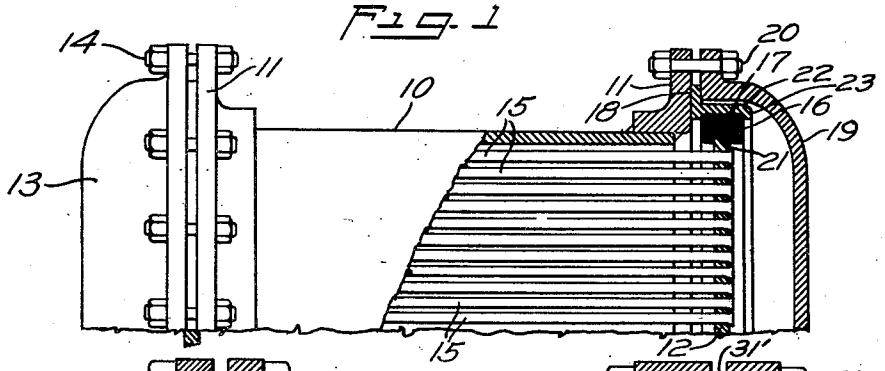
June 27, 1950 C. E. LUCKE 2,512,748

EXPANSION JOINT FOR HEAT EXCHANGERS

Filed Feb. 12, 1945

Fig. 1



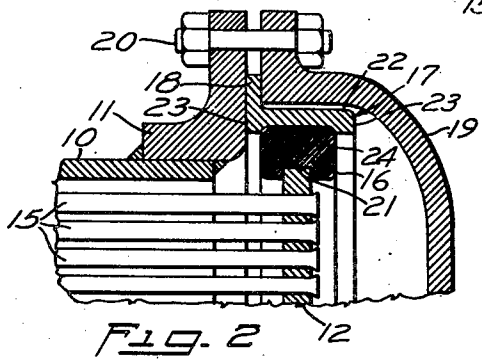


Fig. 2

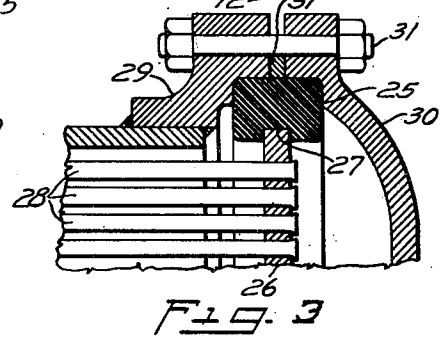


Fig. 3

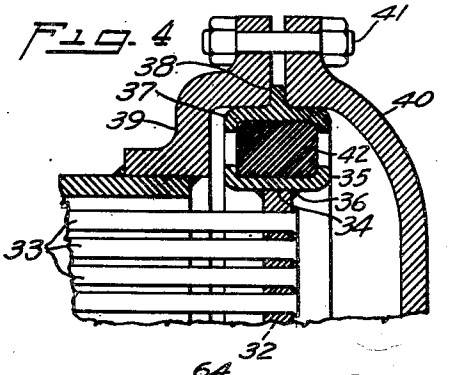


Fig. 4

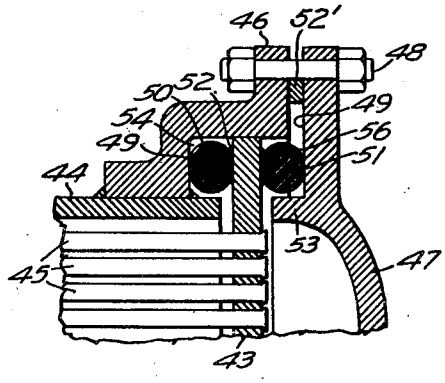


Fig. 5

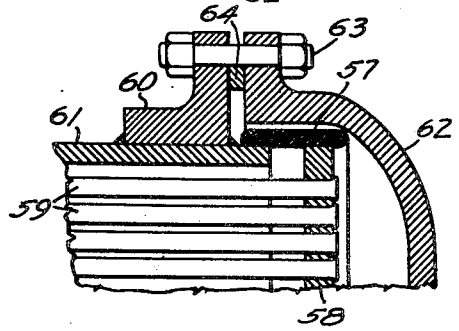


Fig. 6

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EXPANSION JOINT FOR HEAT EXCHANGERS

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Application February 12, 1945, Serial No. 577,413

4 Claims. (Cl. 257—236)

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The present invention relates to heat exchangers or surface condensers, and more particularly to the shell and tube type of construction in which there is a bundle or bank of straight tubes between two tube sheets in the shell, at least one tube sheet being fixed to the shell, such that the shell and the tube bundle do not expand equally and, therefore, require an expansion joint in the shell if both tube sheets are fixed to the shell, or between the free tube sheet and the shell if only one tube sheet is fastened to the shell in order to compensate for relative expansion of the tubes and the shell. Shell expansion joints heretofore devised are often ineffective, too stiff or too weak, and always expensive. For freedom of expansion of the tube bundle in the shell, such devices as floating heads, packed shells, stuffing boxes and the like have been in use, but all are expensive and not entirely satisfactory in service.

