

Nov. 21, 1944.

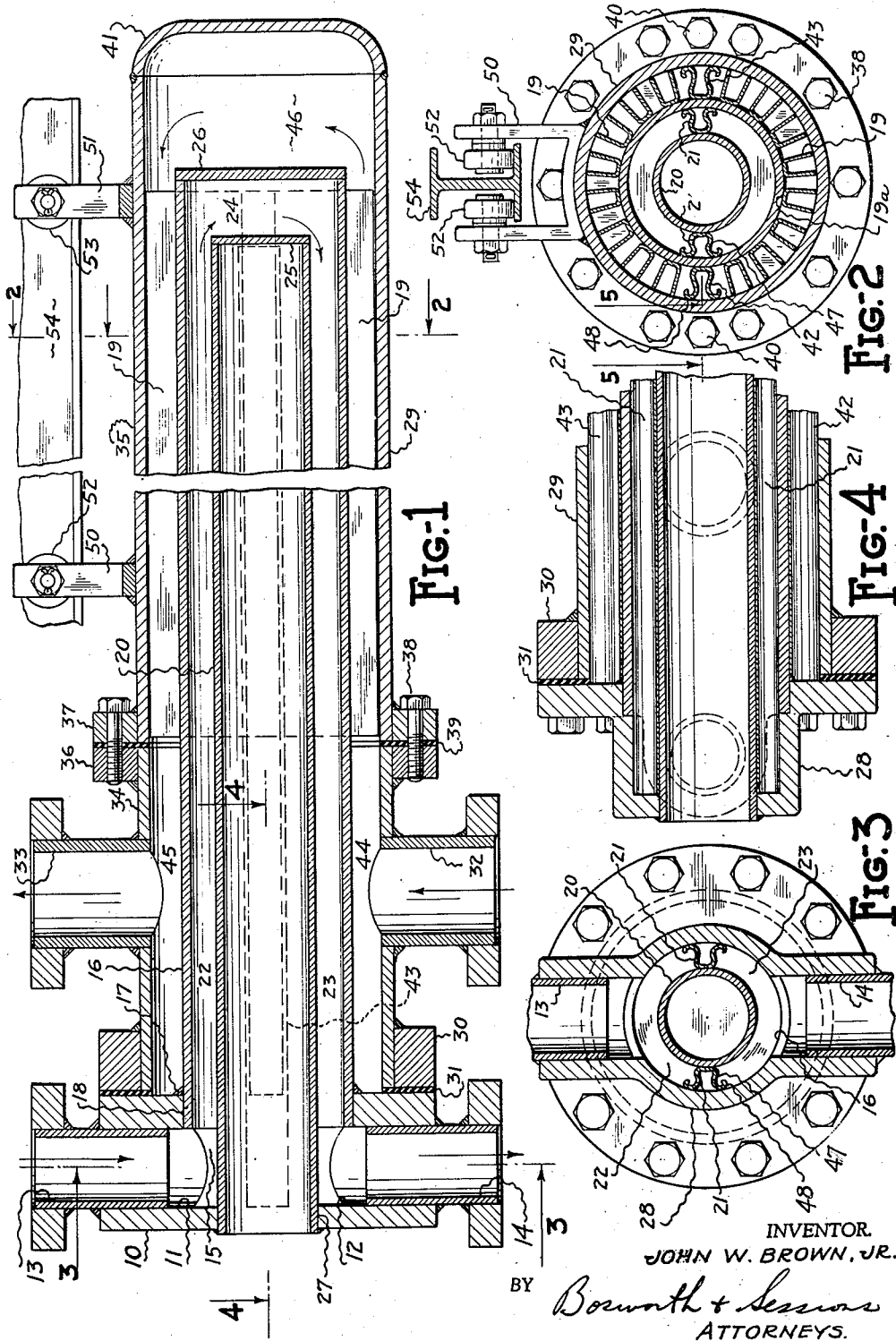
J. W. BROWN, JR

2,362,985

HEAT EXCHANGER

Filed Dec. 24, 1941

3 Sheets-Sheet 1



Nov. 21, 1944.

