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J. A. POTTER

1,803,035

HEAT EXCHANGER

Filed June 30, 1930

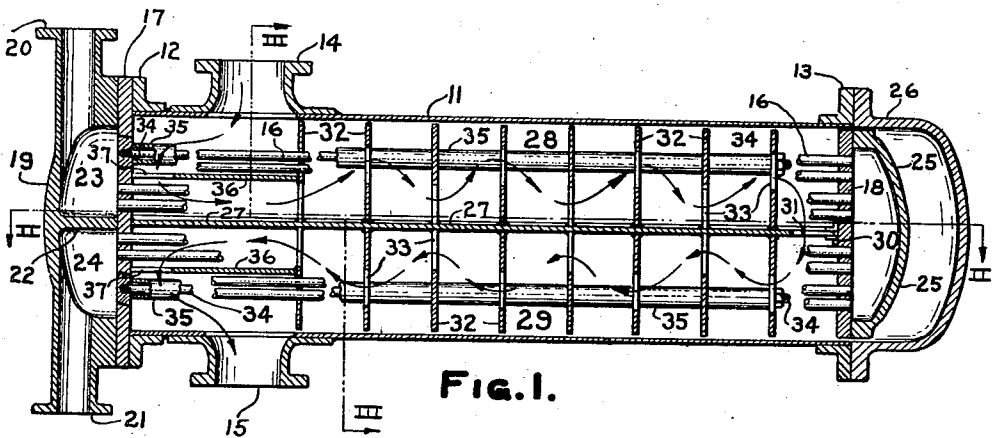


FIG. 1.

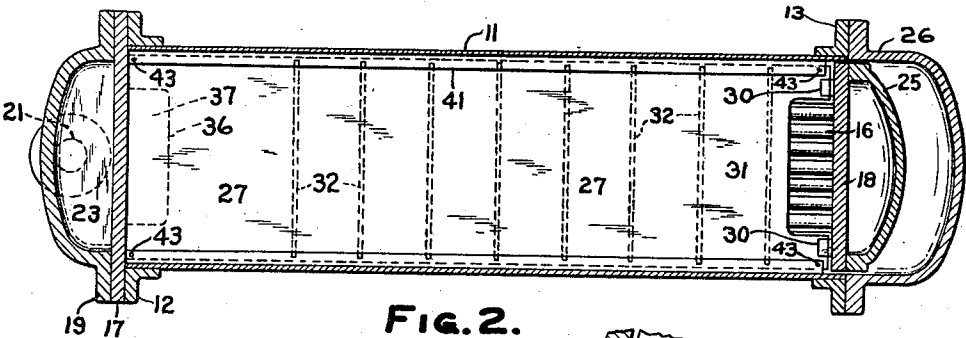


FIG. 2.

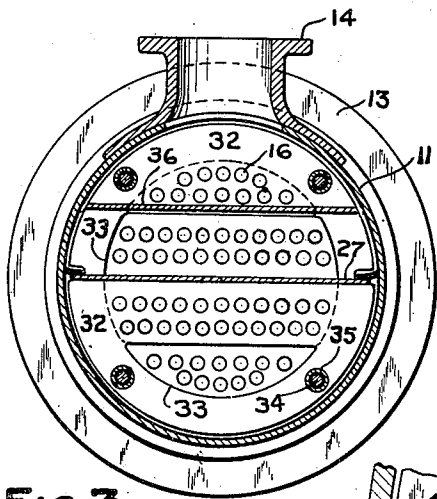


FIG. 3.

WITNESS
E. Lutz

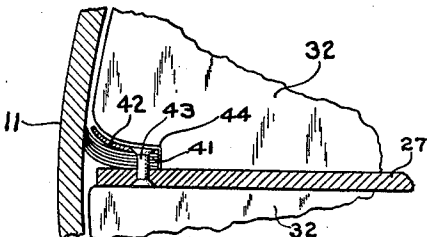


FIG. 4.

