Aug. 29, 1950 J. W. BROWN, JR 2,520,755

MULTIPLE TUBE HEAT EXCHANGER

Filed Sept. 13, 1948 2 Sheets-Sheet 1

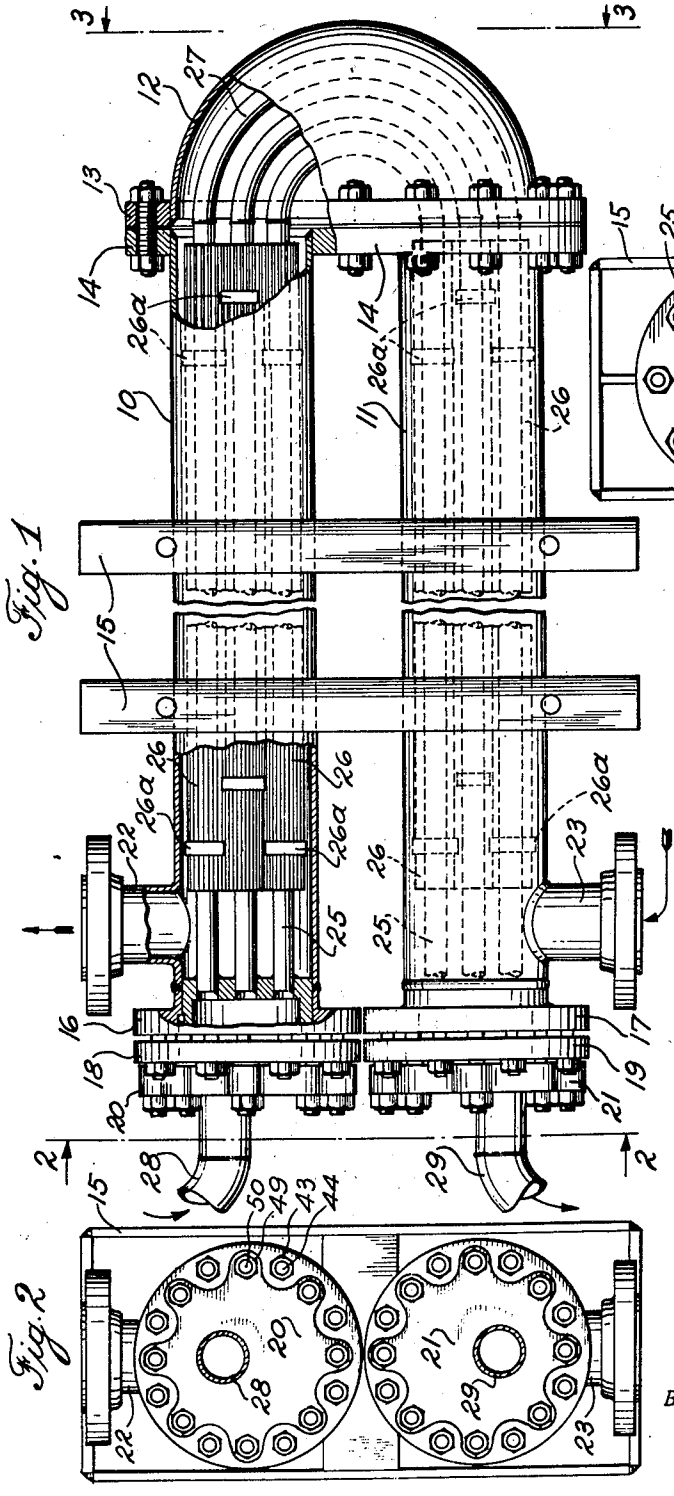


Fig. 1

