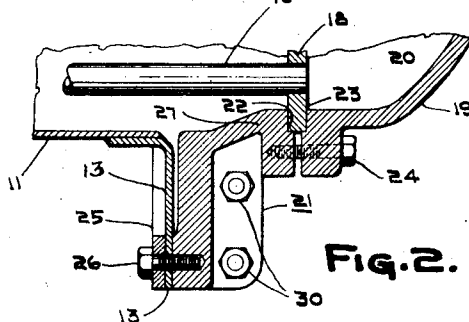


FIG. 2.

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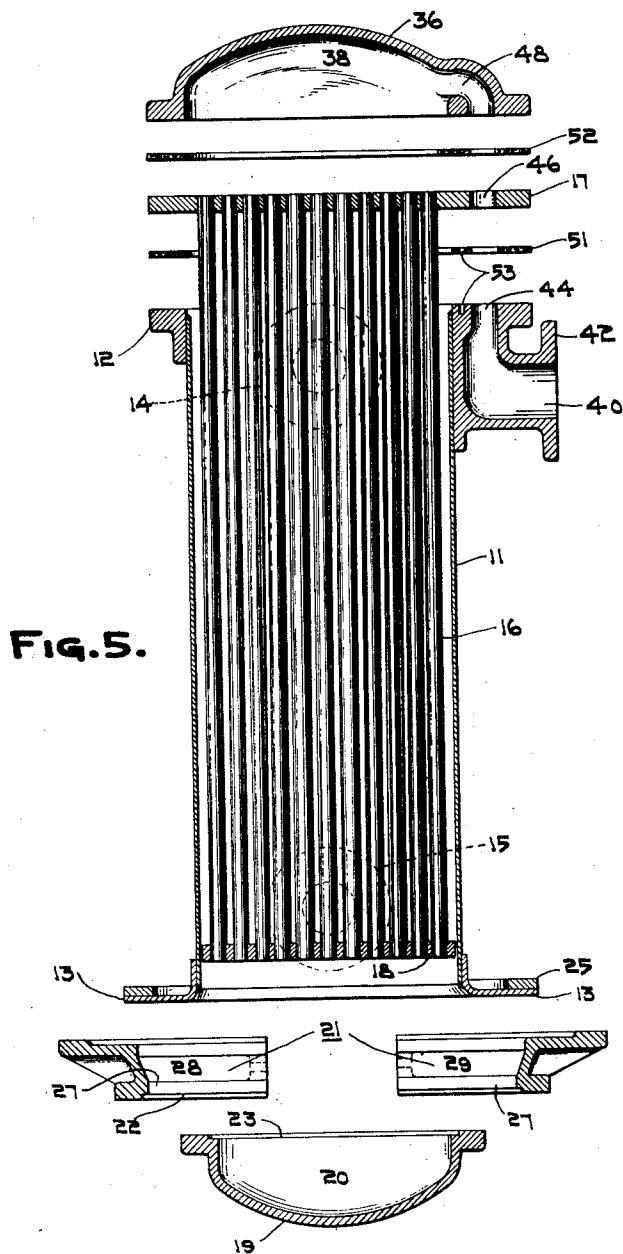
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HEAT EXCHANGE APPARATUS

Original Filed Sept. 18, 1930 2 Sheets-Sheet 2



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HEAT EXCHANGE APPARATUS

Application filed September 18, 1930, Serial No. 482,834. Renewed February 17, 1932.

My invention relates to heat exchange apparatus of the surface type having a shell and a tube bundle aggregate removably secured therein, the tube bundle aggregate embodying a bundle of tubes, and tube plates at both ends of the shell in which the tubes of the tube bundle are rolled or otherwise secured, and it has for an object to provide a form of structure which shall permit relative expansion and contraction of the tubes with respect to the shell and, at the same time, afford ready removal of the tube bundle aggregate from the shell.

My invention has for a further object to provide a form of heat exchanger which shall embody a "floating" tube plate in order to afford expansion of the tube bundle relative to the shell of the heat exchanger and it has for a more particular object to utilize a flat circular disc for the floating tube plate as distinguished from a floating tube plate having annular flanges or other protuberances cast thereon.

My invention has for still another object to effect a fluid-tight joint between the floating tube plate and the shell structure by means of a flexible diaphragm so as to entirely avoid the use of stuffing boxes or their equivalents because of the degree of care and maintenance required by the latter.

My invention has for still another object to provide a form of supporting means for the floating tube plate which shall permit the latter to become displaced angularly at such times as one portion of the tube bundle may assume a relatively different temperature than another portion.