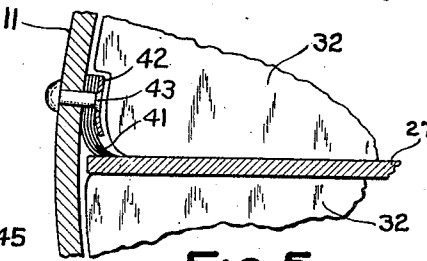


FIG. 5.

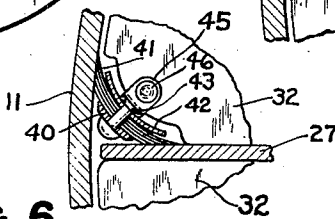


FIG. 6.

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HEAT EXCHANGER

Application filed June 30, 1930. Serial No. 464,922.

My invention relates to tubular heat exchangers of the multi-pass type having a baffle between the tubes of the passes and it has for an object to provide apparatus of this character having a removable tube bundle and a removable baffle with improved sealing means for the baffle.

My invention has for a further object to provide sealing means for the baffle which will effect a fluid-tight joint between the baffle and the shell of the heat exchanger but which, at the same time, will not interfere with the freedom of removal of the baffle and the tube bundle from the shell.

In my copending application, Serial No. 463,123, entitled Heat exchanger, and assigned to the Westinghouse Electric & Manufacturing Company, I disclose and claim a form of heat exchanger having a shell with a tube bundle and a baffle disposed interiorly of the shell and arranged to be readily removable therefrom. In the embodiment, there disclosed, I effect a substantially fluid-tight joint between the baffle and the shell with an improved form of sealing structure which does not interfere with the freedom of removal of the tube bundle and the baffle from the shell.

In the present application, I show a structure for effecting a seal between the baffle and the shell, which structure is arranged in accordance with the principles set forth in the aforesaid application, but which is of a more simplified form and less expensive to construct. As shown in the present application, the sealing structure embodies, in its preferred form, a strip at the lateral edges of the baffle and arranged to directly engage the interior surface of the shell. In another form, the strip may be secured to the interior of the shell so as to directly engage one side of the lateral marginal portions of the baffle. While the strip employed in this embodiment may be of one layer, or in other words a single element, I prefer to utilize a laminated strip composed of a plurality of relatively thin elements which are arranged to form a seal in the nature of a labyrinth. The element or elements are sufficiently flexible to permit them to be held in sealing en-

gagement in response to fluid pressure. In addition, in the present embodiment, I disclose an improved form of interior baffle structure for compelling the fluid to more completely traverse the full length of the shell.

More particularly, therefore, it is an object of my invention to provide in apparatus of the character designated a joint between the removable baffle and the interior surface of the shell, which joint shall include a strip or strips secured either to the baffle in sealing engagement at their free edges with the interior surface of the shell, or, secured to the interior of the shell in sealing engagement at their free edges with the baffle.

A further object of my invention is to form these strips with sufficient flexibility to permit the differential pressure existing on opposite sides of the baffle to press the free edges of the strips into continuous and substantially fluid-tight engagement with the shell or the baffle.

A still further object of my invention is to provide a substantially fluid-tight joint, in apparatus of the type designated, which includes adjacent substantially co-extensive abutment surfaces and a plurality of strips fixed along one of the abutment surfaces and responsive to fluid pressure to engage the adjacent abutment surface.

A still further object of my invention is to provide, in the type of joint designated, a flexible sealing strip secured along one of the abutment surfaces, presenting a plurality of narrow lines of contact with the adjacent abutment surface.

Still another object of my invention is to provide improved baffle means for causing the fluid to more completely traverse the full length of the shell.

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

Fig. 1 is a view, in sectional elevation, of one form of heat exchanger arranged in accordance with my invention;

Fig. 2 is a horizontal plan view taken

along the lines II—II of Fig. 1 and showing the arrangement of the sealing strips along the lateral margins of the longitudinal baffle;

5 Fig. 3 is a cross-sectional elevation taken along the line III—III of Fig. 1 and showing the arrangement of the sealing strips with respect to the shell;

Fig. 4 is a detail view of one edge of the baffle showing the sealing strip secured to the baffle and engaging the shell, also the lamination of the sealing strip;

Fig. 5 is a detail view of a modification of the arrangement shown in Figs. 1 to 4, showing the sealing strip fixed to the shell instead of the baffle; and,

Fig. 6 is a detail view of another modification of the arrangement shown in Figs. 1 to 4, showing the sealing strip supported at its center and free at both edges.

