

Sept. 8, 1936.

J. PRICE ET AL

2,053,780

HEAT EXCHANGER

Filed June 8, 1935

2 Sheets-Sheet 1

Fig.1.

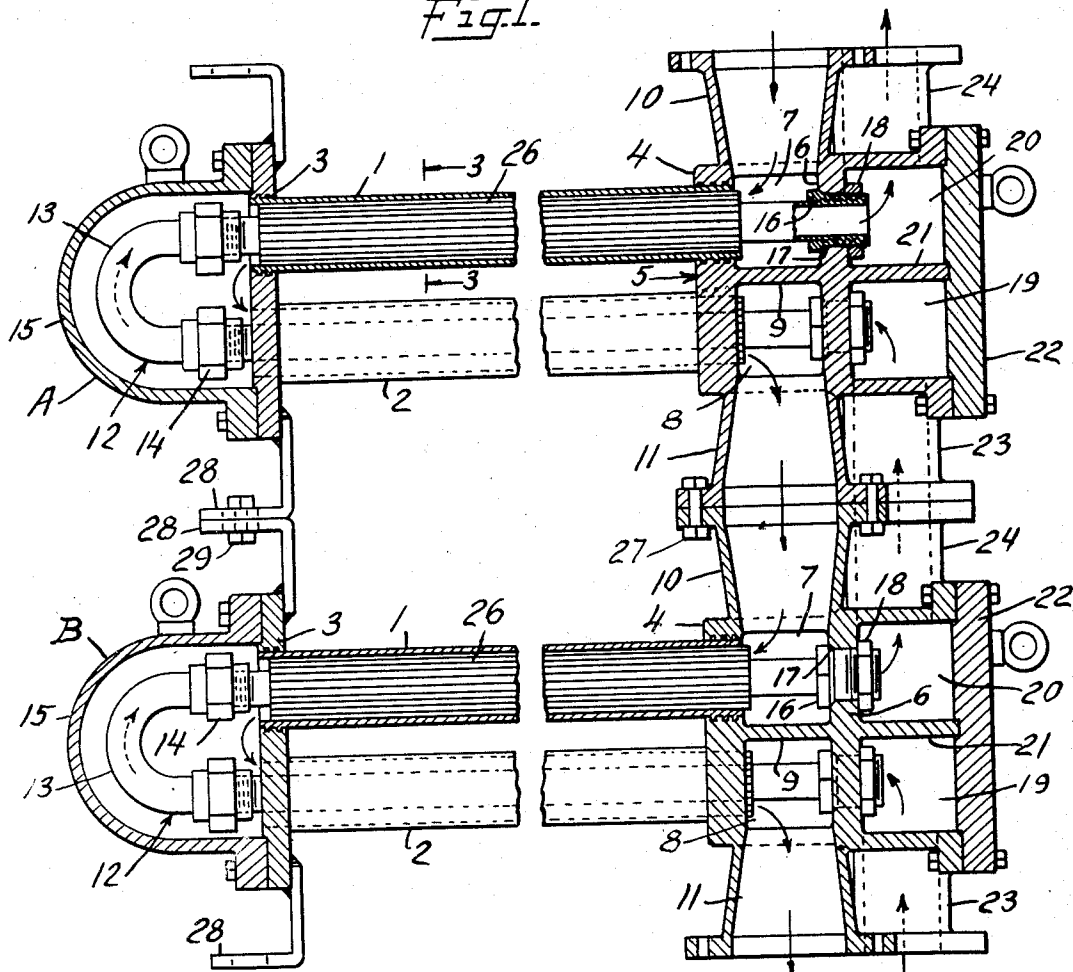
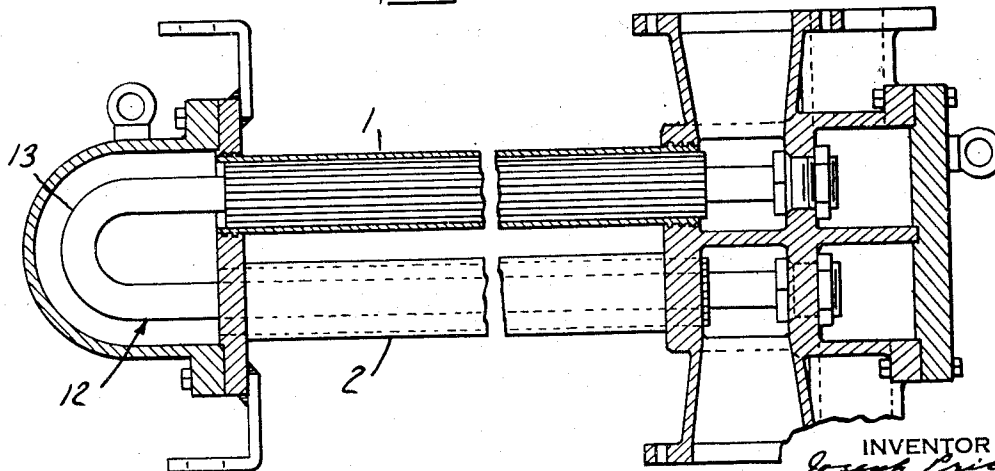


Fig. 4.



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2 Sheets-Sheet 2

Fig. 2.