My invention has for still another object to provide a heat exchanger of the foregoing character wherein one edge of each joint embodied in the heat exchanger at the end containing the floating tube plate shall be exposed in order that internal leakage between the fluid circulated inside the tubes of the tube bundle and the fluid circulated outside the tubes of the tube bundle may be avoided.

My invention has for still another object to provide a heat exchanger of the foregoing character which shall embody only one head-
er or cover for the end of the apparatus em-

bodying the floating tube plate distinguished from heat exchange apparatus wherein one cover is provided for the tube plate and a second and surrounding cover is provided for the shell structure.

My invention has for still another object to provide a heat exchanger of the foregoing character wherein the floating tube plate is clamped in position in order to avoid having the retaining means project through or into the tube plate.

Referring to the end of the heat exchange apparatus which embodies the fixed tube plate, my invention has for an object to provide, in heat exchange apparatus wherein the pipes for circulating the fluid through the tube bundle are attached to flanges provided on the shell, improved means for preventing leakage between the fluid circulating inside the tubes of the tube bundle and the fluid circulating outside the tubes of the tube bundle.

These and other objects are effected by my invention, as will be apparent from the following descriptions and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a view, partly in elevation, and partly in cross-section, showing one embodiment of my heat exchange apparatus, the portion of the view in cross-section being taken on the line I—I of Fig. 3;

Fig. 2 is an enlarged, fragmentary detail view of that end of the heat exchange apparatus shown in Fig. 1 which embodies the floating tube sheet portion of the section taken along the line II—II of Fig. 1;

Fig. 3 is a fragmentary, enlarged cross-sectional view taken along the line III—III of Fig. 1 and showing the arrangement of the ducts on the shell and the vent in the joint between the interior of the shell and the ducts;

Fig. 4 is a fragmentary view in detail, taken along the line IV—IV of Fig. 3, showing the arrangement of the packing and the vent to the atmosphere; and,

Fig. 5 is a sectional elevation of the apparatus as illustrated in Fig. 1, showing the same in a vertical position and the parts dis-

connected as when the tube bundle is being withdrawn.

Referring to the drawings, I show a shell 11 having a substantially rigid flange 12 at one end and a flexible or diaphragm-like flange 13 at the other end. The shell 11 is also provided with an inlet opening 14 at one end and an outlet opening 15 at the other end. A tube bundle aggregate is removably secured within the shell 11 and consists of a tube bundle 16 supported at one end by a tube plate 17 which is secured in fixed position to the flange 12, and at the other end by a floating tube plate 18. The latter tube plate is preferably a flat, rolled disc entirely devoid of annular flanges or other protuberances or projections.

As shown particularly in Fig. 2, a cover member 19 abuts against one face of the floating tube plate 18 and cooperates therewith to provide a return fluid chamber 20 for the fluid circulating through the tubes of the tube bundle 16. Interposed between the other face of the floating tube plate 18 and the flexible flange 13 is a ring or annular member 21. The annular member 21, the tube plate 18 and the cover member 19 are retained in axial alignment by suitable recesses 22 and 23 provided in the flanges of the respective members, suitable bolts or screws 24 serving to clamp the tube plate between the members. By means of this clamping arrangement, no retaining bolts or screws need project through or into the floating tube plate. The annular member 21 is secured to the flexible flange 13 by use of a suitable backing ring 25 and suitable screws or bolts 26 passing through the backing ring and through the flexible flange into the annular member.

The flange 13 is made of relatively thin material which permits it to flex axially, or in other words, act as a diaphragm. When any relative expansion or contraction takes place between the tubes of the tube bundle 16 and the shell 11, the tube plate 18 and the annular member 21, rigidly secured thereto, move axially of the shell by flexing the flange 13. In this manner, the tube plate 18 is movably supported by the body of the shell 11 without the use of a stuffing box. Furthermore, the flange 13 has sufficient flexibility to permit the tube plate 18 to incline itself somewhat should one portion of the tube bundle assume a different temperature than another portion. In addition, the joint between the annular member 21 and the tube plate 18 and the joint between the header 19 and the tube plate 18 are all exposed, along one edge, to the outside atmosphere.

In order to afford removal of the tube bundle 16 and tube plates 17 and 18 as a unit from the shell, I split the annular member 21 longitudinally into two oppositely-disposed sections 28 and 29, as illustrated in Figs. 1 and 5. These lateral sections are suitably

joined, preferably, in a plane horizontal to the axis of the shell, and held together by suitable bolts 30 (shown in Fig. 1).