Referring now to the drawing, I show, in Fig. 1, a heat exchanger embodying a shell 11 having secured thereto flanges 12 and 13 and having located, near one end thereof, an inlet connection 14 and an oppositely-disposed outlet connection 15 for circulating a fluid medium through the shell. A tube bundle 16 is longitudinally disposed within the shell and is supported, at one 30 of its ends, in a stationary tube plate 17 secured to the flange 12, and is supported at the other of its ends in a floating tube plate 18. A cover member 19, having an inlet connection 20, an oppositely-disposed 35 outlet connection 21 and a partition 22, cooperates with the tube plate 17 to provide an upper inlet box or chamber 23 for directing a fluid into the upper portion of the tube bundle and a lower box or chamber 40 24 for receiving the fluid from the lower portion of the tube bundle. The cover 19 is removably secured to the tube plate 17 to provide access to the tubes.

A bonnet member 25 cooperates with the 45 floating tube plate 18 to direct the fluid from the upper portion of the tube bundle back through the lower portion. The bonnet member 25 is secured at its periphery with a fluid-tight joint to tube plate 18.

50 A removable hood member 26 is secured to the flange 13 and encloses the bonnet member 25 and the floating tube plate 18. The tube plate 18 and the bonnet member 25 are so arranged that they fit loosely at their peripheral portions in the interior of the shell and hood member which permits them to "float" back and forth to allow for relative expansion and contraction of the tube bundle with respect to the shell.

80 A longitudinal baffle plate 27 is disposed interiorly of the tube bundle 16 between the inlet 14 and the outlet 15 and arranged to extend longitudinally of the shell for dividing the interior thereof into two passes or compartments, an upper pass 28 and a

lower pass 29. The longitudinal baffle 27 is secured at one end to the tube plate 17 by any suitable means, such as welding, and is permitted to "float" at the other end between bracket 30 secured to the tube plate 18. An opening 31 in the floating end of the baffle 27 provides fluid communication between the upper pass 28 and the lower pass 29.

Transverse baffles 32 are located in each of the passes 28 and 29, and may be arranged on opposite sides of the longitudinal baffle 27 in pairs in diametrically-opposed position. They are secured at their inner edges to the longitudinal baffle 27 by any suitable means, such as welding. At their outer edges they are held in the desired position by longitudinal stay-bolts 34 and spacers 35. The stay-bolts are secured in the tube plate 17 and extend longitudinally through the transverse baffles. The spacers 35 surround the stay-bolts with their ends in engagement with the sides of the adjacent transverse baffles. The transverse baffles are provided with openings 33, the openings in alternate baffles being staggered with respect to the openings in the remaining baffles so as to produce a zig-zag flow of the fluid as shown by the arrows. The tubes of the tube bundle 16, which are shown in broken outline in Fig. 1, pass through holes provided therefor in the transverse baffles and may be grouped somewhat as shown in Fig. 3.

Supplementary longitudinal baffles 36 are provided in each of the passes, in the first pass 28 facing the inlet 14 and in the second pass 29 facing the outlet 15. Each of these extend between the tube plate 17 and the first transverse baffle 32. However, openings 37 are provided in the ends of the supplementary baffles which abut against the tube plate 17 whereby the fluid is compelled to traverse the full length of the tube bundle in each of the passes.

The path of flow of one fluid through the tubes of the tube bundle and the path of flow of another fluid through the interior of the shell will now be apparent from the foregoing description. In addition, it will be observed that the tube bundle and the entire baffle structure are tied together as a single assembly and are removably secured as a unit in the shell by means of the tube plate 17. The tube plate 18, the bonnet member 25 carried thereby, the transverse baffles 32, and etc., are all of such size as to permit the tube bundle to be readily withdrawn longitudinally as a single assembly from the shell structure.