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HEAT EXCHANGER

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3 Sheets-Sheet 2

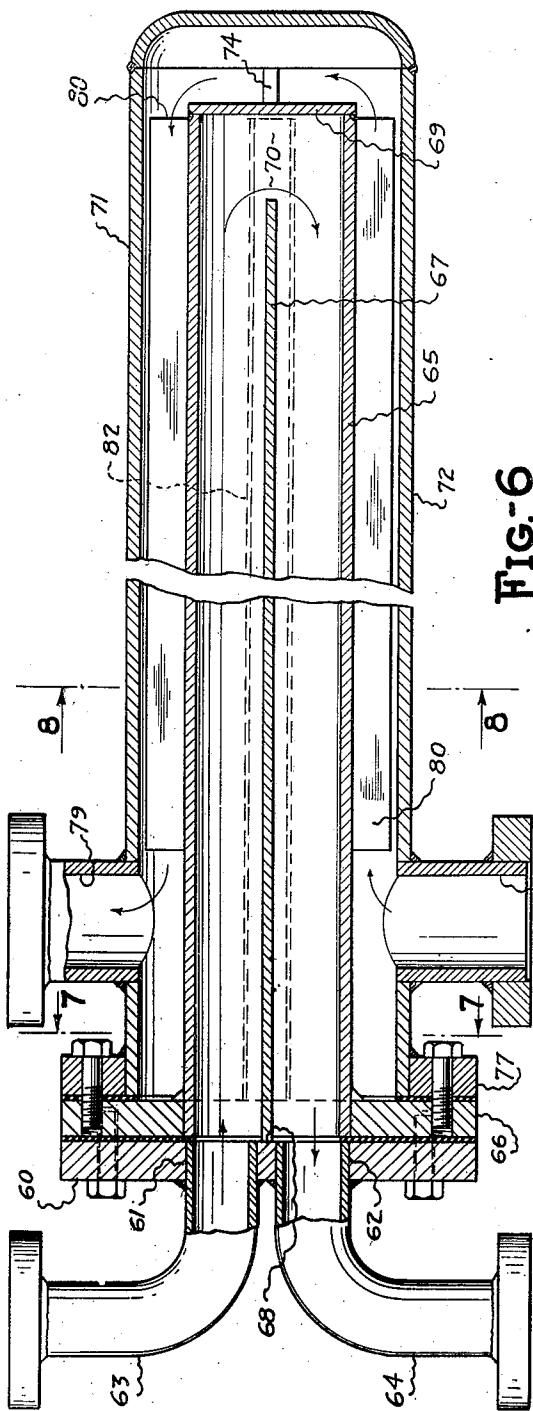


FIG-6

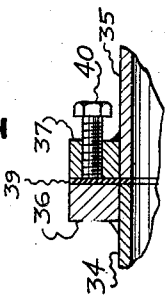


FIG-5

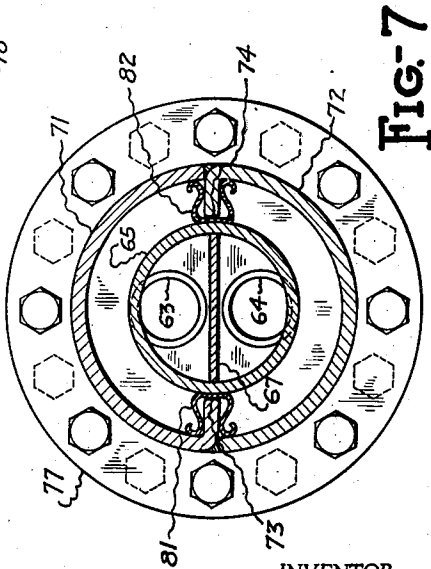


FIG-7

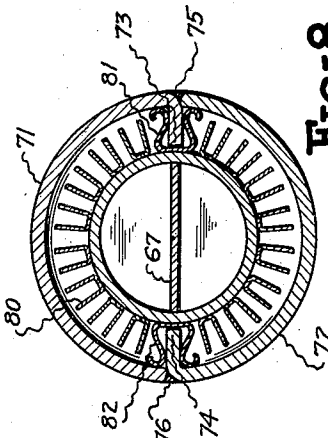


FIG-8

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3 Sheets-Sheet 3

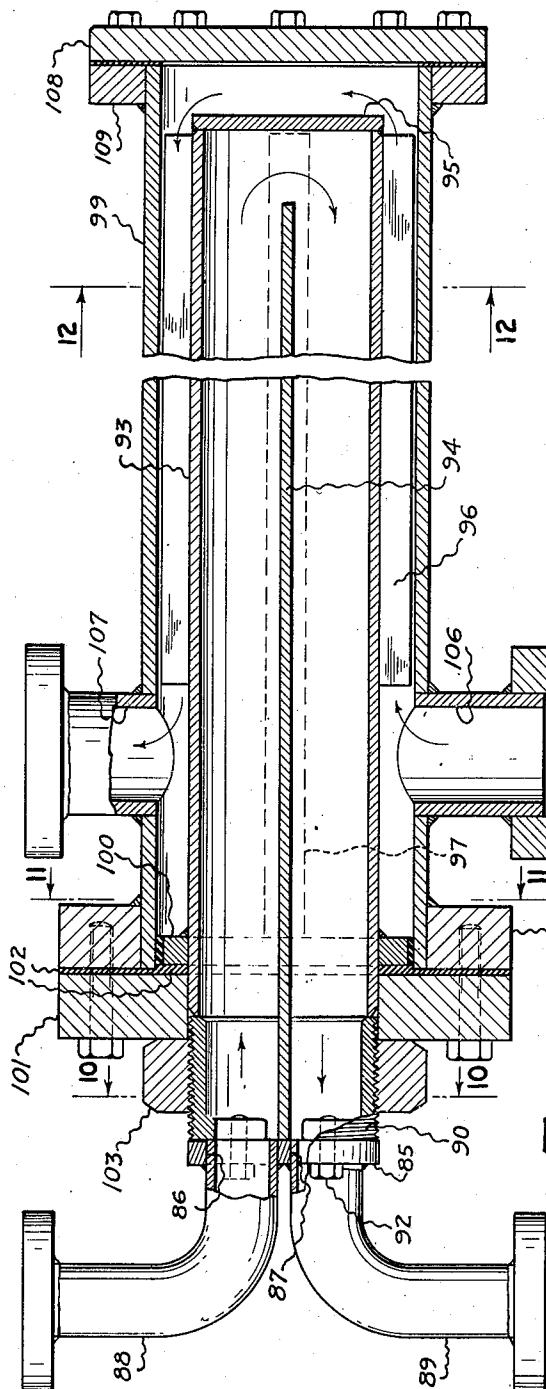


Fig-9

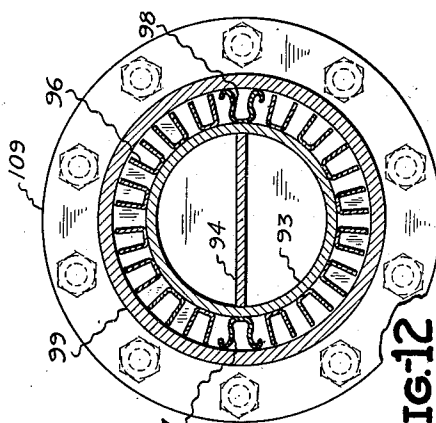


Fig-12

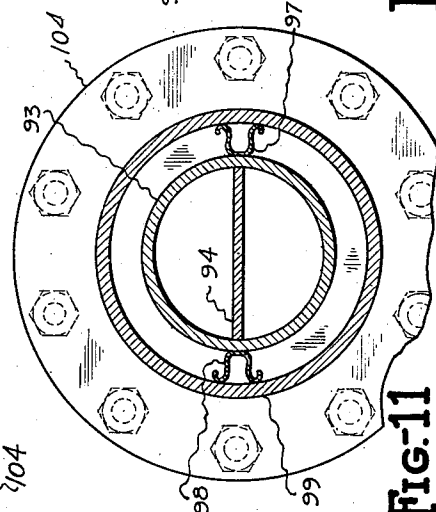


Fig-11

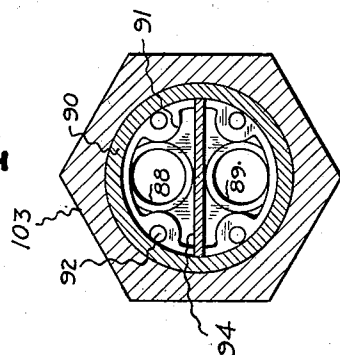


Fig-10

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UNITED STATES PATENT OFFICE

2,362,985

HEAT EXCHANGER

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Application December 24, 1941, Serial No. 424,241

3 Claims. (Cl. 257-246)

This invention relates to heat exchangers and more particularly to heat exchangers particularly adapted to take advantage of the heat transferring capacity of finned tubes such as those described in my Patents Nos. 2,261,136 and 2,261,137, issued November 4, 1941, although other types of heat exchange conductors may be incorporated therein.

A general object of my invention is to provide an efficient heat exchanger which is compact and which can be economically manufactured. Another object is to provide a heat exchanger embodying a finned tube and arranged to utilize the high heat transfer efficiency of the tube. Another object of my invention is to provide a heat