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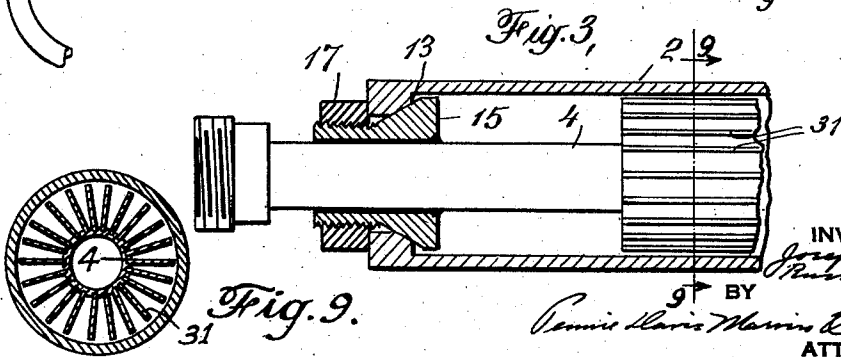
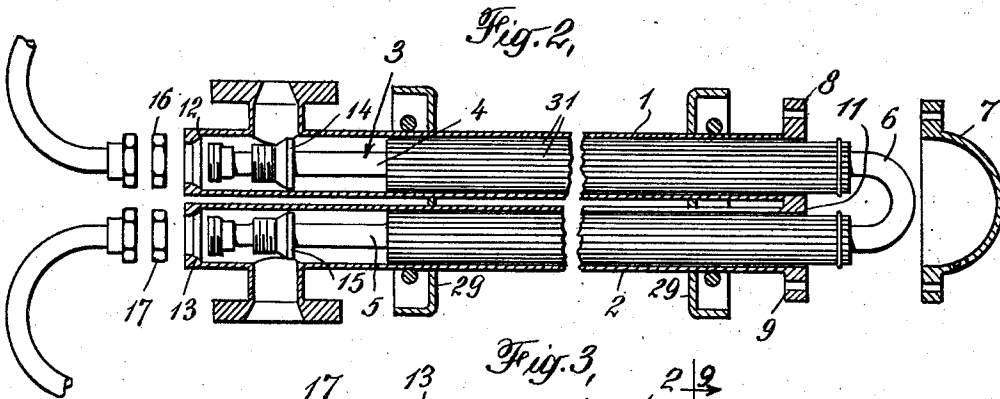
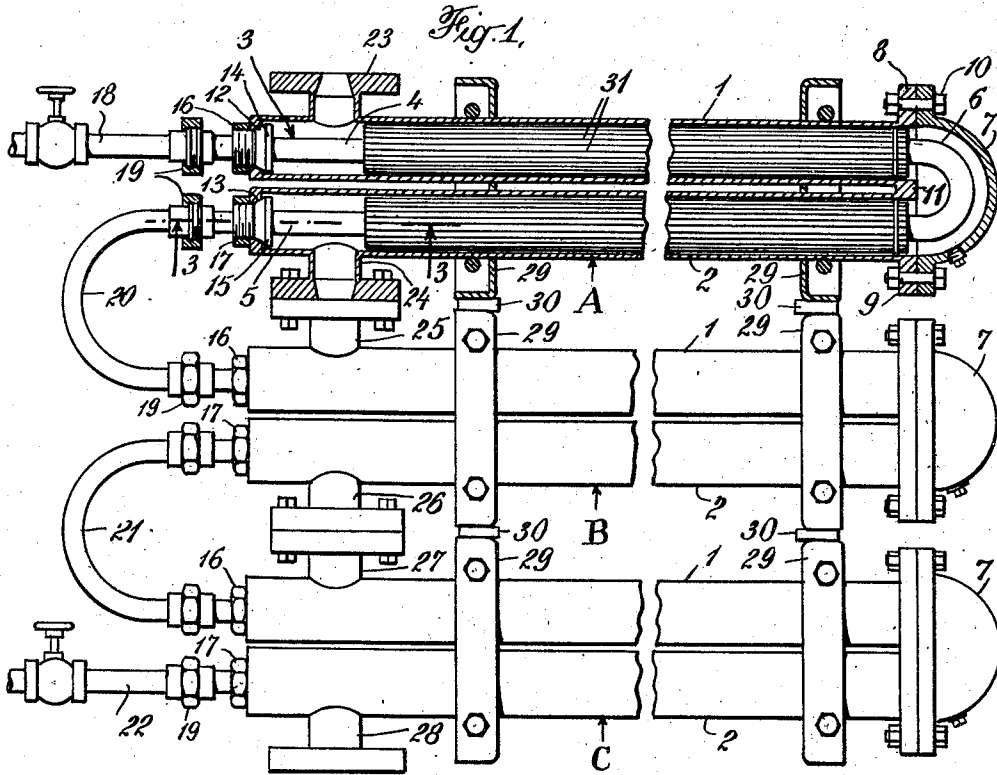
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HEAT EXCHANGER

