June 22, 1937. E. A. DEWALD 2,084,324

HEAT EXCHANGER

Filed June 29, 1935 2 Sheets-Sheet 1

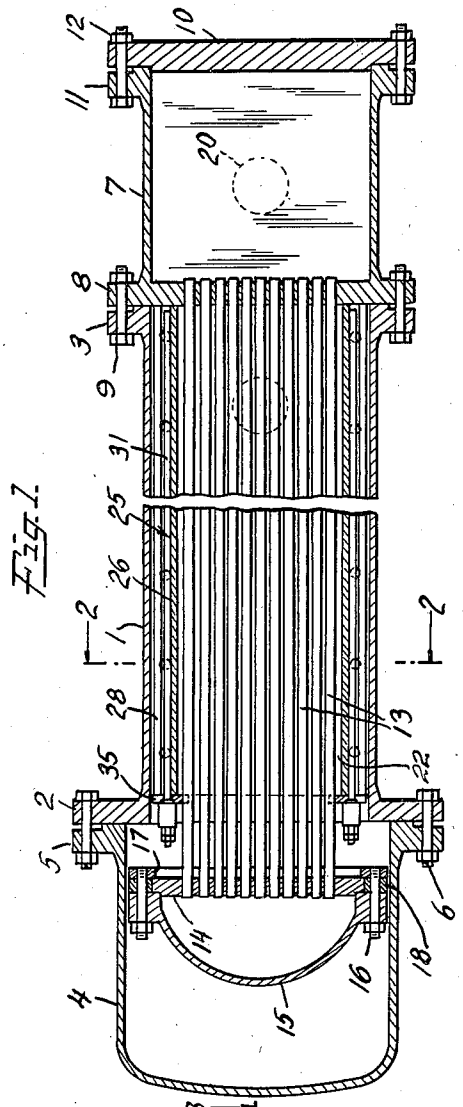

Fig. 1

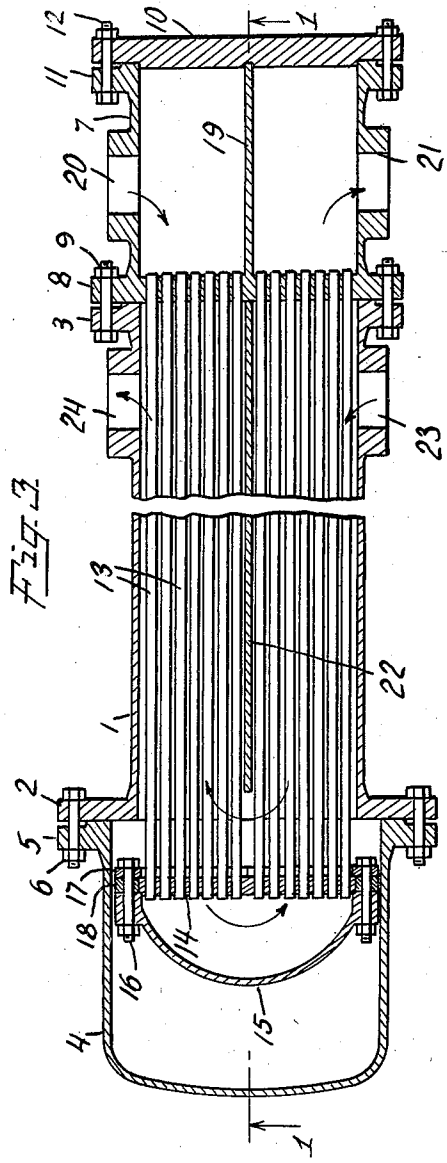

Fig. 3

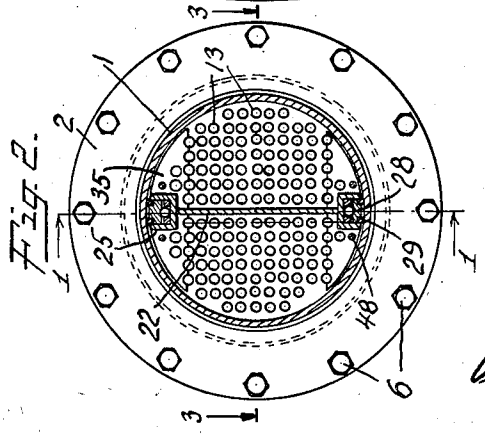

Fig. 2.