As heretofore set forth, I provide means to effect a seal between the longitudinal baffle 27 and the interior of the shell structure when the baffle is in assembled position. In accordance therewith, I provide along each lateral margin of the baffle a sealing

strip 41 and a retaining strip 42 both secured, preferably, on the side of the baffle subjected to higher fluid pressure, that is, the inlet side of the baffle. The sealing strip 41 and the retaining strip 42 may be secured at their ends to the baffle by means of rivets 43. Intermediate of their ends, they are held in position on the margin of the baffle by the edges of suitable slots or recesses 44 provided at the junction of the periphery of the transverse baffles 32 and the longitudinal baffle 27. By retaining the strips in position upon the baffle in this manner, they may be readily removed therefrom merely by cutting the rivets 43 holding them at each end. The retaining strip 42 besides holding the fixed edge of the sealing strips firmly against the baffle provides, also, a protecting guard over the laminations of the sealing strip so as to minimize the damage in handling.

The laminations of the sealing strips 41 are made of yieldable or flexible material which is of such relatively small thickness that, when in position to contact with the interior of the shell structure at a suitable angle, any very small pressure difference existing between the fluid flowing in the first and second passes of the shell, as caused by the resistance of the tube bundle and baffle elements, compels the free edges of the sealing strips 41 to be pressed into engagement with the adjacent portions of the shell. One of the outstanding advantages of such an arrangement, resides in the fact that the laminations may have such flexibility that they readily conform with any surface irregularities obtaining in the engaged surface of the shell resulting from commercial manufacture.

I prefer to make the sealing strip 41 of a plurality of laminations so that the edges of the individual laminations form a plurality of lines contacts with the interior surface of the shell. Each lamination is so arranged that it is free to assume its own sealing position without interference from the other laminations. In this manner, somewhat of the labyrinth type of seal is formed, that is, a plurality of lines of sealing engagement arranged in series. It is to be understood that, while I use a strip of a plurality of laminations, or, in other words, a plurality of thin strips arranged in sealing engagement, I may use a sealing strip comprising only one lamination. I may also use a sealing strip having the fixed edge thereof formed as a solid strip while the free edge, or the edge in contact with the interior of the shell is formed of a plurality of relatively thin web portions such as would be obtained by cutting longitudinal recesses in the free edge of the strip, thus having essentially a plurality of single strips forming a

plurality of lines of sealing engagement with the interior of the shell.

The sealing strip 41 may be biased toward a horizontal position so that, when raised to an inclined position at the time of insertion of the baffle 27 into the shell 11, the laminations engage the shell with a spring tension. However, the pressure exerted upon the laminations by the higher fluid pressure existing on that side of the baffle is mainly relied upon for pressing the free edges of the laminations into continuous engagement with the adjacent portion of the interior surface of the shell.

In Fig. 5, I show another form of seal embodying my invention in which the laminated sealing strips 41, instead of being attached to the removable baffle 27, are attached to the interior of the shell. The sealing strips are secured to the shell in a position above the longitudinal baffle 27, or on the side thereof exposed to the higher pressure. The upper edge of the sealing strips are made fast to the shell while the lower edge is free to be flexed or pressed into engagement with the longitudinal baffle 27 in response to the higher fluid pressure existing above the baffle. The strip 42 is secured over the sealing strips 41 to retain the fixed edge in position and to provide a protecting guard over portions of the sealing strips.

Referring now to Fig. 6, I show a detail view of still another form of seal embodying my invention in which the laminated sealing strip 41 is secured substantially midway between its edges to the transverse baffles 32, and is free at both of its edges to engage, at one edge, the interior surface of the shell 11 and, at the other edge, the upper side of the baffle 27 in response to the fluid pressure difference on opposite sides of the baffle. In this embodiment the sealing strip 41, the retaining strips 40 and 42 are secured to a bracket 45 by means of rivets 43. The retaining strips 40 and 42 are placed on opposite sides of the sealing strip 41 and are spaced away from the edge thereof sufficiently to allow the latter to maintain the desired flexibility. The bracket 45 which is above the sealing strip is in turn secured to the transverse baffle 32 by means of a rivet 46. I may place the bracket 45 below the sealing strip and secure it to the shell 11 or modify it in any other suitable manner that will permit it to be secured to the shell 11 instead of the transverse baffle 32. The bracket 45 may be fitted loosely about the rivet 46 for allowing the sealing strip to have a limited transverse and side-to-side movement for the purpose of permitting the flexible edges thereof to find their engaging position freely in response to fluid pressure.