Fig. 2

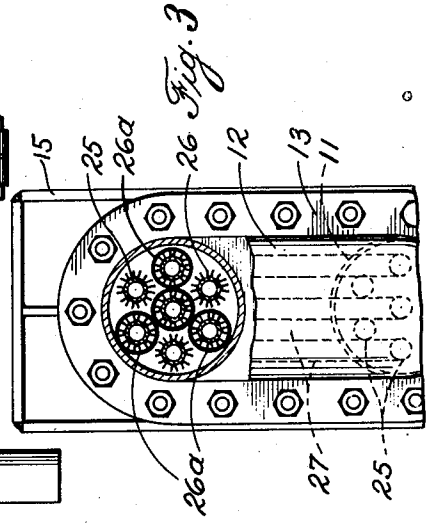


Fig. 3

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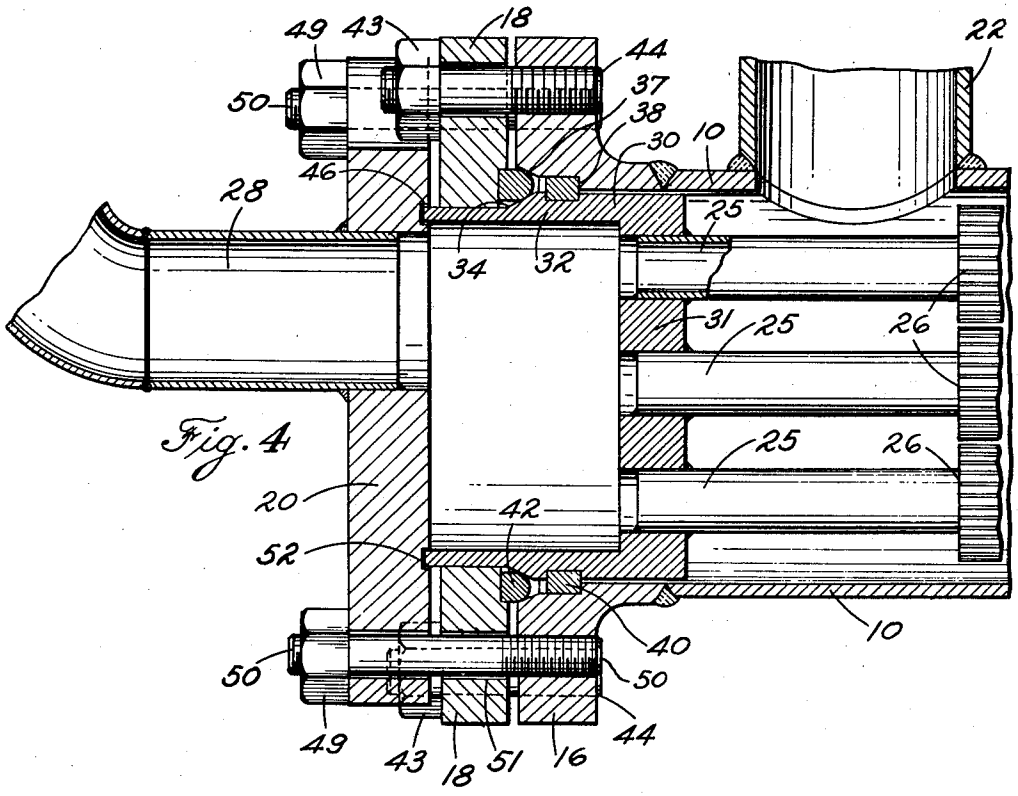