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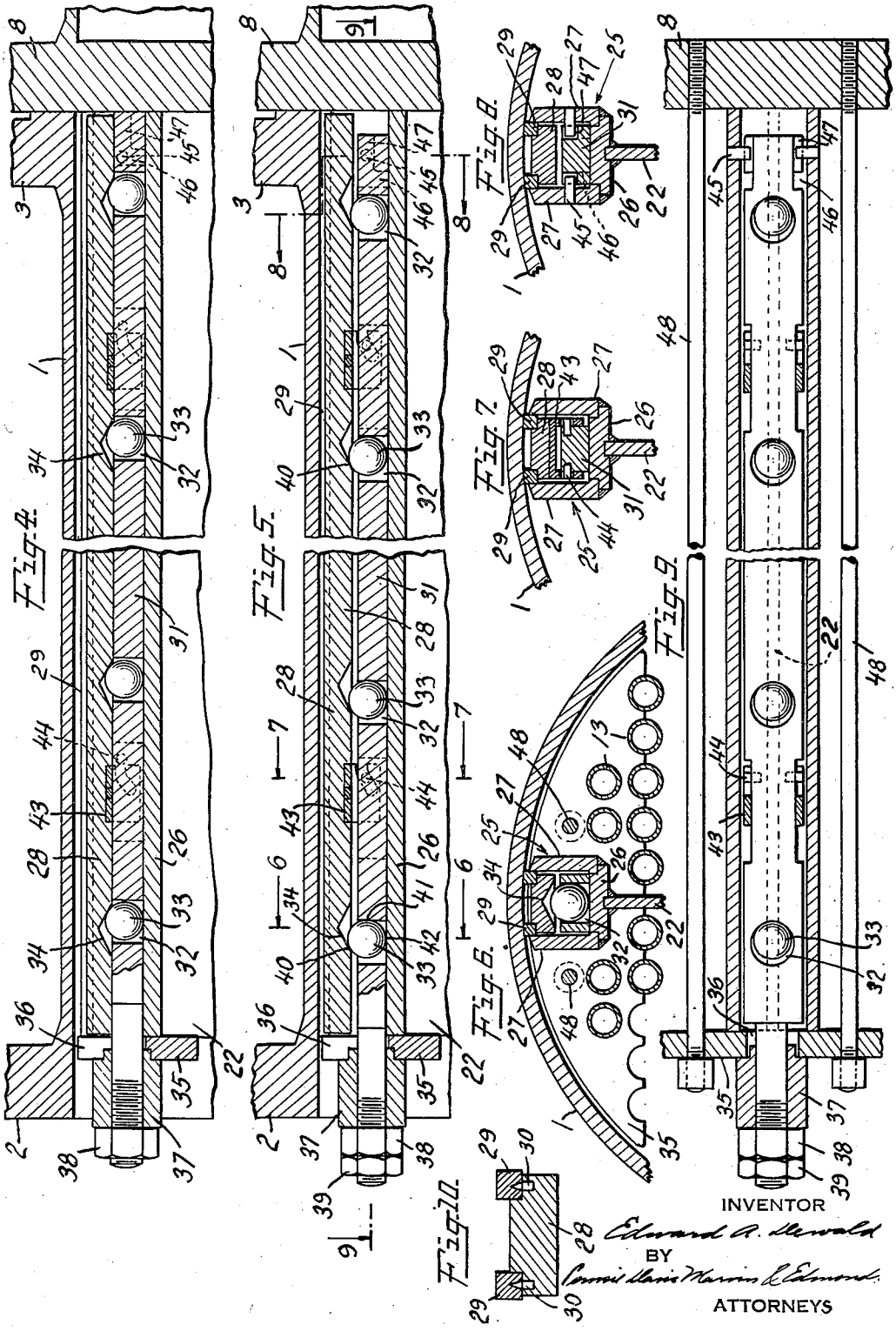