exchanger which may be readily cleaned and in which the entire cleaning operation can be carried out from one end of the exchanger. Another object is to provide a heat exchanger which embodies a reduced number of connections and fittings as compared to prior types. A further object is to provide a heat exchanger which can be disassembled for cleaning without requiring that all of the fluid connections to the exchanger be disconnected. Another object is to provide a heat exchanger which can be disassembled for cleaning without disconnecting any of the fluid connections. Another object is to provide such a heat exchanger which embodies the counter-flow principle within and outside of a single tube. A further object is to provide such a heat exchanger which can be adapted to various uses and purposes, and which may be designed to embody various mass-flow characteristics depending upon the service for which the exchanger is intended.

Further objects and advantages of my invention will become apparent from the following description of preferred forms thereof, reference being made to the accompanying drawings wherein Fig. 1 is a longitudinal section through a heat exchanger made according to my invention; Fig. 2 is a transverse section taken along the line 2-2 of Fig. 1; Fig. 3 is a transverse section taken along the line 3-3 of Fig. 1; Fig. 4 is a fragmentary longitudinal section taken on a plane at right angles to the plane of Fig. 1 as indicated by the line 4-4 of Fig. 1; Fig. 5 is a fragmentary section as indicated by the line 5-5 of Fig. 2; Fig. 6 is a longitudinal section through another form of heat exchanger embodying my invention; Fig. 7 is a transverse section taken along the line 7-7 of Fig. 6; Fig. 8 is a transverse section taken along the line 8-8 of Fig. 6; Fig. 9 is a longitudinal section through a third form of

heat exchanger embodying my invention; and Figs. 10, 11 and 12 are transverse sections as indicated by the lines 10-10, 11-11 and 12-12, respectively, of Fig. 9.

Referring to Figs. 1 to 5, a heat exchanger made according to a preferred form of my invention may comprise a header 10, shown here as being a header for a single unit, but which can be constructed to accommodate a number of heat exchanger units. The header may be a forging or casting, and is provided with inlet and outlet openings 11 and 12, respectively, in which the conduits 13 and 14, terminating in conventional flanged couplings, are suitably secured, for example, by welding as shown. The inlet and outlet passageways join to form a central chamber 15 communicating with the interior of the tube 16 which is preferably welded as at 17 into the counter-bored opening 18 in the header. The tube 16 is preferably provided with a plurality of channel section fins 19, preferably of the type more particularly described in my aforesaid patents, to assist in transfer of heat from the commodity within the tube to the commodity on the exterior of the tube. The construction of the fins will be described in greater detail below.