Fig. 4

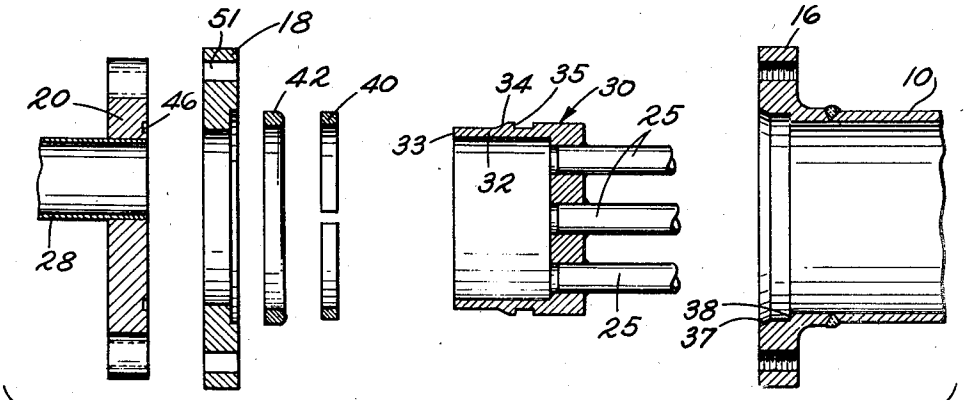


Fig. 5

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MULTIPLE TUBE HEAT EXCHANGER

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Application September 13, 1948, Serial No. 49,051

6 Claims. (Cl. 257—234)

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This invention relates to heat exchangers and more particularly to multiple tube heat exchangers of the hairpin type. This application is a continuation-in-part of my copending application Serial No. 572,627, filed January 13, 1945, now Patent No. 2,449,052, issued September 14, 1948.

A general object of the invention is the provision of a compact and economical heat exchanger which is adaptable to a wide variety of uses. More specific objects include the provision of a heat exchanger embodying a multiple inner tube assembly which can be easily removed and replaced; the provision of a connection or union for joining the multiple inner tubes of a heat exchanger to inlet and outlet conduits and to the interior of the shell tube surrounding the multiple tubes; the provision of such a connection which can be assembled and disassembled readily without applying any great or unusual forces to the heat exchanger assembly; the provision of such connection in which there is no possibility of intermingling of the fluids passing through the heat exchanger because of leaking joints; and the provision of a simple tubular connection adapted to make leakproof high pressure joints between the plurality of tubes and a single connecting pipe and between the exterior of the tubes and the interior of a surrounding shell or tube.

Further objects and advantages of the invention will become apparent from the following description of a preferred form thereof, reference being made to the accompanying drawings in which Figure 1 is a side elevation with parts broken away of a preferred form of heat exchanger embodying my invention; Figure 2 is a front elevation of the heat exchanger shown in Figure 1, the view being taken as indicated by the line 2—2 of Figure 1; Figure 3 is a rear elevation of the heat exchanger shown in Figure 1 with parts broken away, the view being taken as shown by line 3—3 of Figure 1; Figure 4 is an enlarged axial sectional view showing the connection at one end of one of the shell tubes of the heat exchanger; and Figure 5 is an exploded view on a reduced scale of the parts making up the assembly shown in Figure 4.

As shown in Figures 1, 2 and 3 of the drawings, a preferred form of heat exchanger embodying my invention comprises a pair of external or shell tubes 10 and 11 disposed one above the other and with their axes substantially parallel. These tubes are connected together at their rear ends through a return bend housing 12 which is provided with a flange 13, the flange 13 being bolted to the flange 14 which is welded to both shell tubes. The shell tubes may be supported by frame members 15 or any other convenient means. The forward ends of the shell tubes are provided with flanges 16 and 17 to which clamping rings

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18 and 19 and cover plates 20 and 21, respectively, are secured as will be explained in greater detail below. Fluid is supplied to and discharged from the interior of the shell tubes through the connections 22 and 23 which are welded to the tubes 10 and 11 near the flanges 16 and 17. In the form of the heat exchanger shown in the drawing, the connection 23 is the inlet and connection 22 is the outlet as indicated by the arrows. It will be understood, however, that the direction of flow through the shell tubes may be reversed if desired.