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UNITED STATES PATENT OFFICE

2,084,324

HEAT EXCHANGER

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15 Claims. (Cl. 257—239)

This invention relates to heat exchangers and more particularly to heat exchangers of the shell and tube type in which the tube bundle is preferably removable as a unit from the shell. The invention is primarily concerned with an improved expansion baffle construction suitable for use in any heat exchanger where a removable baffle may be employed and where it is desirable to provide a fluid-tight seal along one or more edges of the baffle.

In heat exchangers of the shell and tube type having a removable tube bundle it is frequently desirable to employ a longitudinal baffle for causing multipass flow of the fluid supplied to the shell. In assembling apparatus of this type it is customary to secure the ends of the tubes to the stationary tube sheet and to the floating tube sheet and then, before this tube bundle is inserted in the shell, the longitudinal baffle may be inserted between the tubes, and one end of the baffle secured to the stationary tube sheet. In order that this unit may be inserted in the shell without difficulty it is necessary to provide some clearance between the edges of the baffle and the inner surface of the shell. In order to prevent the fluid supplied to the shell from bypassing around the edges of the baffle through these clearance spaces it is necessary to provide a fluid-tight seal between the longitudinal edges of the baffle and the shell. My invention, as applied to a heat exchanger of this type, is primarily concerned with the problem of providing an efficient seal between the longitudinal edges of the baffle and the shell. An object of the invention is to provide a baffle seal which will not interfere in any way with the insertion of the tube bundle into the shell. A further object is to provide such a sealing means including a packing element which can be forced firmly against the inner surface of the shell after the tube bundle is in place this operation being performed with a minimum of friction between the several parts of the mechanism employed for moving the packing element. Another object of the invention is to provide means whereby the packing element is permitted to adjust itself to the contour of the shell. My invention also contemplates a construction which does not require accurate machining of the inner surface of the shell or of the longitudinal edges of the baffle. A further object of the invention is to provide a sealing mechanism including an actuating element which performs its necessary function when moved longitudinally of the baffle. In order to avoid objectionable distortion of the actuating mechanism or excessive friction it is desirable to avoid any arrangement in which the actuating means is displaced laterally with respect to the baffle as well as longitudinally of the baffle. Still another object of the invention is to provide means for locking the sealing mechanism to the baffle thus preventing these parts from becoming separated either when the tube bundle is inserted in the shell or when it is being removed from the shell. Accordingly, this mechanism may include means for locking a packing bar, or the like, to the means for actuating the same, and means for locking the actuating means to the baffle.

The various objects and advantages of my invention will be more apparent upon considering the following detailed description which is to be taken in conjunction with the accompanying drawings in which:

Fig. 1 is a vertical section view of a heat exchanger embodying my invention;

Fig. 2 is a transverse section view taken on line 2—2 of Fig. 1;

Fig. 3 is a horizontal section view of the heat exchanger shown in Figs. 1 and 2, taken on line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary section view of a portion of the apparatus shown in Figs. 1, 2, and 3, illustrating details of construction of the baffle seal;

Fig. 5 is a section view similar to Fig. 4 but showing some of the parts in a different position whereby a tight seal is formed between the shell and the longitudinal baffle;

Fig. 6 is a transverse section view taken on line 6—6 of Fig. 5 showing details of construction;

Fig. 7 is a transverse section view taken on line 7—7 of Fig. 5 illustrating details of construction;

Fig. 8 is a transverse section view taken on line 8—8 of Fig. 5 showing details of construction;

Fig. 9 is a section view taken on line 9—9 of Fig. 5 and

Fig. 10 is an enlarged transverse section view of the packing bar forming a part of the apparatus illustrated in the other figures.