To cause a proper flow of the fluid within the finned tube from the inlet 11 to the outlet 12, an inner tube 20 is disposed within the finned tube 16, the tube 20 being provided with a pair of oppositely disposed fins or baffles 21, engaging the internal surface of the finned tube 16 and thereby dividing the annular space between the interior of the finned tube 16 and the inner tube 20 into two substantially equal arcuate passageways indicated at 22 and 23. The inner tube stops short of the end of the finned tube, leaving a space as at 24, and the ends of both tubes opposite the header are closed, for example, by plates 25 and 26 welded in position. At the opposite end the tube 20 extends beyond the end of the finned tube 16 and into the header, preferably being welded into place within the opening 27 in the boss 28 of the header. The tube 20 and the fins 21 thus function to divide the chamber 15 in half and to separate the inlet and outlet openings so that fluid flowing into the exchanger through the conduit 13 is caused to flow outwardly away from the header through the passageway 22, then around the end of the tube 20 through the space 24, back toward the header through the passageway 23 and out through the discharge conduit 14. The tube 20 is employed to reduce the cross-sectional area of the passageways within the finned tube 16, the tube diameter being selected to pro-

vide the desired annular space to give the proper mass-flow characteristics for the commodities being circulated through the exchanger. As will be described below, the tube is not always necessary or desirable, a flat tongue or baffle being preferred for some purposes.

In order to control the flow of the other commodity or fluid passing through the heat exchanger, a shell tube indicated generally at 29 is provided. The internal diameter of the shell tube is preferably just enough larger than the external diameter of the fins 19 to permit the tubes to be assembled together readily. The assembly thus embodies a number of parallel, longitudinally extending passageways between the shell tube and the finned tube as shown particularly in Fig. 2. At the end adjacent the header the shell tube is provided with a flange 30 which may be bolted to the flat surface of the header as shown in Fig. 3, a gasket 31 being provided to insure the production of a leakproof joint. Near the flange 30 the shell tube is provided with suitable inlet and outlet conduits 32 and 33, respectively, these also being provided with conventional coupling means such as the flanges shown in the drawings.

To provide another, or alternate, means for disassembling the exchanger, the shell tube may be made up of two sections 34 and 35 provided with flanges 36 and 37 which may be secured together by bolts 38, with a gasket 39 interposed to provide a leakproof joint. In order to facilitate breaking the connection between the sections, push bolts 40 as shown in Figs. 2 and 5 may be employed. The end of the section 35 away from the header is closed by any suitable closure member such as the cap 41 welded thereto.

It will be noted that the fins 19 terminate adjacent the ends of the inlet and outlet conduits 32 and 33. To insure the proper flow of fluid through the passageways formed by the fins between the finned tube and the shell tube, the finned tube is provided with a pair of oppositely disposed baffle fins 42 and 43 shown particularly in Figs. 2 and 4 and which extend to the header. These baffle fins function to divide the annular space between the shell tube and the finned tube adjacent the inlet conduit and outlet conduits 32 and 33 into two zones 44 and 45, respectively. Fluid entering the shell tube through the conduit 32 is prevented from flowing directly around the finned tube to the outlet conduit 33 by the baffle fins 42 and 43 and is distributed from the chamber 44 into the passageways formed by the fin members 19 on the lower half of the finned tube as shown in the drawings. The fluid flows out along the fins to the end space 46 and around the end of the finned tube and back through the passageways formed by the upper fins to the discharge chamber 45 and ultimately out the discharge conduit 33. It will be noted that the connections are preferably as shown in the drawings so that the flow of one commodity is counter to the flow of the other commodity.

The baffle fins 42 and 43, as well as the baffle fins 21 on the inner tube 20 are preferably formed with the flanges of the channels bent as at 47, and with the outer edges bent or rolled over as at 48 to provide a resilient structure. With this construction, the baffle fins can be proportioned to resiliently engage the inner surfaces of the respective tubes and thus make sealing connections with the tubes adequate to prevent any substantial "short circuiting" of the fluids in their flow through the exchanger. Further, the

baffle fins assist in centering the tubes with respect to each other.