In order to provide a path for another fluid or commodity to flow in heat exchange relation to the fluid or commodity within the shell tubes, a plurality of hairpin tubes 25 are disposed within the shell tubes. The tubes 25 each comprise two straight sections, preferably provided with fins 26, and connected by return bends 27 which are disposed within the return bend housing 12. In the form of the invention shown in the drawings, seven hairpin tubes are employed. It is to be understood, however, that a greater or lesser number may be utilized without departing from the invention. The fins 26 are provided to increase the rate of interchange of heat between the commodity within the tube 25 and the commodity surrounding these tubes and within the shell tubes. The fins preferably are constructed in accordance with the teachings of my prior Patents Nos. 2,261,136 and 2,261,137. Bands 26a may be provided to space the tubes properly and prevent intermeshing of the fins. The commodity, which is ordinarily a fluid, is supplied to the interior of the inner tubes through connecting pipes 28 and 29, connecting pipe 28 constituting the inlet in the form of the invention shown in the drawings, while connecting pipe 29 constitutes the outlet, thus providing for counterflow of the commodities in the heat exchanger. Obviously the flow can be reversed if desired, and it will be evident that the connecting pipes 28 and 29 and the lateral connections 22 and 23 can be arranged to connect a plurality of heat exchanger units such as shown in Figure 1 in series or in multiple.

In order to make the heat exchanger operative, a fluid-tight connection must be provided at the front end of the exchanger between the connecting pipes 28 and 29 and the interior of the hairpin tubes 25. Also, the space around the hairpin tubes 25 and the interior of the shell tubes 10 and 11 must be sealed at the ends of the shell tubes. To make these two joints efficiently and easily and to provide a construction in which there is not possibility of intermingling of the fluid on the exterior of the hairpin tubes with the fluid on the interior of the hairpin tubes, I provide the unions or connections shown particularly in Figures 4 and 5 of the drawings.

Inasmuch as the connections at the ends of shell tubes 10 and 11 are identical, only the connection at the end of the upper shell tube 10 will be described in detail herein.

This connection comprises a hollow fitting 30 having a radial portion 31 which constitutes in effect a tube sheet and which is provided with openings into which the inner tubes 25 are secured preferably by welding. A generally cylindrical flange 32 projects from the radial portion 31, the interior of the flange constituting a channel or distributing chamber for distributing the fluid from the connecting pipe 28 to the several hairpin tubes 25. The flange 32 projects axially outwardly from the radial portion 31 as shown and terminates in a sealing surface 33 at its end. Intermediate the ends of the flange 32 and on the exterior thereof, there is a second, preferably tapered sealing surface 34, and axially inward from the sealing surface 34 the flange is grooved to provide an inwardly facing shoulder 35. The outer tube 10 is provided with a tapered sealing surface 37 which is disposed adjacent the sealing surface 34 of the flange when the parts are assembled. The outer tube also is recessed or counter-bored as shown to provide an outwardly facing shoulder 38 which is disposed axially inwardly from the sealing surface 37.

In order to retain the fitting 30 in its correct position at the forward end of the exchanger and to prevent it from being moved rearwardly into the shell tube as a result of sealing pressures exerted against it, a split locking ring 40 is disposed in the groove in the exterior of the fitting and interposed between the inwardly facing shoulder 35 of the fitting and the outwardly facing shoulder 38 of the shell tube. Thus, so long as the split locking ring is in position, the fitting is held securely against inward movement. However, the locking ring may readily be released by moving the hairpin tubes outwardly or toward the front of the exchanger a distance sufficient to bring the locking ring beyond the sealing surface 37 at the end of the shell tube. It will be noted that the maximum external diameter of the flange 32 of the fitting 30 is less than the internal diameter of the outer tube 10. Thus, the hairpin tubes 25 together with the fittings 30 can be removed rearwardly from the outer or shell tubes by removing the return bend housing 12, disconnecting the connections at the front of the exchanger and removing the split locking ring.

Inasmuch as the fitting 30 is joined to the tubes 25 in leakproof relationship, it is only necessary to seal the clearance space between the exterior of the fitting 30 and the interior of the shell tube in order effectively to seal the end of the shell tube against leakage. This result is accomplished by means of the clamping ring 18 which engages the sealing ring 42. The sealing ring 42 may be of soft iron or other suitable gasket material and is drawn into sealing engagement with the sealing surfaces 34 and 37 when the nuts 43 are tightened on the studs 44 which are threaded into openings in the flange 16; this action draws the clamping ring 18 toward the flange 16 and creates an effective seal between the sealing ring 42 and sealing surfaces 34 and 37.