In all embodiments, I prefer, according to my invention, to make the relatively thin

laminations of the sealing strips of a corrosive-resistant material such as, for example, "stainless steel", brass, or bronze. The use of strips of this type avoids frequent replacement and minimizes cleaning.

By using the type of sealing means herein described, I am able to utilize an element to provide the seal having the desired characteristics of resistance to corrosion, of forming the plurality of lines of seal, of the required strength and of sufficient flexibility to permit it to bend under fluid pressure.

While in the embodiments of my invention illustrated and described, I have used sealing strips on the side of the baffle exposed to the higher pressure, it is to be understood that my invention is not confined to using the sealing strips on this side only.

Also, while I have shown my invention in three forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other 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 heat exchange apparatus, the combination of a shell, a removable tube bundle disposed in the shell, a removable baffle disposed in the shell and dividing the latter into first and second compartments, fluid inlet and outlet means provided in the shell and arranged to circulate the fluid through the compartments in series, and a flexible strip fitted directly between the inner wall of the shell and the baffle and responsive to fluid pressure for effecting a substantially fluid-tight joint between the baffle and the shell.

2. In heat exchange apparatus, the combination of a shell, a removable tube bundle disposed in the shell, a removable baffle disposed in the shell and dividing the latter into first and second compartments, fluid inlet and outlet means provided in the shell and arranged to circulate the fluid through the compartments in series, and a strip formed on a marginal portion of the baffle and having a flexible edge portion directly engaging the interior surface of the shell, said flexible edge portion being retained in substantially fluid-tight engagement with the interior surface of the shell by the fluid pressure difference existing on opposite sides of the baffle.

3. In heat exchange apparatus, the combination of a shell, a removable tube bundle disposed in the shell, a removable baffle disposed in the shell and dividing the latter into first and second compartments, fluid inlet and outlet means provided in the shell

and arranged to circulate the fluid through the compartments in series, and a strip formed directly on the interior surface of the shell and having a flexible edge portion engaging the baffle, said flexible edge portion being retained in substantially fluid-tight engagement with the baffle by the fluid pressure difference existing on opposite sides of the baffle.

4. In heat exchange apparatus, the combination of a shell structure, a removable tube bundle structure disposed within the shell structure, a removable baffle incorporated in the tube bundle structure and dividing the interior of the shell structure into first and second compartments, fluid inlet and outlet means provided in the shell structure and arranged to circulate fluid through the compartments in series, a strip having oppositely-disposed flexible marginal portions, one of the marginal portions engaging the baffle and the other of the marginal portions engaging the interior surface of the shell, and means to secure the strip intermediate the marginal portions thereof to the tube bundle structure, said flexible marginal portions being retained in substantially fluid-tight engagement with both the baffle and the interior surface of the shell by the fluid pressure difference existing on opposite sides of the baffle.

5. The combination with a heat exchanger including a shell element and a baffle element dividing the interior space of the shell element into first and second passes, of laminated flexible elements responsive to the pressure difference existing between the first and second passes for forming a plurality of lines of seal between the lateral marginal portions of the baffle element and the shell element.

6. A heat exchange apparatus as claimed in claim 5 in which the laminated flexible elements are composed of a corrosive-resistant material.

7. The combination with a heat exchanger including a shell element and a removable baffle element dividing the interior space of the shell element into first and second passes, of flexible metallic strip means carried by one of said elements and cooperating with the other element to effect a plurality of narrow lines of seal in response to pressure difference existing between the first and second passes.

8. A heat exchange apparatus as claimed in claim 7 in which the laminated flexible strip is composed of a corrosive-resistant metal.