The construction of the exchanger is such that the channels between the shell tube and finned tube may be made accessible for cleaning either by disconnecting the two sections of the finned tube at the flanges 36 and 37 and removing the section 35, using the push bolts 40 to break any adhesion, if necessary, or by disconnecting the header 10 from the flange 30 of the shell tube and pulling out the finned tube from the inside of the shell tube. If the flanges 36 and 37 are disconnected the cleaning operation can be effected without disturbing any one of the fluid connections, and if the exchangers are arranged in a bank the whole bank of exchangers will be accessible for cleaning from the end opposite the fluid connections. If the connection is broken between the header and the flange 30, then it will be necessary to disconnect the fluid connections to the conduits 13 and 14 or to the conduits 32 and 33, but not to all four of the conduits, and the cleaning operation then can be carried out from either end of the exchanger, depending upon which of the conduits are disconnected. Ordinarily if the exchanger is designed for such an installation the shell tube will be made in one piece, eliminating the flanges 36 and 37 and the connection at this point. If the exchanger is designed for the installation first described above, the flange 27 to which the shell tube is secured may be formed integrally with the header if desired.

To facilitate the handling of the shell tube incident to cleaning operations, I may provide means for supporting the shell tube in alignment with the finned tube so that it may be moved into and out of position with a minimum amount of effort and without any danger of damaging the fins of the finned tube. For example, section 35 of the shell tube may be provided with U-shaped brackets 50 and 51 suitably secured to the exterior of the tube as by welding, and carrying pairs of trolley wheels 52 and 53. The wheels run on the flanges of the I-beam 54 which is supported by any suitable structure, not shown. The I-beam or track 54 extends parallel to the axis of the finned tube and is supported in such a position that there will be clearance between the flange 37 and the I-beam and that the axes of the finned tube and the shell tube will substantially coincide. By this arrangement, one man can readily disassemble a large heat exchanger, handling a heavy shell tube section that may be several feet long. Supporting tracks or trolleys are illustrated in the drawings only with respect to this form of my invention. However, it is to be understood that supporting tracks may be used with the other forms of my invention, and those skilled in the art will appreciate that the supports may be modified to suit the needs of particular situations.

The fins 19 and also the baffle fins, as noted above, are preferably made according to the disclosure of my aforesaid patents, the fins proper being flanges of channel section members, the bases 19a of which are preferably welded to the exterior of the tubes as described in my patents and according to the method described and claimed in my copending application Serial No. 388,835, filed April 16, 1941, now Patent 2,298,250 issued Oct. 6, 1942, to provide adequate paths for the flow of heat from the fins to the tube.

In Figs. 6 to 8 I have illustrated another form of heat exchanger made according to my inven-

tion. In this type of exchanger the header 60 is formed by a plate having openings 61 and 62 therein to receive the inlet and outlet conduits 63 and 64, respectively. These conduits are preferably in the form of 90° bends as shown and are provided with suitable means for making fluid connections such as the coupling flanges illustrated. The conduits are preferably welded into the openings 61 and 62 and the connection between the conduits and the interior of the finned tube 65 is made by bolting the plate 60 to the flange 66 which is welded onto the end of the finned tube. In this modification instead of employing an inner tube as in the previous modification, the fluid is caused to flow out to the end of the finned tube and back again by a baffle or tongue 67 which abuts the plate 60 as at 68 and stops short of the closed end 69 of the finned tube, leaving a passageway 70 around the end of the tongue. Fluid entering the inlet conduit 63 flows out around the end of the tongue 67 and back through the lower half of the finned tube to the discharge conduit 64. This construction is particularly useful where it is not necessary to have a high velocity of flow on the inside of the finned tube. For example, when steam is employed within the finned tube a tongue such as shown in this modification is frequently satisfactory, it being unnecessary to employ an inner tube such as shown in the previous modification.