In order to provide a connection for the connecting pipe 28 with the interior of the fitting 30 and hence with the interior of the tubes 25, the connecting pipe is secured in leakproof relationship to the cover plate 20 preferably by welding. The cover plate 20 is provided with an annular groove 46 of the same diameter as the sealing surface 33 at the end of the fitting 30, the groove surrounding the connection with the connecting pipe 28. The cover plate is urged into sealing engagement with the fitting 30 by means of nuts 49 threaded on studs 50 which are also threaded into the flange 16 on the shell tube. The periphery of the cover plate 20 is cut away as shown particularly in Figure 2 to provide room for the insertion of a wrench to engage the nuts 43, and the clamping ring 18 is provided with openings 51 for passage of studs 50. A suitable gasket 52 may be interposed between the sealing surface 33 at the end of the fitting 30 and the sealing surface at the base of the groove 46 if desired. It will be noted that the connecting pipe 28 is eccentric with respect to the cover plate 20, and as shown in Figure 1, the connecting pipe 29 is eccentric with respect to cover plate 21. This construction provides for drainage of any condensate particularly from the lower section of the exchanger. It is to be understood, however, that the connecting pipes can be otherwise disposed so long as they are joined to the cover plates within the sealing surface provided by the groove 46.

From the foregoing, it will be evident that I have provided a simple and effective multiple tube heat exchanger in which the necessary fluid connections can be made and broken by the use of small wrenches and without imposing any unusual strains on the exchanger. My connections are such that leakproof joints having the ability to withstand high pressures can be provided readily; the construction is compact, making it possible to obtain large heat exchange capacity in a small space. There is no possibility of intermingling of the commodities within the exchanger by reason of leakage of the joints. If a leak should take place adjacent the sealing ring 42, the leakage would go to the exterior of the exchanger through the spaces between flange 16 and clamping ring 18 and between clamping ring 18 and cover plate 20; if a leak should occur in the connection between the cover plate 20 and the end of the fitting 30, the leakage would go to the exterior of the exchanger through the space between the clamping ring 18 and the cover plate 20. In neither case is there any path to permit intermingling of the fluid.

The exchanger can be disassembled readily for cleaning or other purposes merely by removing the return bend housing 12, sliding the hairpin tubes toward the forward end of the exchanger sufficiently to permit the removal of the split locking ring 40 and then removing the hairpin tubes and the fittings 30 as a unit from the rear of the exchanger. In re-assembling the exchanger, the sealing surfaces can be cleaned immediately before they are sealed, and the tightness of the joints can be determined readily by visual inspection inasmuch as any leakage will be immediately evident at the exterior of the exchanger. The parts of the exchanger are designed so that they can be manufactured economically by ordinary machining operations.

Various changes and modifications in my invention will be apparent to those skilled in the art. It is, therefore, to be understood that my patent is not limited to the preferred form of the invention disclosed herein or in any manner other than by the scope of the appended claims.

I claim:

1. A union for connecting a plurality of inner tubes to an outer tube surrounding the inner tubes, and for connecting the inner tubes to a connecting pipe, said union comprising a hollow fitting having a tube sheet portion provided with openings to which said inner tubes are secured and having a flange extending axially outward from said tube sheet portion, said flange having a first sealing surface, a second sealing surface disposed on the exterior of the flange axially inward from said first sealing surface and having an inwardly facing shoulder disposed on the exterior of the flange axially inward from said second sealing surface, said outer tube having a sealing surface adjacent said second sealing surface and having an outwardly facing shoulder disposed axially inward therefrom, stop means adapted to engage between the shoulder on the outer tube and the shoulder on the flange for limiting inward movement of the fitting in the outer tube, a sealing ring adapted to seal against the adjacent sealing surfaces of said outer tube and said flange, means connected to said outer tube for drawing said sealing ring simultaneously against the adjacent sealing surfaces of said outer tube and said flange, a cover plate connected to said connecting pipe and having a sealing surface surrounding said connecting pipe and adapted to be sealed to said first sealing surface of said flange, and means connected to said outer tube for drawing said cover plate into sealing engagement with said first sealing surface of said flange.