Accordingly, an object of the present invention is to provide a heat exchanger wherein a relatively inexpensive and highly efficient expansion joint is provided to accommodate relative expansion between the tubes and the containing shell and to maintain fluid-tight joints between the relatively movable parts. More specifically, the present invention embodies a rubber ring which is bonded to the edge of the free tube sheet, and either held tightly to the shell by squeezing, or bonded to a metal member so held, or bonded directly to the shell. The rubber and its fastening are such as will stress the rubber preferably in shear by relative movement of the sheet and the shell, or cause the rubber to flex, or stretch in tension, it being understood that rubber is substantially non-compressible. The expansion joint is also so designed that bonding of the rubber may be omitted in one embodiment thereof.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing an expansion joint for heat exchangers of a preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a fragmentary sectional view of a heat exchanger in accordance with the present invention.

Figure 2 is an enlarged sectional detail view of a portion of the expansion joint illustrated in Figure 1.

Figure 3 is a view similar to Figure 2 but illustrating an expansion joint embodying differences in details of construction.

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Figure 4 is a view similar to Figure 2 but illustrating other differences in mechanical detail.

Figure 5 is a view similar to Figure 2 but illustrating other changes in the details of construction.

Figure 6 is also a view similar to Figure 2 but illustrating further changes in mechanical detail.

Referring more particularly to the drawings, Figure 1 illustrates a portion of a heat exchanger which embodies a shell 10 having flanges 11 welded to its ends. While the condenser structure of Figure 1 illustrates one tube sheet 12 only, the construction will, of course, incorporate two tube sheets in the usual manner. The tube sheet shown is of the floating type, while the other tube sheet may be fixedly anchored to the shell structure. Such anchorage may be obtained by clamping the tube sheet between one of the flanges 11 and a bonnet or cover 13, bolts 14 being provided for clamping the tube sheet firmly in such a position.

Within the shell 10 is mounted a bundle or bank of conventional tubes 15, the ends of which tubes are expanded into both tube sheets, only one of which is herein illustrated, as at 12. An annular rubber body 16 is mounted between the tube sheet 12 and a metallic ring 17, the latter having a flange 18 interposed between the second flange 11 and a bonnet or cover 19, the latter being attached to the flange 11 by bolts 20.

The rubber body 16 includes a groove 21 in its inside wall face, which groove receives the peripheral margin of the tube sheet 12, and this margin is bonded to the body 16 in accordance with well known methods of bonding material such as rubber to metal. The ring 17 includes a flange 22 which is arranged concentrically of the tube sheet 12 and the body 16, which flange includes circumferentially extending ribs 23 which co-act with the flange 22 to provide a channel 24 within which is housed the outer edge margin of the body 16, which margin is bonded to the flange 22 and the ribs 23.

Figures 1 and 2 illustrate an expansion joint wherein the construction is such as to utilize the rubber in shear. Such a construction provides a highly efficient expansion joint for accommodating relative expansion of the tubes and the shell, a joint which remains fluid-tight to prevent contamination of one liquid by another.

Figure 3 illustrates different details of construction wherein the rubber body 25 is substantially identical with that shown in Figure 2, in that

the edge margin of the tube sheet 26 is lodged in the groove 27 in the body 25 and bonded thereto. The tubes 28 are expanded in the tube sheet 26, the difference in construction residing in the fact that the rubber body 25 is located between the shell flange 29 and the bonnet or cover 30. Thus the outer edge margin of the body 25 is clamped firmly in the position shown through tightening of the bolts 31. The construction of Figure 3 also utilizes the rubber in shear and eliminates the ring structure such as that shown at 17 in Figure 2, in addition to remaining fluid-tight in the same degree as the structure of Figures 1 and 2. To prevent excessive compression and distortion of the body 25 when the bolts 31 are tightened, a spacing ring 31' is placed between the flange 29 and the cover 30.

In Figure 4, the tube sheet 32 is also of the floating type and carries the tubes 33, the latter being expanded in the sheet. To the peripheral face 34 of the tube sheet 32 is secured an outwardly opening channel 35, as by welds 36. A similar channel 37 is fixedly secured to the heat exchanger shell structure, as by a flange 38 which is located between the condenser shell flange 39 and the hood or cover 40, flange 38 being made secure through tightening of the bolts 41. Between the channels 35 and 37 is arranged an annular rubber body 42, which body is bonded to both flanges or rings 35 and 37. Accordingly, the expansion joint of Figure 4 is identical with the forms of Figures 2 and 3 so far as utilization of the rubber in shear and the provision of a fluid-tight joint are concerned.