Referring now to the fixed tube plate 17 at the other end of the shell, I provide, a header 36 which cooperates with the tube plate 17 to form a distribution chamber for the fluid flowing through the tubes. This chamber is divided by a partition 37 into an inlet compartment 38 and an outlet compartment 39.

Along one side of the shell 11, a portion of the flange 12 is extended back to form fluid circulation ducts 40 and 41 terminating with flanges 42 and 43 to which pipes or conduits, not shown, are secured for supplying the circulating fluid. At their other ends, each of the ducts 40 and 41 communicates through similar openings 44 and 45 in the flange 12 and corresponding openings 46 and 47 in the tube plate 17 and conduits 48 and 49 formed in the cover or header member 36, with the inlet compartment 38 and outlet compartment 39, respectively.

As shown most clearly in Fig. 4, I provide a gasket or packing member 51 between the tube plate 17 and the flange 12 for securing a fluid-tight joint therebetween. Between the tube plate 17 and the cover 36 another packing member 52 is placed. Referring to the joint between the plate 17 and the flange 12, it will be observed that the packing 51 is relied on to form the seal between the fluid flowing through the shell and that flowing through the ducts to the tubes. Any leakage through this packing would result in the commingling of the two fluids. To prevent this, I provide an annular slot 53 cut in that portion of the face of the flange 12 lying between the duct openings 40 and 41 and the shell. A corresponding slot is cut in the packing 51. The slot 53 and the corresponding slot in the packing thus form a vent in the joint between the two fluids, which vent serves to collect any fluid that may attempt to pass from one fluid space to the other. These slots are connected to a source of vacuum or to the atmosphere through suitable ducts or openings 54. Any fluid tending to leak in either direction through the joint between the duct openings 40 and 41 and the interior of the shell will flow into the venting slot 53 and be led away through openings 54.

When it is desired to remove the tube bundle aggregate from the shell for the purpose of cleaning the tubes, repair, etc., the header or cover member 36 is removed from one end of the shell and the annular member 21 and the header or cover member 19 associated therewith are removed from the other end of the shell. The annular member 21 is removed by detaching it from the flange 13 and the header 19 and by then disconnecting the oppositely-disposed horizontal joints provided in the annular member 21 so as to di-

vide the latter into two sections 28 and 29, which sections can then be moved laterally from between the flexible flange 13 and the tube plate 18. After releasing the stationary tube plate 17 by the removal of header 36 and the floating tube plate 18 by the removal of the header 19 and the annular member 21, the tube bundle aggregate may be withdrawn longitudinally through the end 12 of the shell, the diameter of the floating tube sheet 18 being less than the inside diameter of the shell. During this procedure, it will be noted that all of the parts secured to the floating tube plate 18 are easily removable, leaving no impediment to the passage of the floating tube plate through the shell; secondly, that it is not necessary to disconnect any of the pipes or conduits from the shell structure to release the tube bundle aggregate for removal from the shell.

It will therefore be seen that, according to my invention, I provide a heat exchanger so constructed and arranged as to secure the floating tube plate directly to the shell structure with a type of connection which will permit the necessary axial movement of this tube plate and, at the same time, eliminate the possibility of interchange between the fluids circulating through the shell at this point inasmuch as one side of each joint is exposed. It will further be seen that I provide a construction which eliminates the necessity of removing any of the pipes that supply fluid to the heat exchanger and, at the same time, I also eliminate the possibility of interchange of fluids at this end of the shell.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a heat exchanger, the combination of a shell, a tube bundle aggregate for the shell including a tube plate, an expansion joint for connecting the shell to the plate including a flexible member connected to the shell and a ring consisting of lateral sections and connected to the flexible member and to the tube plate.

2. In a heat exchanger, the combination of a shell; a tube bundle aggregate for the shell including a tube plate; and an expansion joint for connecting the shell to the plate including a flexible member connected to the shell, a ring consisting of arcuate sections, means for connecting the outer portion of the ring to the flexible member, and means for connecting the inner portion of the ring to the tube plate.

3. In a heat exchanger, the combination of

a shell; a tube bundle aggregate for the shell including a tube plate; and an expansion joint for connecting the shell to the plate including an annular flexible member connected to the shell and extended outwardly therefrom, a ring, means for connecting the outer margin of the flexible member to the ring, and means for connecting the plate to the ring embodying a member providing a chamber communicating with the tubes of the aggregate.