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2 Sheets-Sheet 1



INVENTORS

Joseph Price
Russell C. Jones

BY

Samuel Harris Morris & Edwards
ATTORNEYS

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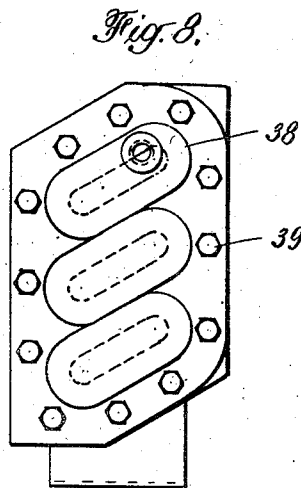
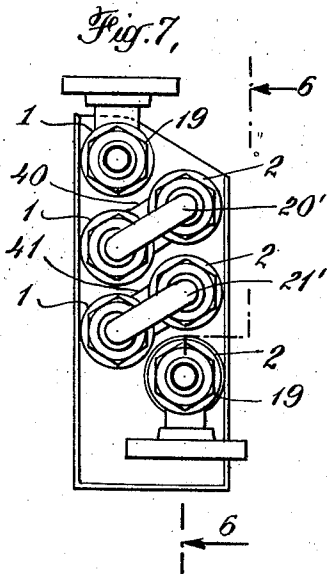
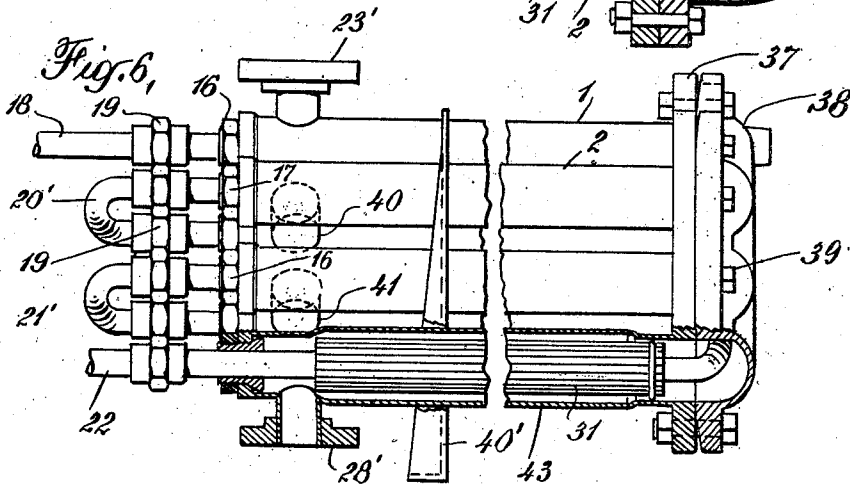
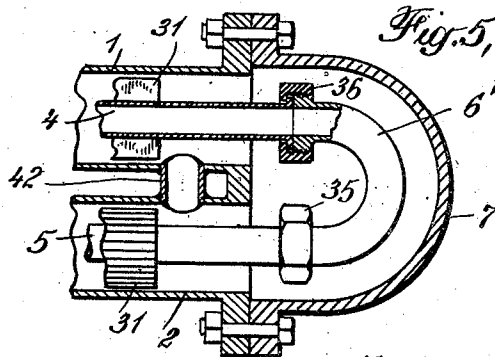
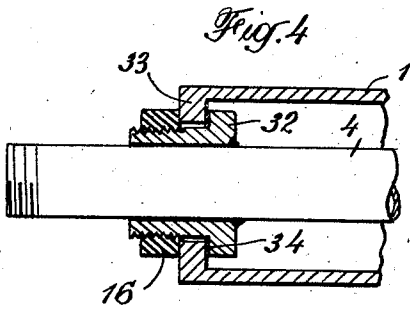
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HEAT EXCHANGER

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2 Sheets-Sheet 2



Joseph Price and Russell C. Jones
BY
Clemens Davis Morris & Edwards
ATTORNEYS

UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Joseph Price, West New Brighton, and Russell C. Jones, Bronxville, N. Y., assignors to The Griscom-Russell Company, New York, N. Y., a corporation of Delaware

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9 Claims. (Cl. 257—247)

This invention relates to heat exchangers and more particularly to that type of heat exchanger in which the hot and cold fluids flow in concentric passages. In such apparatus one fluid flows through a relatively small tube or conduit located inside a larger conduit and heat is transferred from the fluid in one conduit to that in the other conduit through the wall of the inner conduit.