One embodiment of my invention, as applied to a shell and tube type of heat exchanger having a removable tube bundle, is shown in the accompanying drawings. In these drawings the heat exchanger comprises a cylindrical shell 1 having end flanges 2 and 3. A cap 4 having a flange 5 is secured to the shell flange 2 by a plurality of bolts 6. A manifold chamber or housing 7 having an integral tube sheet 8 is secured

to the shell flange 3 by means of bolts 9. A cover plate 10 is secured to a flange 11 on the housing member 7 by a plurality of bolts 12. A plurality of tubes 13 are secured at one end to the stationary tube sheet 8 and at the other end to a floating tube sheet 14. The cap 15 is secured to the marginal portion of the tube sheet 14 by means of a plurality of bolts 16 which engage an inner sectional ring 17. A continuous ring 18 is interposed between the sectional ring and the rim of the cap 15. The diameter of the floating tube sheet 14 is slightly less than the inside diameter of the shell 1 so that after the tube bundle has been secured to the tube sheets this assembled unit may be inserted in the shell 1 until the stationary tube sheet 8 engages the shell flange 3. The cap 15 is then secured to the floating tube sheet and the end cap 4 is secured to the shell flange 2.

A partition plate 19 is provided in the housing 7 so that fluid entering this housing through the inlet 20 is caused to flow through a portion of the tube bundle to the space within the cap 15 which serves to direct the fluid into the remaining portion of the tube bundle so that it is returned to the housing member 7 and discharged through the discharge port 21 as indicated by the arrows.

In order to provide multipass flow of the fluid supplied to the shell the apparatus includes a longitudinal baffle 22 which may be welded or otherwise permanently secured to the stationary tube sheet 8. Accordingly, fluid entering the shell through the inlet 23 near the stationary tube sheet is caused to flow lengthwise of the shell and around the end of the longitudinal baffle and then back toward the stationary tube sheet and through the discharge port 24. This arrangement provides countercurrent flow of the two fluids supplied to the apparatus thus insuring an efficient transfer of heat from the hot fluid to the cold fluid. It is to be understood that the fluid connections for one of the fluids may be reversed if desired so as to provide concurrent flow of the two fluids instead of countercurrent flow.

It is desirable to secure the longitudinal baffle 22 to the stationary tube sheet 8 before the tube bundle is inserted in the shell and in order to avoid difficulty in inserting the tube bundle in the shell it is necessary to provide some clearance between the longitudinal edges of the baffle 22 and the inside of the shell. In order to prevent by-passing of the fluid from the shell inlet 23 to the shell outlet 24 through these clearance spaces it is necessary to provide means for sealing these clearance spaces after the tube bundle has been inserted in the shell. As stated above, the present invention is primarily concerned with an improved means for effecting the desired seal between the longitudinal edges of the baffle and the shell.

The details of the preferred embodiment of my improved sealing mechanism are best illustrated in the enlarged Figures 4 to 10 inclusive.

My improved sealing mechanism which is provided along each longitudinal edge of the baffle comprises a housing or shroud 25 consisting of a base plate 26 welded or otherwise fixed to the edge of the baffle and side plates 27 which may be integral with or welded to the base plate 26. The sealing element comprises a packing bar 28 having strips of packing material 29 along the outside edges or corners of the packing bar. These strips of packing material of soft metal, or the like, may be anchored to the packing bar 28 by means of a series of pointed pins 30 as best shown in Fig. 10. Each packing strip preferably extends beyond the adjacent edges of the packing bar so as to readily engage the inner surface of the shell and the marginal portions of the shroud plates 27 when the packing bar is forced outwardly toward the shell.