2. A union for connecting a plurality of inner tubes to an outer tube surrounding the inner tubes, and for connecting the inner tubes to a connecting pipe, said union comprising a hollow fitting having a substantially flat, radial portion provided with openings to which said inner tubes are secured and disposed within said outer tube, said fitting having a generally cylindrical flange extending axially outward from said radial portion, said flange having a maximum external diameter less than the internal diameter of said outer tube and having a first sealing surface disposed beyond the end of said outer tube, a second sealing surface disposed on the exterior of the flange axially inward from said first sealing surface and having a groove providing an inwardly facing shoulder disposed on the exterior of the flange axially inward from said second sealing surface, said outer tube having a sealing surface adjacent said second sealing surface and having an outwardly facing shoulder disposed axially inward therefrom, a split locking ring disposed in said groove and adapted to engage between the shoulder on the outer tube and the shoulder on the flange for limiting inward movement of the fitting in the outer tube, a sealing ring adapted to seal against the adjacent sealing surfaces of said outer tube and said flange, means connected to said outer tube for drawing said sealing ring simultaneously against the adjacent sealing surfaces of said outer tube and said flange, a substantially flat cover plate connected to said connecting pipe and disposed entirely outside of said outer tube and having a sealing surface surrounding said connecting pipe and adapted to be sealed to the first sealing surface of said flange, and means connected to said outer tube for drawing said cover plate into sealing engagement with said first sealing surface of said flange.

3. A union for connecting a plurality of inner tubes to an outer tube surrounding the inner tubes and for connecting the inner tubes to a connecting pipe, said union comprising a hollow fitting having a tube sheet portion provided with openings to which said inner tubes are secured and having a portion provided with two sealing surfaces and an inwardly facing shoulder disposed on the exterior of the fitting axially inward from said sealing surfaces, said outer tube having a sealing surface adjacent one of said sealing surfaces on said fitting and having an outwardly facing shoulder disposed axially inward therefrom, stop means adapted to engage between the shoulder on the outer tube and the shoulder on the fitting for limiting inward movement of the fitting in the outer tube, a sealing ring adapted to seal against the adjacent sealing surfaces of said outer tube and said fitting, means connected to said outer tube for drawing said sealing ring simultaneously against the adjacent sealing surfaces of said outer tube and said fitting, and means for connecting said connecting pipe to the other of said sealing surfaces of said fitting.

4. A union according to claim 3 wherein the connecting pipe is sealed to the fitting by means of a substantially flat cover plate to which the pipe is welded, the cover plate being disposed beyond the end of said outer tube and being drawn into sealing engagement with said fitting by means connected to said outer tube.

5. A union according to claim 3 wherein the hollow fitting constitutes a chamber for distributing fluid from the connecting pipe to the several inner tubes.

6. A union for connecting a plurality of inner tubes to an outer tube surrounding the inner tubes and for connecting the inner tubes to a connecting pipe, said union comprising a fitting having a tube sheet portion provided with openings to which said inner tubes are secured, said fitting having two annular sealing surfaces and an inwardly facing shoulder disposed on the exterior of the fitting, said outer tube having a sealing surface adjacent one of said sealing surfaces on said fitting and having an outwardly facing shoulder disposed axially inward therefrom, stop means adapted to engage between the shoulder on the outer tube and the shoulder on the fitting for limiting inward movement of the fitting in the outer tube, a sealing ring adapted to seal against the adjacent sealing surfaces of said outer tube and said fitting, said sealing ring being disposed axially outward from said shoulders, means connected to said outer tube for drawing said sealing ring simultaneously against the adjacent sealing surfaces of said outer tube and said fitting, and means for connecting said connecting pipe to the other of said sealing surfaces of said fitting.

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