One of the objects of this invention is to provide a heat exchanger of the concentric tube type suitable for use as a high efficiency heat exchanger regardless of the particular purpose for which it is employed, and of a construction such that the parts may be readily assembled at minimum expense. A further object of the invention is to provide a heat exchanger of the type mentioned above in which one of the fluid conduits may be readily opened up for the purpose of making repairs or for cleaning this conduit, without in any way disturbing the other conduit which may continue to carry one of the working fluids. We also contemplate a construction and arrangement of the several parts such that the inner conduit or passage of each heat exchanger unit comprises a U-shaped tube which can be removed from the apparatus as a unit by merely detaching the fluid connections at the ends of the U-shaped tube and removing a housing member which normally encloses the bend of the U-shaped tube.

In general, we provide a heat exchanger including one or more units each consisting of a U-shaped tube having the legs or straight portions thereof extending within a pair of outer tubes whereby concentric fluid passages are formed, the parts being so constructed and arranged that the U-shaped tube may be removed as a unit whenever that becomes necessary. A return bend conduit for the outer tubes may be formed by a detachable housing member inclosing the return bend of the U-tube and a portion of an end flange or tube sheet. This housing member can be removed quite independently of the U-tube, thus permitting free access to the U-tube for the purpose of making repairs or for cleaning the outer passage, all of which may be accomplished without in any way disturbing the flow of fluid through the U-tube. The straight portions of the U-tube are preferably, although not necessarily, provided with longitudinally extending fins whereby the effective heat transferring surface of these tubes is greatly increased. Where such fins are provided we prefer to have them extend into close proximity to the inner surfaces of the outer tubes, thus insuring efficient heat transfer

by preventing any appreciable amount of by-passing of the fluid in the outer tubes out of contact with the heat conducting fins.

The outer fluid passages, whether formed by the inner surfaces of sections of tubing or otherwise, serve to convey one of the working fluids in efficient heat transferring relation to the other fluid which is carried by the U-shaped tube, and it will be understood that the fluid connections for the separate passages may be arranged so that the fluids flow in countercurrent or concurrent relation as may be desired.

Where the outer fluid passages are formed by lengths of tubing, we prefer to provide each tube with an internal flange at one end and with an external flange at the other; and detachable means may be employed for securing the ends of the inner U-shaped tube to the internal flanges of the outer tubes and for securing the above mentioned detachable housing member to the external flanges carried by the other pair of ends of the outer tubes. According to one embodiment of our invention a number of pairs of tubes are secured to a tube sheet and each pair of tubes is adapted to receive the straight portions of a U-tube, the several tubes being provided with connections for supplying separate fluids to the outer tubes and to the inner U-shaped tubes. In this embodiment of our invention a single housing member may be detachably secured to the tube sheet, the housing member being constructed and arranged so as to provide separate return bend passages for the several pairs of tubes secured to the tube sheet. This housing member may be readily removed to provide access to the several U-shaped tubes and to the fluid passages surrounding these tubes.

The various objects and advantages of our invention will be more apparent upon considering certain illustrative embodiments thereof shown in the accompanying drawings in which

Fig. 1 is an elevation of a heat exchanger embodying our invention, the upper portion of the apparatus being shown in section to illustrate details of construction;

Fig. 2 is a vertical section view of one of the heat exchanger elements illustrated in Fig. 1 showing the manner in which the apparatus may be assembled or taken apart;

Fig. 3 is an enlarged section view taken on line 3—3 of Fig. 1;

Fig. 4 is an enlarged section view similar to Fig. 3 but illustrating a modified construction;

Fig. 5 is a fragmentary vertical section view of

a portion of another embodiment of our improved heat exchanger;

Fig. 6 is an elevation of still another embodiment of our invention, the lower part of the apparatus being shown in section on line 6—6 of Fig. 7, to illustrate structural features;

Fig. 7 is a left end elevation of the apparatus shown in Fig. 6 and

Fig. 8 is a right end elevation of the apparatus shown in Fig. 6.