The actuating mechanism which I prefer to employ for the purpose of forcing each packing bar 28 toward the shell comprises what may be characterized as a ball cage bar 31 movably mounted within the shroud 25 and normally resting on the base plate 26 thereof. The ball cage bar has a plurality of openings 32 therein forming ball sockets for receiving a plurality of balls 33. These balls are of such size that they project out from the ball cage bar so as to engage inclined surfaces 34 provided at intervals along the inner surface of the packing bar 28. A transverse supporting plate 35 is welded or otherwise secured to the longitudinal baffle and this plate is provided with a notch or opening 36 adapted to receive one end of the ball cage bar. This end of the ball cage bar is provided with screw threads and is adapted to receive a collar or bushing 37 which engages the supporting plate 35. An adjusting nut 38 is provided on the end of the ball cage bar and it will be understood that by turning this nut the ball cage bar may be moved longitudinally of the baffle to cause the balls 33 to force the packing bar outwardly toward the shell. After the packing bar has been forced firmly against the inner surface of the shell a lock nut 39 may be applied to the projecting end of the ball cage bar to lock the nut 38 in its adjusted position as shown in Figs. 5 and 9. With the parts in the position shown in these figures it will be understood that the strips of packing material 29 provide a fluid-tight seal which prevents by-passing of fluid around the longitudinal edges of the baffle. This is accomplished by virtue of the tight seal formed between the packing strips 29 and the inner surface of the shell and also between these packing strips and the marginal edges of the shroud plates 27.

One of the particular advantages of my invention resides in the fact that a pivot contact is made between the several balls and the packing bar whereby the packing bar may adjust itself to the contour of the inner surface of the shell. It is to be understood that the expression "pivot contact" as used throughout the specification and claims is intended to define a contact or relation between the packing bar and the actuating means therefor which permits a lateral rocking movement of the packing bar as well as an outward movement away from the baffle and toward the shell. This condition exists by virtue of the fact that each ball makes a point contact with the adjacent inclined surface of the packing bar as shown at 40. It will be noted that each ball makes a three point contact with the elements associated therewith as shown at 40, 41, and 42. This construction is particularly advantageous because it reduces to a minimum the friction incident to actuating the packing bar to force the same firmly again the inner surface of the shell. This greatly facilitates the operation of sealing the longitudinal edges of the baffle and it eliminates any danger of stripping the threads at the ends of the ball cage bar. It will be understood that the required lateral outward movement of each packing bar is accomplished by a longitudinal movement of each ball cage bar and that the movement of the ball cage bars to perform its intended function is

accomplished without the necessity for having the ball cage bars move transversely with respect to the baffle plate.

In order to release the packing bars so that the tube bundle may be removed from the shell it is merely necessary to remove the lock nuts **39** and unscrew the adjusting nuts **38** so that the ball cage bars may be forced toward the stationary tube sheets. This releases the pressure of the balls against the ball cage bar so that the parts may occupy the position shown in Fig. 4.

In order to facilitate the assembly of the apparatus it is desirable to provide means for locking the packing bars and the means for actuating the same to the longitudinal edges of the baffle. To accomplish this purpose I may provide a plurality of clips **43** spot welded or otherwise secured to the packing bars **28**. These clips have bayonet slots therein adapted to receive pins **44** carried by the ball cage bar **31**. The bayonet slots have portions parallel to the axis of the ball cage bar and other portions substantially parallel to the inclined surfaces **34** of the packing bar **28** to accommodate the lateral movement of the packing bars when the same are forced outwardly toward the shell. The shroud plates **27** may be provided with pins **45** which engage interconnected channels **46** and **47** provided at the ends of the ball cage bars near the stationary tube sheet **8**. In assembling the sealing mechanism on the baffle **22** the several parts are first placed in the position shown in Fig. 4 with the ball cage bars engaging the tube sheet. The adjusting nuts **38** are then turned so as to cause the ball cage bars to move longitudinally until the pins **44** engage the longitudinally extending portions of the bayonet slots in the clips **43** and this movement of the ball cage bars also causes the pins **45** to register with the channels **47** at the ends of the ball cage bars. In this manner the ball cage bars are locked to the shrouds **25** by virtue of the pins **45** and the packing bars are locked to the ball cage bars by virtue of the clips **43** engaging the pins **44**. With the parts in this position the tube bundle may be inserted in the shell without any danger of the sealing mechanism becoming accidentally separated from the longitudinal edges of the baffle **22**. As explained above, after the tube bundle has been inserted the adjusting nuts **38** may be turned so as to cause further longitudinal movement of the ball cage bars whereby the balls are caused to engage the inclined surfaces **43** of the packing bars and force the same outwardly toward the shell, thus providing the desired seal between the shell and the longitudinal baffle.

