April 28, 1931. J. A. POTTER 1,803,034

HEAT EXCHANGER

Filed June 23, 1930

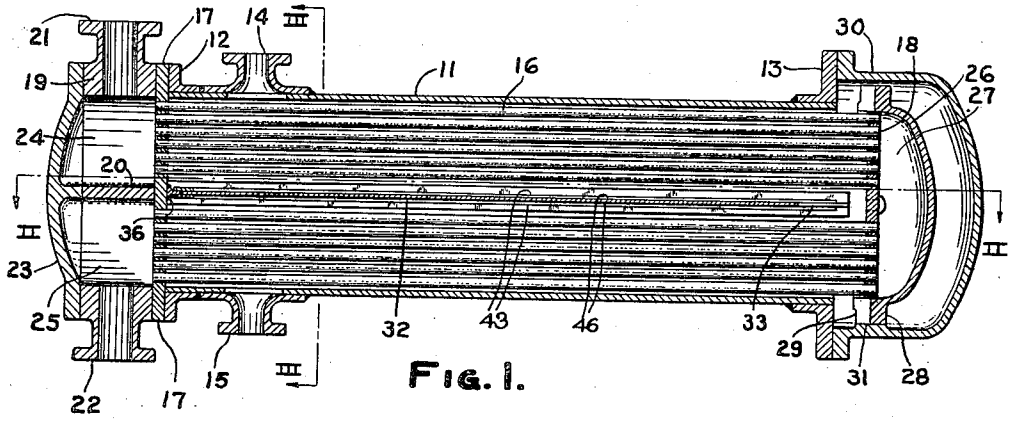


FIG. 1.

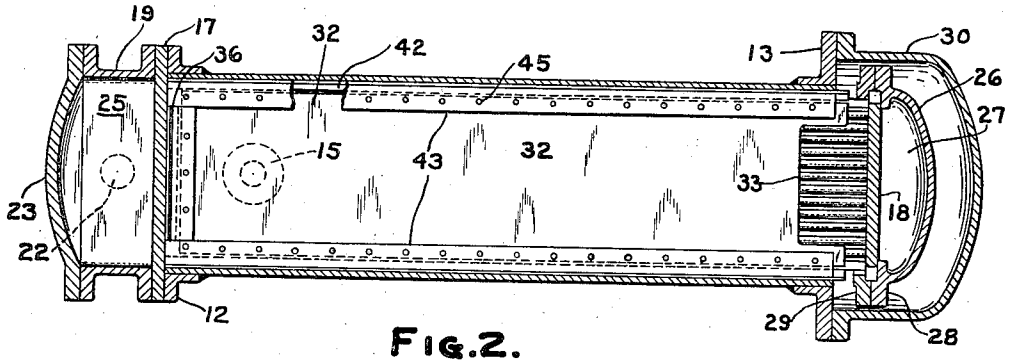


FIG. 2.

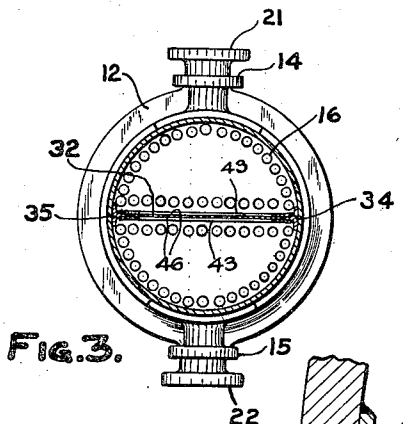


FIG. 3.

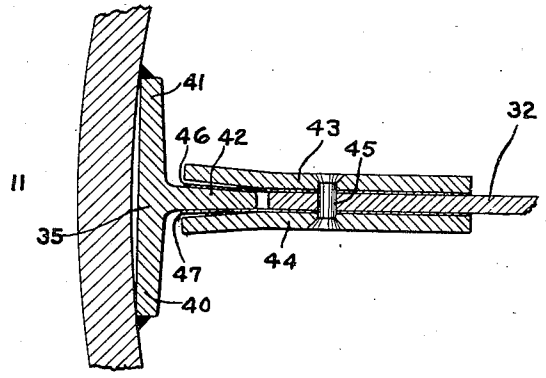


FIG. 4.