The construction of Figure 5 illustrates a tube sheet 43 which is of such diameter as to extend laterally beyond the heat exchanger shell 44. Tubes 45 are expanded in the tube sheet 43. To the shell 44 is welded a flange 46, and the bonnet or cover 47 is fixedly secured to the flange 46 by bolts 48. The flange 46 and the cover 47 are of such diameters as to provide parallel faces 49 which are of such diameters as to lie outside the shell 44, with the edge margins of the tube sheet 43 lying between the faces 49. Between the face 49 of the flange 46 and the tube sheet 43 is arranged a rubber ring 50 which may be circular in cross section. A similar rubber ring 51 is interposed between the tube sheet 43 and the face 49 on the cover 47. Both rubber rings 50 and 51 are bonded to the tube sheet 43, as indicated at 52, although this is not of critical importance, and the rubber rings may also be bonded to the shell and the cover to provide greater protection against leakage. When installed, the rubber rings 50 and 51 are placed under the necessary degree of initial compression, so that the cross sectional contours are flexed from round in the manner shown. A spacing ring 52' is placed between the flange 46 and the cover 47 to prevent excessive compression and distortion of the rubber rings when the bolts 48 are tightened. The shell 44 extends a short distance beyond the face 49 on the flange 46, while the cover 14 is provided with a flange 53 which is similarly arranged with respect to the face 49 on that cover. Accordingly, the rubber bodies or rings 50 and 51 are confined in metal pockets 54 and 56, respectively, which are of larger volumes than the contained rubber rings, since the pockets are of greater dimensions in radial directions.

In the construction of Figure 6, a rubber body or ring 57 of tubular contour is bonded to the peripheral face of the tube sheet 58, the latter having the tubes 59 expanded therein. The flange 60 is welded to the heat exchanger shell 61 a short distance inwardly from one end of the shell 61 to provide an annular flange to which the rubber ring 57 is bonded. In the drawing, the tube sheet 58 is of the same diameter as the outside diameter of the shell 61, and one end of the ring 57 is bonded to the shell 61 and the other end of the ring is bonded to the tube sheet 58, with the zones of bond so spaced as to provide an unbonded length between the end of the shell and the tube sheet.

In a construction such as that shown in Figure 6, the construction is such as to utilize the rubber ring 57 in tension or in flexure. In operation, any movement of the tube sheet away from the shell 61 places the rubber ring 57 in tension, while movement in the opposite direction will flex the ring, as in the buckling of a long column, but the expansion joint remains fluid-tight at all times. In the structure shown, the bonnet or cover 62 is bolted at 63 to the flange 60, and the cover 62 is of such inside diameter as to provide freedom for the ring 57 and the tube sheet 58. A spacing ring 64 between the flange 60 and the cover 62 prevents excessive distortion of the rubber 57 when the bolts 63 are tightened.

The term rubber as herein employed includes both natural rubber and equivalent materials of the synthetic class, the latter being preferable in many cases because of its resistance to higher temperatures than natural rubber and to deterioration by certain liquids, such as oils. Different operating conditions may require rubber of different properties, and the rubber used in the expansion joint is selected on that basis. The term "surface adhesion" as employed in the claims is intended to include all methods by which rubber may be bonded to metals. It particularly contemplates certain modern methods in which the rubber is, in effect, welded to the metal.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In an expansion means for a heat exchanger having an elongated shell and a movable transverse tube sheet within the shell, a circumferential member inside of the shell, means removably connecting the member to the shell, a second circumferential member fixed to the outer periphery of the tube sheet, and a circumferential rubber body connected in fluid tight relationship to each of the members to provied a flexible fluid tight joint within the shell, said rubber body having a cross sectional length which is at least as great as its cross sectional width whereby it will be stressed in shear through relative movement of said sheet and said shell with respect to each other.

2. In an expansion means for a heat exchanger having an elongated shell and a movable transverse tube sheet within the shell, a circumferential member inside of the shell lying in the plane of the sheet, said member having a concave surface facing the outer periphery of the sheet, means removably connecting the member to the shell, and a circumferential rubber body connected by surface adhesion to the concave surface and in fluid tight relationship to the outer periphery of the sheet, said rubber body having a length width ratio at least equal to 1 whereby it will be stressed in shear through relative move-

ment of said sheet and said shell with respect to each other.

3. In an expansion means for a heat exchanger having an elongated shell and a movable transverse tube sheet within the shell, a circumferential member inside of shell lying in the plane of the sheet, means removably connecting the member to the shell, a second circumferential member fixed to the outer periphery of the tube sheet, said members having opposing concave surfaces, and a circumferential rubber body connected by surface adhesion to the concave surfaces to provide a flexible fluid tight joint within the shell, said rubber body having a cross sectional length which is at least as great as its cross sectional width whereby it will be stressed in shear through relative movement of said sheet and said shell with respect to each other.

4. In an expansion means for a heat exchanger having an elongated shell and a movable transverse sheet within the shell, a closure member for engagement with said elongated shell, a first channel having a flange secured between said elongated shell and said closure member, a second channel connected to the outer periphery of said transverse sheet, means providing a yieldable fluid tight joint between the shell and sheet comprising a rubber member connected by surface adhesion to the second channel and to the first channel, in cross section said member having a ratio of length to width which is at least equal to 1 whereby it will be stressed in shear through relative movement of said sheet and said shell with respect to each other.

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