4. In a heat exchanger, the combination of a shell; a tube bundle aggregate for the shell including a tube plate withdrawable through the shell; an expansion joint for connecting the shell to the plate including a flexible member connected to the shell, a ring consisting of arcuate sections, a detachable means for securing the ring sections together, means for securing the flexible member to the ring, and means for securing the plate to the ring with the plate overlapping the latter.

5. In a heat exchanger, the combination of a shell; a tube bundle aggregate for the shell embodying tubes and a tube plate withdrawable through the shell; and an expansion joint for connecting the shell to the plate including a flexible member connected to the shell, a ring consisting of arcuate sections, detachable means for securing the ring sections together, detachable means for connecting the plate in overlapped relation with respect to the ring and embodying a chamber communicating with said tubes.

6. In a heat exchanger, the combination of a shell; a tube bundle aggregate for the shell embodying tubes and a tube plate withdrawable through the shell; and an expansion joint for connecting the shell to the plate including an annular flexible member surrounding and connected to the shell at one end, a ring consisting of arcuate sections, detachable means for securing the ring sections together, detachable means for connecting together the outer portions of the flexible member and of the ring, said plate overlapping the ring, a head provided with a chamber communicating with the tubes, and means for connecting the head to the ring with the plate interposed therebetween.

7. In a heat exchanger, the combination of a shell, a tube bundle aggregate with for shell and embodying tubes and a tube plate withdrawable through the shell; and an expansion joint for connecting the shell to the plate including an annular flexible member connected to one end of the shell, a ring consisting of arcuate sections, detachable means for securing the ring sections together, an annular series of bolts for connecting the outer margins of the flexible member and of the ring laterally in contact, said ring having an inner annular recess at the side thereof opposite to the flexible member, a head having an annular recess mating with the first recess and provided with a chamber commu-

nicating with the tubes, and an annular series of bolts for connecting the head to the ring with the plate disposed in said mating recesses and clamped between the ring and the head.

5 8. In a heat exchanger, the combination of a shell having openings providing for the circulation of medium therethrough, a tube bundle aggregate for the shell embodying
10 tubes and a tube plate, a joint between one side of the tube plate and the shell including a portion of the tube plate lateral surface and one end surface of the shell, a head cooperating with the other side of the tube plate to
15 provide a chamber communicating with the tubes, means providing a conduit intersecting said joint and communicating with said chamber and including connecting passages formed in the shell, the tube plate, and the
20 head, and an escape passage bounded by said end of the shell and the tube plate and located within the portion of the joint between said conduit and the interior of the shell.

9. In a heat exchanger, the combination
25 of a shell, a removable tube bundle aggregate including a tube sheet having a diameter smaller than the shell to permit withdrawal through the shell and tubes having their ends extending through the tube sheet and rigidly
30 secured thereto, and means connecting the tube sheet and shell including an annular clamping ring formed of arcuate sections.

10. In a heat exchanger, the combination of a shell, a removable tube bundle aggregate
35 including a tube sheet having a diameter smaller than the shell to permit withdrawal through the shell and tubes having their ends extending through the tube sheet and rigidly secured thereto, and flexible means connect-
40 ing the tube sheet and shell to permit relative longitudinal movement therebetween and including an annular clamping ring formed of arcuate sections.

11. In a heat exchanger, the combination
45 of a shell, a removable tube bundle aggregate including a tube sheet having a diameter smaller than the shell to permit withdrawal through the shell and tubes having their ends extending through the tube sheet and rigidly
50 secured thereto, and means connecting the tube sheet and shell and including a flexible diaphragm and an annular clamping ring formed of arcuate sections.

12. In a heat exchanger, the combination
55 of a shell, a removable tube bundle aggregate comprising a pair of spaced tube sheets and tubes extending between the tube sheets and having their ends extending through and fix-
60 edly secured to the sheets, one of said tube sheets being rigidly and detachably secured to one end of the shell, a head rigidly and detachably secured to the shell at the end adjacent said one tube sheet, the other of said
65 tube sheets being disposed adjacent the other

end of the shell and being of smaller diameter than the shell so as to permit withdrawal therethrough, a flexible annulus fixed to the end of the shell adjacent said other tube sheet, a head structure secured to the flexible annulus and including an annular ring formed of arcuate sections for rigidly clamping said other tube sheet with respect to the head structure.

In testimony whereof, I have hereunto subscribed my name this 10th day of September, 1930.

JOHN A. POTTER.