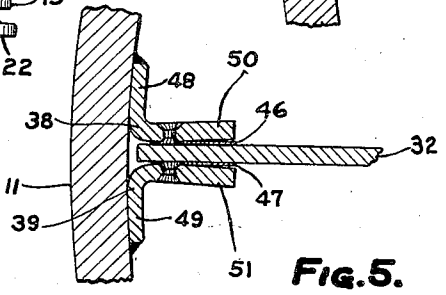


FIG. 5.

WITNESS
E. Lutz.

INVENTOR
John A. Potter

BY
A. B. Rivers
ATTORNEY

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UNITED STATES PATENT OFFICE

JOHN A. POTTER, OF MOORES, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

HEAT EXCHANGER

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

Tubular heat exchangers of the two-pass type are commonly used for transferring heat from one medium to another, for example, in heating oil in oil refinery apparatus. It is desirable that the tube bundle and the baffle shall be capable of ready removal for cleaning or other purposes and that, when assembled, the baffle shall be effectively sealed to prevent leakage thereby. My invention has for its object to provide sealing guide means for such a baffle which permits of ready removal and replacement of the baffle, which supports the baffle, which effectively seals the baffle where required, and which is simple in design and economical to manufacture.

One method, heretofore proposed, of providing for ready removal of the longitudinal baffle along with the tube bundle is to loosely fit the lateral edges of the baffle into grooves or slots provided on the interior of the shell. In this arrangement, the difference in pressure on opposite sides of the baffle caused by the resistance to the flow of the fluid through the shell is relied upon to press the edges of the baffle against one of the faces of the grooves with sufficient force to maintain a substantially fluid-tight joint. This arrangement makes adequate provision for ready removal of the baffle, but I have found that the slight irregularities in the marginal portions thereof resulting from commercial manufacture prevent continuous engagement of the baffle with the face of the groove. As a consequence, considerable leakage occurs between the baffle and the shell.

Another method has been proposed in which the walls forming the groove are made flexible so as to grip the marginal portions of the baffle by spring tension with sufficient force to maintain a substantially fluid-tight joint. I have found that, with this arrangement, great difficulty is experienced in the withdrawal of the baffle, particularly after corrosion has set in.

I have, therefore, conceived the idea, of providing strips which form a loosely fitting groove about the marginal portions of the baffle but which are sufficiently flexible that the difference in fluid pressure obtaining between the opposite sides of the baffle is capable of retaining the flexible strips in engagement with either the baffle or the interior of the shell structure with sufficient force to maintain a substantially fluid-tight joint. One of the principal advantages of such an arrangement resides in the fact that the tube bundle can be readily and easily withdrawn from the shell upon interruption of the circulation of the fluid therethrough. Another and even greater advantage resides in the fact that the strips have sufficient flexibility that the fluid pressure exerted on the strips can maintain a joint which is substantially fluid-tight throughout its length even though there be irregularities in the alignment of the baffle with respect to the shell structure.

More specifically, therefore, it is an object of my invention to provide, in apparatus of the character designated, auxiliary strips carried either by the baffle or by the shell for forming a seal, which strips are sufficiently thin to permit the differential fluid pressure existing on opposite sides of the baffle to press the strips into continuous engagement with the abutment surface even though irregularities may exist therein.

A further object of my invention is to provide a seal for a baffle including abutment surfaces and strips or walls cooperating with the surfaces which are capable of being deflected or flexed in order to improve sealing.

A still further object of my invention is to provide a baffle guide having flexible groove elements with rigid reinforcing elements to withstand the load imposed on the baffle.

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 drawings, 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 sealing strips;

Fig. 3 is a cross-sectional elevation taken along lines III—III of Fig. 1 showing the position of the sealing strips on the longitudinal baffle;

Fig. 4 is a detail view of one edge of the baffle showing the arrangement of sealing strips and auxiliary supporting strips; and,

Fig. 5 is a detail view of a modification of the arrangement shown in Figs. 1 to 4, showing the sealing and supporting strips attached to the shell structure.

Referring now to the drawing, I show, in Fig. 1, a heat exchanger embodying a shell 11 having 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 supported, at one end, in a stationary tube plate 17 secured to the flange 12 and, at the other end, in a floating tube plate 18.

An annular member 19 provided with a partition 20, a fluid medium inlet 21, a fluid medium outlet 22, and a cover 23 cooperates with tube plate 17 to provide an inlet box or chamber 24 directing fluid into the upper portion of the tube bundle and a lower box or chamber 25 receiving fluid from the lower portion of the bundle. The cover 23 is removably secured to the member 19 to provide access to the tubes through the boxes or chambers 24 and 25.