The heat exchanger shown in Figs. 6 to 8 is also modified in the construction of the shell tube, which is produced from two semi-circular pieces 71 and 72 having inturned flanges 73 and 74, the pieces being welded together as shown at 75 and 76. It will be noted that the inturned flange provides a groove at the juncture of the two pieces, this facilitating arc welding of the parts. The shell tube is secured to the header assembly by a flange 77 welded to the end of the shell tube and bolted to the flange 66 which is, as noted above, welded to the finned tube and bolted to the header plate 60, suitable gaskets being employed where required. Push bolts (not shown) may be employed to assist in breaking these connections if desired. The inlet 78 and the outlet 79 of the shell tube are formed as described above with respect to the inlet 32 and outlet 33.

In this modification the fins 80 on the tube 65 are shown as having their outer edges spaced from the inner surfaces of the shell tube. This arrangement is desirable for some services, particularly where viscous or sticky liquids are circulated through the heat exchangers. By having the fins spaced from the inner surface of the shell tube, there is less likelihood of the finned tube becoming stuck within the shell tube. To prevent fluid from flowing directly around the finned tube from the inlet 78 to the outlet 79, the baffle fins 81 and 82 are employed. These are spring fins of the same general type as described above and engage the inturned flanges 73 and 74 on the interior of the shell tube. This arrangement provides an adequate seal, and further, the fins with their engagement with the flanges 73 and 74 and with the inner surface of the members 71 and 72 act to center the finned tube accurately with respect to the shell tube.

This type of exchanger can be disassembled either by disconnecting the connections to the conduits 63 and 64 and removing the bolts that secure the plate 60 to the flange 66 or by disconnecting the connections to the conduits 78 and 79 and removing the bolts that connect the flange 77 to the flange 66. Except for the changes

noted, the construction is substantially the same as that shown and described with reference to Figs. 1 to 5.

In Figs. 9 to 12 a further modification is illustrated, in which the inlet and outlet connections with the interior of the finned tube are made through a plate 85 having openings 86 and 87 therein to which the inlet and outlet conduits 88 and 89, respectively, are welded, these conduits being generally similar to the conduits 63 and 64 heretofore described. The plate 85 is bolted to the threaded end fitting 90, which is provided with inwardly extending lugs or ears 91 to receive the bolts 92 and is welded to the end of the finned tube 93. The interior arrangement of the finned tube is similar to that described with respect to Figs. 6 to 8 including a baffle or tongue 94 which abuts the plate 85 at one end and is spaced from the closure plate 95 at the other end to provide a passageway. The finned tube is provided with a plurality of fins 96 and oppositely disposed baffle fins 97 and 98, the baffle fins being of resilient construction similar to fins 42 and 43 and engaging the inner surface of the shell tube 99.

In order to support the finned tube within the shell tube the finned tube is provided with a flange 100 welded thereto near the threaded end fitting 90. The end of the finned tube is extended through an opening in the plate 101 and the flange is drawn up tightly against the gasket 102, which abuts the plate, by a large nut 103 which is threaded on the end fitting 90. The shell tube is also supported from the plate 101, being provided with a flange 104 welded to the end thereof and bolted to the flange 101.

The shell tube has inlet and outlet openings 106 and 107 similar to those previously described but instead of having a welded closure at its end, it is provided with a closure plate 108 which is bolted to the flange 109 welded to the end of the shell tube. With this type of construction the exchanger can be disassembled for cleaning either by breaking the connections to the conduits 106 and 107 and loosening the bolts securing the flanges 101 and 104 together, which makes it possible to remove the shell tube from the finned tube; or the plate 85 may be disconnected from the end fitting 90, the nut 103 unscrewed from the end fitting and the end plate 108 removed, thus permitting the finned tube to be removed from the exchanger from the end opposite the fluid connections.