Fig. 9 is a transverse section view taken on line 9—9 of Fig. 3.

The embodiment of our invention illustrated in Figs. 1, 2 and 3 comprises a multiple unit heat exchanger consisting of units A, B and C of identical construction and arranged vertically one above another. Each unit comprises a pair of tubes 1 and 2 of steel or other metal, and a U-shaped tube 3 mounted with its straight portions 4 and 5 extending lengthwise throughout the larger tubes 1 and 2. The bend 6 of the U-shaped tube is enclosed in a housing member 7. The outer tubes 1 and 2 are provided at one end with external flanges 8 and 9 which may or may not be integral with the tubes, as desired, and the housing member 7 is detachably mounted on these flanges by bolts 10, or the like. The flanges 8 and 9 may be regarded as a tube sheet or end plate 11 and it will be noted that this tube sheet 11 and the housing 7 constitute the walls of a chamber in which the return bend 6 is located. This chamber constitutes a return bend passage interconnecting the adjacent ends of the outer tubes 1 and 2. The housing member 7 is entirely independent of the U-shaped tube and accordingly it may be removed without in any way disturbing the U-shaped tube, this being accomplished by merely removing the bolts 10 which normally secure the housing member to the flanges 8 and 9. The other ends of the outer tubes 1 and 2 are provided with internal flanges 12 and 13. The ends of the U-shaped tube are provided with externally threaded bushings 14 and 15 welded or otherwise permanently secured thereto. The internal flanges 12 and 13 and the bushings 14 and 15 have complementary tapered surfaces which form a fluid-tight force-fit joint when the nuts 16 and 17 are tightened on the threaded portions of the bushings 14 and 15 respectively. The straight portion 4 of the U-shaped tube 3 is connected to a fluid discharge pipe 18 by means of an ordinary pipe coupling 19 and in like manner the straight portion 5 of the U-shaped tube is connected to a return bend pipe 20 which communicates with the U-shaped tube in the heat exchanger unit B. A similar end connection 21 interconnects the U-shaped tubes in the units B and C and a fluid supply pipe 22 is coupled to the lower straight portion of the U-shaped tube in the bottom unit C.

The outer pipe 1 of the unit A is provided with a fluid inlet 23 and similar fluid connections 24 and 25 connect the bottom tube 2 to the upper tube 1 of the unit B. In like manner the tubes 2 and 1 of the units B and C respectively are interconnected by the fluid connections 26 and 27 and a fluid outlet 28 communicates with the bottom tube 2 of the unit C. If desired, a number of supports 29 may be mounted on the tubes 1 and 2 of each unit, these supports consisting of angle members bolted together. These supports may be slidably mounted on the tubes 1 and 2 so that they can be adjusted to any desired longitudinal position, and shims 30 may

be inserted between the supports after the apparatus has been assembled.

The U-shaped tubes are preferably, although not necessarily, provided with longitudinal fins 31, and where these fins are employed they preferably extend into close proximity to the inner surfaces of the outer tubes 1 and 2. The use of these fins greatly increases the heat transferring surfaces of the U-shaped tubes.

From the above description it will be understood that fluid entering the straight section 5 of the U-shaped tube flows lengthwise through the apparatus to the return bend 6 and then back through the upper straight section 4 from which it is discharged through the pipe 18. In like manner fluid entering the tube 1 through the inlet 23 flows to the right end of the apparatus and then through the return bend conduit formed by the housing member 7 and the tube sheet 11, and then flows through the tube 2 to the discharge connection 24. The separate fluid may thus flow in countercurrent relation, but, if desired, the flow of one of these fluids may be reversed to provide concurrent flow of these separate fluids through the apparatus.

The advantages of our invention reside particularly in the construction and arrangement of the several parts which facilitate the assembly of the apparatus and the necessary inspection and cleaning of the apparatus after it has been in use for some time. In Fig. 2 the parts are separated to better illustrate the manner in which they can be assembled or taken apart and from this figure it will be apparent that as soon as the detachable connections at the ends of the U-shaped tube have been removed and the housing 7 disconnected from the external flanges 8 and 9 the U-tube 3 can be removed from the tubes 1 and 2 as a unit. Furthermore, if it is merely desirable to gain access to the interior of the outer tubes 1 and 2 without disturbing the connections to the U-shaped tube this may be accomplished by removing the housing member 7. This provides free access to the U-shaped tube the bend of which is then fully exposed.