9. In a heat exchanger, in combination, a shell, a tube bundle and baffle removably supported in the shell, the inner wall surface of the shell and the lateral marginal portions of the baffle providing co-extending abutment surfaces, and sealing means coop-

erating with the abutment surfaces for forming a substantially fluid-tight joint between the baffle and the shell, said sealing means including a flexed strip secured along one of said abutment surfaces and retained in engagement with the other of said abutment surfaces partly in response to spring tension existing in the strip and partly in response to the differential fluid pressure existing on opposite sides of the baffle.

10. In a heat exchanger, in combination, a shell, a tube bundle and baffle removably supported in the shell, the inner wall surface of the shell and the lateral marginal portions of the baffle providing co-extending abutment surfaces, and sealing means cooperating with the abutment surfaces to form a substantially fluid-tight joint between the baffle and the shell, said sealing means including flexible laminated strips secured along one of said abutment surfaces and retained in substantially fluid-tight engagement with the other of said abutment surfaces in response to the differential fluid pressure exhausting on opposite sides of the baffle.

11. In heat exchange apparatus, the combination of a shell, a removable tube bundle disposed within the shell, and embodying a removable baffle member, said baffle member having a portion thereof arranged to form a joint with a portion of the interior surface of the shell, said joint including a plurality of strips of flexible sheet material each secured to one of the portions and each responsive to fluid pressure in one direction for engaging the other portion, and said joint also including a strip of relatively rigid sheet material secured to one of the portions in a position to embrace the flexible strips.

12. In heat exchange apparatus, the combination of a shell, a tube bundle, means for supporting the tube bundle within the shell and providing for removal thereof from the shell, longitudinally-extending and transversely-extending baffles incorporated in the tube bundle and removable therewith from the shell, a plurality of flexible strips secured to the lateral edges of one side of the longitudinal baffle, means responsive to fluid pressure in the shell for retaining the flexible strips in engagement with the interior surface of the shell to effect a substantially fluid-tight joint between the longitudinal baffle and the shell, and means including slots formed in the transverse baffles for securing the flexible strips in position on the longitudinal baffle.

13. In heat exchange apparatus, the combination of a shell, a removable tube bundle disposed within the shell and embodying a removable baffle member, said baffle member arranged to divide the interior of the shell into first and second passes, fluid inlet and

outlet means provided in the shell and arranged for circulating a fluid through the passes in series, whereby the average fluid pressure obtaining in the first pass is relatively higher than the average fluid pressure obtaining in the second pass, and means for effecting a substantially fluid-tight joint between the marginal portions of the baffle and the adjacent portion of the interior surface of the shell, said joint including a plurality of flexible members secured at one of their edges along the marginal portions of the side of the baffle exposed to the higher fluid pressure and having their other edges held in sealing engagement with the interior surface of the shell by the fluid pressure difference obtaining between the passes.

14. In heat exchange apparatus, the combination of a shell, a tube bundle structure, means for supporting the tube bundle structure within the shell and providing for removal thereof from the shell, a longitudinally-extending baffle and a plurality of transversely-extending baffles incorporated in the tube bundle structure, and a flexible strip for effecting a substantially fluid-tight joint between the longitudinal baffle and the shell, said transverse baffles cooperating with the longitudinal baffle to retain an edge of the flexible strip in fixed position upon the latter.

15. In heat exchange apparatus, the combination of a shell, a tube bundle, means for supporting the tube bundle in the shell and providing for removal thereof from the shell, a baffle extending longitudinally within the shell and removable therefrom with the tube bundle, said baffle being arranged to divide the shell into first and second passes, means for effecting a substantially fluid-tight seal between the baffle and the interior of the shell, said joint including a plurality of flexible strips extending longitudinally of the shell in the first pass, and means for securing said strips at one of their edges to the interior surface of the shell and providing for engagement of the other edges of the strips with the baffle in response to the fluid pressure difference existing between the passes.

In testimony whereof, I have hereunto subscribed my name this 26th day of June, 1930.

JOHN A. POTTER.