A bonnet member 26 cooperates with the floating tube plate 18 to form a chamber 27 to direct the fluid from the upper portion of the tube bundle back through the lower portion. The floating tube sheet 18 is gripped peripherally between the flange 28 of the bonnet member 26 and the flange or ring 29.

A removable hood member 30 is secured to the flange 13 and encloses the bonnet 26 and the floating tube plate 18. A bearing pad 31 is provided in the lower portion of the hood 30 which permits the tube plate 18, and the members carried thereby, to float back and forth to allow for relative expansion and contraction of the tube bundle 16 with respect to the shell.

The tube bundle 16 is removable from the shell in a manner which is old and well known in the art. The cover 23 and the annular member 19 may be removed first and the tube plate 17 detached from the flange 12. Thereafter, the hood member 30 can be detached from the flange 13 after which the bonnet member 26 may be detached from the ring 29. The latter is split diametrically so that both the ring 29 and the bonnet member 26 may be freed from the tube plate 18 after which the tube bundle may be drawn (in the embodiment illustrated) to the left so as to remove it from the shell 11, the tube plate 18 being of such a diameter as to pass freely through the bore of the shell 11.

A baffle plate 32 is disposed in a horizontal position within the tube bundle and arranged to extend longitudinally of the shell to compel fluid medium entering inlet 14 to flow longitudinally of the tube bundle over the upper portion thereof and return through opening 33 around the end of the baffle 32 over the lower portion before passing out through outlet 15.

Ordinarily, in this type of apparatus, as heretofore set forth, it is customary to provide for removing the tube bundle 16 and the baffle plate 32 longitudinally from the shell as a unit. I provide for this by arranging longitudinally-extending, baffle-supporting rails or tongues 34 and 35 interiorly of the shell 11 at opposite sides thereof and a transversely-extending rail 36 secured to the tube plate 17. Each of these rails comprises flange portions 40 and 41, as shown in Fig. 4, welded or otherwise secured to the shell, and a web portion 42 projecting inwardly of the shell, with the faces thereof providing oppositely disposed abutment surfaces.

Rigid supporting strips 43 and 44 are secured by rivets 45 on opposite sides of the baffle plate 32 at the marginal portions thereof and project beyond the edges to provide grooves for the reception of the web or tongue of the rail member 41. The strips or groove walls 43 and 44 are made relatively rigid so as to carry the weight of the baffle and transmit to the rail 41 any force exerted on the baffle, as for example, by the fluid circulating through the shell 11.

Sealing strips are preferably disposed at both sides of the marginal portions of the baffle 32 to engage opposed abutment surfaces of the web 42 for permitting the differential pressure to effect a seal in either direction should the direction of fluid flow through the shell be reversed.

Therefore, I provide sealing strips 46 and 47 secured on opposite sides of the baffle 32 underneath the supporting strips 43 and 44. The sealing strips are made of yieldable or flexible material which is of such relatively small thickness that, when the tongue or web member 42 is inserted therebetween, any very small pressure difference on opposite sides of the baffle, resulting from the resistance of the tube bundle and the baffle element to the flow of the fluid through the

shell structure, causes the sealing strip on the side of greater pressure to be pressed against the adjacent abutment surface provided on the rail. At the same time, the sealing strip in engagement with the rail is sufficiently flexible that it readily conforms to any irregularities along the line of engagement.

The sealing strips 46 and 47 may be biased toward each other so that they will grip the opposite faces of the web or tongue portion 42 of the rail by a slight spring tension. However, the pressure exerted upon the strip by the fluid is mainly relied upon for bringing the latter into continuous engagement with the rail.

It will be noted that the supporting strips 43 and 44 extend substantially across the full width of the sealing strips 46 and 47 but are flared outwardly from the sealing strips to permit the latter to be exposed to the fluid pressure in the shell. By arranging the supporting strips 43 and 44 to extend out sufficiently to fully embrace the sealing strips 46 and 47, in addition to supporting the weight of the baffle and preventing undue strain, they constitute a guard over the projecting edges of the relatively thin sealing strips and provide protection during handling. As stated heretofore, the baffle 32 is removable with the tube bundle inasmuch as, shortly after commencement of withdrawal of the tube bundle, the tube plate 18 abuts against the adjacent edge of the baffle 32, causing the latter to be drawn outwardly with the tube bundle.