It will be understood that our invention may be utilized in various forms and accordingly details of construction may be modified without departing from the scope of the invention. For example, in Fig. 4 we have illustrated a form of detachable end connection for the U-shaped tubes which differs from that illustrated in Figs. 1, 2 and 3 in that the bushing and the internal flange 33 are not provided with complementary tapered surfaces but form a joint at substantially right angles to the tubing, a gasket 34 being provided between the opposed surfaces of the joint. The joint may be separated after removing the clamping nut 16 as in the embodiment illustrated in Figs. 1 to 3.

The bend of the U-shaped tube illustrated in Figs. 1 and 2 may be integral with or permanently welded to the straight portions of the U-shaped tube but this feature may be modified as, for example, in the manner illustrated in Fig. 5 where the bend 6' is a separate piece of tubing coupled to the straight portions of the U-shaped tube by ordinary coupling nuts 35 and 36. In some embodiments of our invention and particularly where the interior of the housing member 7 is somewhat obstructed as by the means employed for connecting a separate return bend to the inner tubes it may be desirable to have an additional or separate connection between the

ends of the tubes 1 and 2 for example such as the connection shown at 42 in Fig. 5. Where this feature is employed some or most of the fluid supplied to one of the outer tubes may flow to the other outer tube thru this separate connection in which event the main function performed by the housing member 7 is to provide a fluid-tight seal around the return bend of the inner U-shaped tube. In any event the housing member 7 may be removable quite independently of the U-shaped tube to permit free access thereto.

The embodiment of our invention illustrated in Figs. 6, 7 and 8 is similar to that shown in Figs. 1, 2 and 3 except that all units of the multiple unit heat exchanger have a common tube sheet 37 and a single housing member 38 is mounted on this common tube sheet and provides separate return bend passages for each pair of the outer tubes 1 and 2. It will be understood that these outer tubes each contain the separate straight portions of the U-shaped tubes with the bends of the U-shaped tubes enclosed within the housing member 38. The housing member 38 may be removed by merely removing the bolts 39, thus exposing the bends of the U-shaped tubes. Each U-shaped tube may be then removed as a unit after removing the clamping nuts 16, 17. The units illustrated in Figs. 6, 7 and 8 may be provided with a single supporting member 40'.

In the apparatus illustrated in Figs. 6, 7 and 8 the separate fluids passing through the apparatus may flow in concurrent or countercurrent relation as heretofore described. If the fluid connection 28' is used as an inlet for one of the fluids we prefer to have the outer tube 43 communicating therewith, somewhat enlarged throughout a considerable portion of its length in order to reduce the resistance to the flow of the fluid in this part of the apparatus. This is particularly desirable where the apparatus is used for treating a fluid which is rather viscous at the temperature at which it enters the apparatus. By providing this enlarged outer tube the fluid pressure drop through this part of the apparatus is reduced. It will be understood that fluid leaving this tube 43 is delivered to the next outer tube through the return bend conduit provided in the housing member 38 and then it flows to the next tube through a suitable connection such as that shown at 41. A similar connection 40 is provided between the next pair of outer tubes and the fluid is ultimately discharged through the connection 23' communicating with the uppermost outer tube 1. If one of the fluids passes thru the outer tubes in the manner just described then the other fluid may be supplied to the apparatus so that it flows in the opposite general direction, that is, this second fluid would enter the apparatus through the pipe 18 and be discharged from the apparatus through pipe 22. The ends of the inner tubes may be connected to the pipes 18 and 22 and to intermediate return bends 20' and 21' by means of detachable pipe couplings 19.

In all embodiments of our invention the U-shaped tubes and the larger tubes enclosing the same are arranged to provide concentric fluid passages and each U-shaped tube may be withdrawn as a unit after removing the detachable end connections at the ends of these tubes and after removing the detachable housing enclosing the bends of these tubes. The embodiment of our invention illustrated in Figs. 6 to 8 inclusive provides a very compact arrangement of the several parts and this is partly due to the nesting

of the tubes 1 and 2 in close proximity to each other, as best illustrated in Fig. 7 where it will be noted that the tubes 1 and 2 are not disposed in a vertical plane as in Fig. 1 but define a series of planes at an angle to the vertical.

It is to be understood that our invention is not limited to the details of construction illustrated and described but includes all embodiments falling within the scope of the appended claims.