If desired, the end supporting plates **35** may be secured in place by means of tie rods **48** which serve to secure these plates to the stationary tube sheet **8**.

It is to be understood that my invention is not limited to the particular embodiment thereof described above but includes such modifications thereof as fall within the scope of the appended claims.

I claim:—

1. Apparatus of the type described comprising a shell, a removable baffle within the shell and means for forming a seal between an edge of the baffle and the shell, said means comprising a bar extending along said edge and actuating means for moving said bar toward the shell, said actuating means having a pivot contact with said bar to permit the same to adjust itself to the contour of the shell.

2. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, a strip of packing material along each outer edge of said bar and actuating means for moving said bar toward the shell, said actuating means having a pivot contact with said bar.

3. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell and actuating means for moving said bar toward the shell, said actuating means including a plurality of elements each having a point contact with said bar.

4. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell and actuating means for moving said bar toward the shell, said actuating means including a plurality of balls each making a point contact with said bar.

5. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, said packing bar having a plurality of inclined surfaces, and actuating means for moving said bar towards the shell, said actuating means comprising a plurality of balls each engaging one of the inclined surfaces of said bar and means for moving said balls longitudinally of the shell whereby the balls force the said bar toward the shell.

6. Apparatus of the type described comprising a shell, a removable baffle within the shell, a shroud secured to the baffle along one edge thereof, a packing bar disposed within said shroud, and actuating means for moving said bar toward the shell, said actuating means having a pivot contact with said bar to permit the same to adjust itself to the contour of the shell.

7. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, a plurality of balls for engaging the packing bar to move the same toward the shell, a ball cage bar having sockets therein for holding said balls and means for moving said ball cage bar to cause the balls to force the packing bar toward the shell.

8. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, said packing bar having a plurality of inclined surfaces, a plurality of balls each adapted to engage one of said inclined surfaces, a ball cage bar having sockets for holding said balls and means for moving said ball cage bar longitudinally of the shell.

9. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, actuating means for moving said packing bar toward the shell and means for locking said packing bar to said actuating means.

10. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, an actuating bar movable longitudinally of the shell, elements carried by said bars for interlocking the same and means for moving said second named bar to bring said elements into interlocking relation with each other.

11. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, a shroud secured to the baffle and enclosing said bar, actuating means for moving said bar toward the shell, means for locking said bar to said actuating means and means for locking said actuating means to said shroud.

12. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, a shroud secured to the baffle and enclosing said bar, actuating means for moving said bar toward the shell and means for locking said bar to said actuating means.

13. Apparatus of the type described comprising a shell, a removable baffle within the shell, a packing bar disposed between an edge of the baffle and the shell, a shroud secured to the baffle and enclosing said bar, actuating means for moving said bar toward the shell, said actuating means comprising a bar movable longitudinally of said baffle to any one of a plurality of positions, means whereby movement of said actuating bar to one of said positions locks said bars together, and whereby movement of said actuating bar to another of said positions forces said packing bar toward the shell.

14. Apparatus of the type described comprising a shell, a removable baffle within the shell, a shroud secured to one edge of said baffle, a packing bar disposed within said shroud, said packing bar having a plurality of inclined surfaces, a plurality of balls, a movable ball cage bar within said shroud for holding said balls, and means for moving said ball cage bar longitudinally of said baffle to cause the balls to engage the said inclined surfaces and force the packing bar toward the shell with each ball having a three-point contact with the packing bar, the ball cage bar and the shroud.

15. Apparatus of the type described comprising a shell, a stationary tube sheet fixed with respect to one end of said shell, a floating tube sheet within the shell, a tube bundle having its ends secured to said tube sheets, a baffle extending longitudinally of the shell and having one end secured to said stationary tube sheet, a packing bar disposed between one longitudinal edge of the baffle and the shell and actuating means for moving said bar toward the shell, said actuating means having a pivot contact with said bar to permit the same to adjust itself to the contour of the shell.

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