In Fig. 5, I show another form of seal embodying my invention in which the sealing strips 46 and 47, instead of being attached to the removable baffle plate 32, are attached to the stationary shell structure. In this embodiment, rail members 38 and 39 embodying flange portions 48 and 49 and web or groove forming portions 50 and 51 projecting inwardly are secured to the interior of the shell. The sealing strips 46 and 47 are secured to the web portions 50 and 51 of the rail members near the bottom of the groove formed therebetween. The web portions 50 and 51 of the rail members 38 and 39 are spaced apart sufficiently to permit the baffle 32 to be inserted with a loose sliding fit. The sealing strips are arranged to engage opposite sides of the marginal portions of the baffle 32 when it is inserted in position. The inwardly-projecting web or tongue portions 50 and 51 of the rail members 38 and 39 perform the function of supporting the baffle 32 and provide a protecting guard for the sealing strips 46 and 47.

In all embodiments, I prefer, according to my invention, to make the relatively thin 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 one type of element to provide the seal having the desirable characteristics of resistance to corrosion and of sufficient flexibility, to permit it to flex under fluid pressure, and which can be economically made in the form of relatively thin strips, and I am able to utilize another type of element to perform the function of supporting the longitudinal baffle in relation to the shell structure, made of a cheaper material than is required for the sealing strips.

While, in the embodiments of my invention illustrated and described, I have used sealing strips on both sides of the baffle, it is to be understood that the scope of my invention also includes the use of sealing strips on only one side of the baffle. Also, while I have shown my invention in but two 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. 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 flexible means responsive to the pressure difference existing between the first and second passes for sealing the baffle element with respect to the shell element except where the first pass communicates with the second pass.

2. 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 sealing in response to pressure difference existing between the first and second passes except where the first pass communicates with the second pass.

3. A heat exchanger as claimed in claim 2 in which the flexible metallic strip means is composed of a corrosive-resistant material.

4. In a heat exchanger, in combination, a shell element, a removable tube bundle and baffle element in the shell element, a support for the baffle element including means providing abutment surfaces on one of said elements adjacent to lateral margins of the baffle element and flexible strips carried by the other of said elements and retained in

substantially fluid-tight engagement with said abutment surfaces by fluid pressure.

5. In a heat exchanger, in combination, a shell element, a removable tube bundle and baffle element in the shell element, means for constraining the baffle element to occupy a predetermined position with respect to the shell element when assembled, and sealing means for the baffle element embodying flexible strips which are flexed when the baffle element is in assembled position.

6. In a heat exchanger, in combination, a shell element, a removable tube bundle and baffle element in the shell element, a support for the baffle element including means providing abutment surfaces on one of said elements adjacent to lateral margins of the baffle element and flexible strips carried by the other of said elements and which are flexed when fitting flush against the abutment surfaces.

7. The combination with a heat exchanger having a shell element and a removable tube bundle and baffle element, of supporting and sealing means for the baffle element including tongue-and-groove means carried by said elements and the groove means having substantially flat flexible walls engaging lateral faces of the tongue.

8. The combination with a heat exchanger having a shell element and a removable tube bundle and baffle element, of supporting and sealing means for the baffle element including tongue-and-groove means carried by said elements and the groove means having flexible walls engaging lateral faces of the tongue, said groove means including opposed flexible wall members engaging the lateral faces of the tongue and non-flexible wall members provided outwardly of and adjacent to the flexible wall members and forming a protecting guard over said flexible wall members.

9. The combination with a heat exchanger having a shell element and a removable tube bundle and baffle element, of supporting and sealing means for the baffle including tapered tongues carried by one of the elements and grooves provided on the other element, said grooves having flexible walls responsive to fluid pressure for holding them in engagement with the tongues.

10. In heat exchange apparatus, the combination of a shell structure, a removable tube bundle disposed within the shell structure and embodying a removable baffle member, said baffle member having a portion thereof arranged to form a joint with a portion of the shell structure, said joint including a strip of flexible sheet material secured to one of the portions and responsive to fluid pressure for engaging the other portion.