From the foregoing description of preferred forms of my invention it will be seen that I have provided compact heat exchangers which can be economically manufactured. By reason of the counter-flow principle preferably embodied in my exchangers and the arrangement of the tubes and baffles, very efficient heat exchange characteristics are obtained, thus providing exchangers which can take advantage of the high heat transferring efficiency of the preferred form of finned tubes. Further, my heat exchangers are designed so that they can be readily disassembled for cleaning without the necessity of disconnecting any of the fluid connections to the exchanger, or in alternate arrangements only two of the connections need be disconnected. This is particularly important where high pressure commodities are circulated through the exchangers as in such instances it is very difficult to make leak-tight connections and it is desirable to maintain the connections without disturbing them,

even though the exchangers should require cleaning.

The heat exchangers disclosed herein preferably embody finned tubing made according to my application aforesaid; however, it is to be understood that different types of heat exchanger conductors can be employed if desired. Also, features described with respect to any one form of my invention are not necessarily limited in their use to that particular form, but may be employed with other forms of my invention. It is also to be understood that various other changes and modifications can be made in my invention without departing from the spirit and scope thereof and accordingly that my patent is not limited to the preferred forms disclosed herein or in any manner other than by the scope of the appended claims.

I claim:

1. A heat exchanger comprising two concentric tubes with an annular space therebetween, an inlet conduit and an outlet conduit connected to the interior of the inner of said tubes, an inlet conduit and an outlet conduit connected to the annular space between said tubes, all of said conduits being disposed adjacent one end of the heat exchanger, means closing the end of said annular space adjacent said end of the heat exchanger and both of said tubes being closed at the opposite end of said heat exchanger, baffle means within the inner of said tubes dividing it into two longitudinally extending passageways communicating with each other only adjacent the closed end thereof, the inlet conduit for the interior of said inner tube being connected to one of said passageways and the outlet conduit therefor being connected to the other, and baffle means within said annular space dividing said space into two longitudinally extending passageways communicating with each other only adjacent the closed ends of said tubes, the inlet conduit for said annular space being connected to one of said passageways therein and the outlet conduit for said annular space being connected to the other of said passageways therein, both said baffle means lying in the same general longitudinal plane of the heat exchanger.

2. A heat exchange comprising two concentric tubes with an annular space therebetween, an inlet conduit and an outlet conduit connected to the interior of the inner of said tubes, an inlet conduit and an outlet conduit connected to the annular space between said tubes, all of said conduits being disposed adjacent one end of the heat

exchanger, said tubes being detachably secured together adjacent said conduits and both of said tubes being closed at the opposite end of said heat exchanger, baffle means within the inner of said tubes dividing it into two longitudinally extending passageways communicating with each other only adjacent the closed end thereof, the inlet conduit for the interior of said inner tube being connected to one of said passageways and the outlet conduit therefor being connected to the other, said inner tube being provided with a plurality of longitudinally extending external fins, and baffle means within said annular space dividing said space into two longitudinally extending passageways communicating with each other only adjacent the closed ends of said tubes, the inlet conduit for said annular space being connected to one of said passageways therein and the outlet conduit for said annular space being connected to the other of said passageways therein, both said baffle means lying in the same general longitudinal plane of the heat exchanger.

3. A heat exchanger comprising two concentric tubes with an annular space therebetween, an inlet conduit and an outlet conduit connected to the interior of the inner of said tubes, an inlet conduit and an outlet conduit connected to the annular space between said tubes, all of said conduits being disposed adjacent one end of the heat exchanger, said tubes being detachably secured together adjacent said conduits and both of said tubes being closed at the opposite end of said heat exchanger, baffle means within the inner of said tubes dividing it into two longitudinally extending passageways communicating with each other only adjacent the closed end thereof, the inlet conduit for the interior of said inner tube being connected to one of said passageways and the outlet conduit therefor being connected to the other, and baffle means comprising two oppositely disposed longitudinally extending fin members secured to said inner tube and engaging said outer tube dividing said annular space into two longitudinally extending passageways communicating with each other only adjacent the closed ends of said tubes, the inlet conduit for said annular space being connected to one of said passageways therein and the outlet conduit for said annular space being connected to the other of said passageways therein, both said baffle means lying in the same general longitudinal plane of the heat exchanger.

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