We claim:—

1. Apparatus of the type described comprising a U-shaped tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby concentric fluid conduits are provided, the said pair of tubes having internal flanges at one pair of adjacent ends thereof, means for detachably connecting the ends of said U-shaped tube to said flanges and a member interconnecting the other pair of adjacent ends of said pair of tubes and enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and disconnecting the ends of said U-shaped tube from said flanges.

2. Apparatus of the type described comprising a U-shaped tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby concentric fluid conduits are provided, said pair of tubes having internal flanges at one pair of adjacent ends thereof and external flanges at the other ends thereof, means for detachably connecting the ends of said U-shaped tube to said internal flanges, a housing member enclosing the bend of the U-shaped tube and means for detachably securing said housing member to said external flanges, said member being removable independently of said U-shaped tube.

3. Apparatus of the type described comprising a U-shaped tube, a pair of bushings permanently secured to the ends of said tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby concentric fluid conduits are provided, said pair of tubes having internal flanges at one pair of adjacent ends thereof, means for detachably clamping said bushings against said flanges, a member interconnecting the other pair of adjacent ends of said pair of tubes and enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and detaching the connections at the ends of said U-shaped tube.

4. Apparatus of the type described comprising a U-shaped tube, a pair of bushings permanently secured to the ends of said tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby concentric fluid conduits are provided, said pair of tubes having internal flanges at one pair of adjacent ends thereof, means for detachably clamping said bushings against said flanges, a member interconnecting the other pair of adjacent ends of said pair of tubes and enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and detaching the connections at the ends of said U-shaped tube, the said bushings and flanges having tapered complementary surfaces providing a force-fit joint therebetween.

5. Apparatus of the type described comprising a U-shaped tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby

concentric fluid conduits are provided, the said pair of tubes having internal flanges at one pair of adjacent ends thereof, means for detachably connecting the ends of said U-shaped tube to said flanges and a member enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and disconnecting the ends of said U-shaped tube from said flanges.

6. Apparatus of the type described comprising a U-shaped tube, a pair of bushings permanently secured to the ends of said tube, a pair of tubes separately enclosing each leg of said U-shaped tube whereby concentric fluid conduits are provided, said pair of tubes having internal flanges at one pair of adjacent ends thereof, means for detachably clamping said bushings against said flanges, a member enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and detaching the connections at the ends of said U-shaped tube.

7. Apparatus of the type described comprising a tube sheet, a plurality of pairs of tubes secured thereto, a plurality of U-shaped tubes each having its straight portions disposed in the separate tubes of each pair of tubes secured to the tube sheet, detachable fluid connections for the ends of said U-shaped tubes, a manifold housing member enclosing the bends of the U-shaped tubes to form a separate return bend conduit for each pair of tubes secured to the tube sheet and means for detachably securing said housing member to said tube sheet whereby said member is removable independently of said U-shaped tubes.

8. Apparatus of the type described comprising a pair of tubes, a U-shaped tube having the straight portions thereof positioned in said pair of tubes whereby concentric fluid conduits are provided, the ends of said U-shaped tube projecting beyond one pair of adjacent ends of said

pair of tubes, means for forming a tight joint between said ends of said pair of tubes and the straight portions of the U-shaped tube, fittings for the ends of the U-shaped tube having a diameter smaller than the inside diameter of said pair of tubes, said fittings being located beyond said ends of said pair of tubes, detachable fluid connections for connecting with said fittings, and a member interconnecting adjacent ends of said pair of tubes and enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and detaching said fluid connections from said fittings.

9. Apparatus of the type described comprising a pair of tubes, a U-shaped tube having the straight portions thereof positioned in said pair of tubes whereby concentric fluid conduits are provided, a plurality of longitudinally extending heat conducting fins carried by the straight portions of said U-shaped tube and extending into close proximity to the inner surfaces of said pair of tubes, the ends of said U-shaped tube projecting beyond one pair of adjacent ends of said pair of tubes, means for forming a tight joint between said ends of said pair of tubes and the straight portions of the U-shaped tube, fittings for the ends of the U-shaped tube having a diameter smaller than the inside diameter of said pair of tubes, said fittings being located beyond said ends of said pair of tubes, detachable fluid connections for connecting with said fittings, and a member interconnecting adjacent ends of said pair of tubes and enclosing the bend of the U-shaped tube, said member being removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said member and detaching said fluid connections from said fittings.

JOSEPH PRICE.
RUSSELL C. JONES.