11. In heat exchange apparatus, the combination of a shell structure, a removable tube bundle disposed within the shell structure and embodying a removable baffle member, and means for effecting a substantially fluid-tight joint between the baffle member and the shell structure including a flat strip of flexible material projecting outwardly from the baffle member and held in engagement with the shell structure by spring tension and fluid pressure.

12. In a heat exchange apparatus, the combination of a shell structure, a tube bundle, means for supporting the tube bundle within the shell structure and providing for removal thereof from the shell structure, a removable baffle extending longitudinally in the shell structure, said baffle having flexible marginal portions retained in engagement with interior portions of the shell structure, at least in part, by spring tension for effecting a substantially fluid-tight joint.

13. A baffle for forming a partition between fluid-containing compartments of a heat exchanger, said baffle embodying flexible marginal portions and a substantially non-flexible intermediate portion.

14. In heat exchange apparatus, the combination of a shell structure, a tube bundle, means for supporting the tube bundle within the shell structure and providing for removal thereof from the shell structure, a removable baffle extending longitudinally through the shell structure, a flexible strip attached to the baffle, means responsive to fluid pressure in the shell structure for retaining the flexible strip in engagement with the shell structure so as effect a substantially fluid-tight joint between the baffle and the shell structure, and means for securing said strip to the baffle and for supporting the baffle within the shell structure.

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

16. 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 with the tube bundle, a rail member having oppositely-disposed longitudinal abutment surfaces provided thereon extending longitudinally of the shell, pairs of flexible members secured to the marginal portions of the baffle and embracing the opposite abutment sur-

faces provided on the rail member, and means for fixedly securing one of the edge portions of the flexible members to the baffle and for limiting the movement of the other edge portions of the flexible members.

17. In heat exchange apparatus, the combination of a shell structure, a tube bundle, means for supporting the tube bundle in the shell structure and providing for removal thereof from the shell structure, a baffle extending longitudinally within the shell structure and removable therefrom with the tube bundle, said baffle dividing the shell structure into first and second compartments, fluid inlet and outlet means provided in the shell structure and arranged to convey fluid through the first compartment and thence through the second compartment, whereby the average fluid pressure obtaining in the first compartment is relatively higher than the average fluid pressure obtaining in the second compartment, and means for effecting a substantially fluid-tight joint between edge portions of the baffle and adjacent portions of the shell structure and including flexible members secured to one of the portions and effecting sealing engagement with the other portion in response to the pressure difference obtaining between the compartments.

18. In heat exchange apparatus, the combination of a shell structure having inlet and outlet openings for circulating a fluid through the interior of the shell structure, a tube bundle, means for supporting the tube bundle within the shell structure and providing for the removal thereof from the shell structure, said tube bundle having associated therewith inlet and outlet connections for circulating a second fluid through the tubes thereof, rails secured on opposite sides of the interior portion of the shell structure and extending longitudinally thereof, said rails having oppositely-disposed, longitudinal abutment surfaces, and a baffle plate removable with the tube bundle and dividing the shell structure into compartments, said baffle plate having edge portions thereof disposed adjacent to the rail, flexible metallic strips secured to opposite sides of the baffle and arranged to project beyond the edge portions thereof for engaging the oppositely-disposed abutment surfaces of the rails, said metallic strips being held in substantially fluid-tight engagement with the abutment surfaces by the differential fluid pressure existing on opposite sides of the baffle, and relatively rigid strips secured to the baffle and arranged to limit the transverse movement of the flexible strips and to support the baffle plate from the rails.

19. 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 with the tube bundle, pairs of flexible members extending longitudinally of the shell structure and embracing opposite sides of marginal portions of the baffle, and means for fixedly securing one of the edge portions of the flexible members to the shell and for limiting flexing movements of the other edge portions of the flexible members.

20. In heat exchange apparatus, the combination of a shell, a tube bundle disposed within the shell and removable therefrom, a baffle extending longitudinally within the shell and removable therefrom with the tube bundle, said baffle being arranged to divide the shell into compartments, rail members extending longitudinally within the shell and providing grooves for receiving marginal portions of the baffle, and flexible strips provided on the rail members and forming flexible walls for the grooves, said flexible walls engaging opposite sides of the marginal portions of the baffle and said rail members embodying relatively non-flexible, transversely-projecting portions embracing the flexible strips and detachably supporting the baffle from the shell structure.

In testimony whereof, I have hereunto subscribed my name this twenty-ninth day of May, 1930.

JOHN A. POTTER.