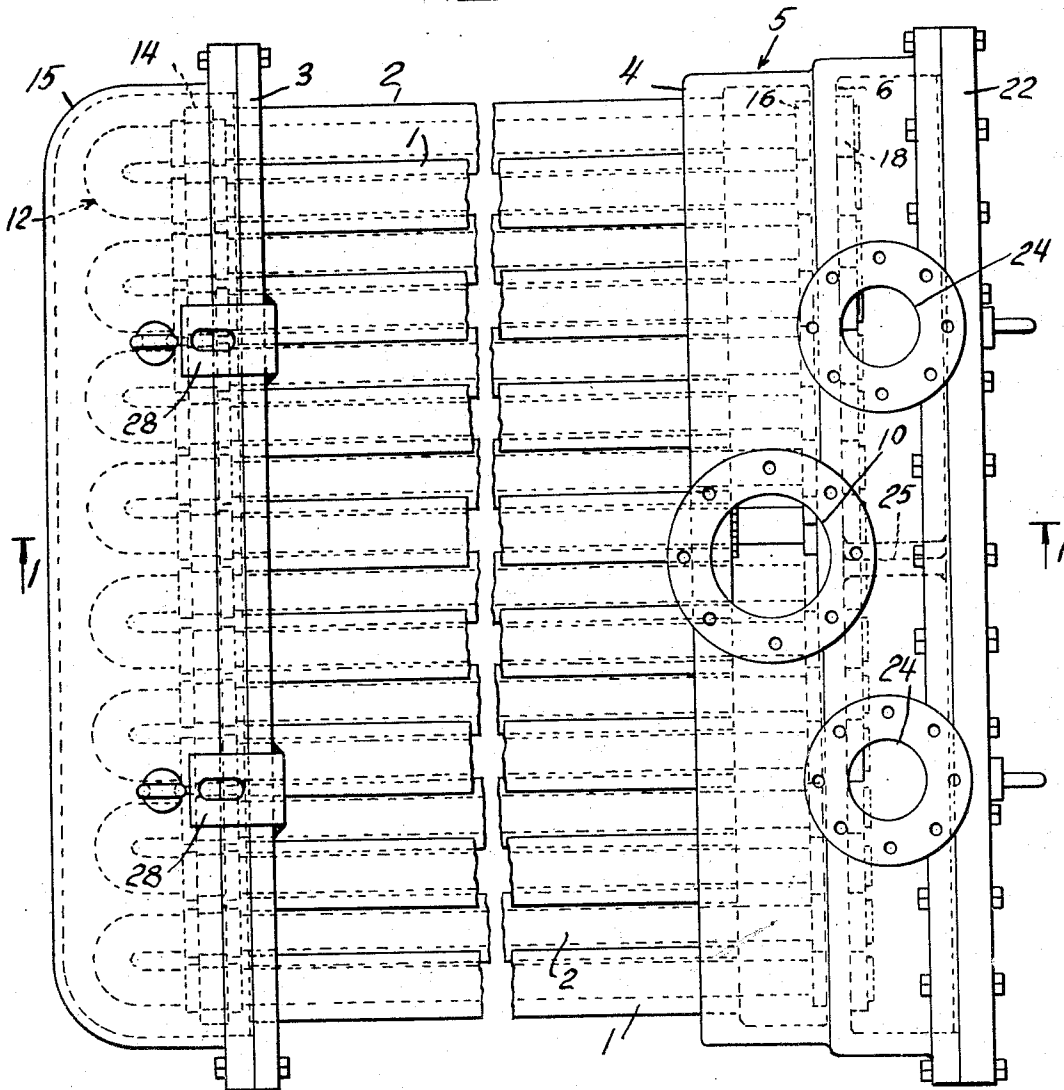
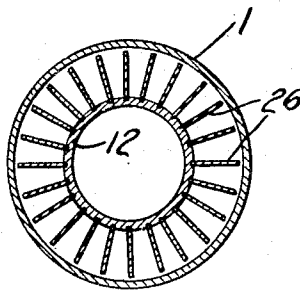


Fig. 3.



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

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Application June 8, 1935, Serial No. 25,638

10 Claims. (Cl. 257—247)

This invention relates to improvements in heat exchangers of the type in which the passages for the separate fluids are provided by one or more U-shaped tubes each leg of which is enclosed within an outer tube and in which both sets of tubes are secured in a header. An object of the invention is to provide efficient apparatus of this type in which all of the parts are readily accessible for inspection and cleaning purposes. A specific object of the invention is to provide such apparatus in which the U-shaped tube or tubes may be readily withdrawn from the outer tubes without injuring the U-shaped tubes in any way or taking them apart. A further object of the invention is to provide such apparatus in which the passage for any one fluid may be readily opened up for inspection and cleaning, without interrupting the flow of the fluid or fluids supplied to other parts of the apparatus. The invention contemplates a construction and arrangement of the several parts such that any desired number of units may be assembled to provide a heat exchanger of any desired capacity.

In general, the invention comprises a header having a front wall in which one or more pairs of outer tubes are mounted and a rear wall to which the ends of U-shaped tubes, extending within the outer tubes, are detachably secured. The bends of the U-tubes are enclosed within a cap which is removable independently of the U-tubes whereby each U-tube may be removed as a unit after removing this cap and detaching the ends of the U-tube from the rear wall of the header. The cap enclosing the bends of the U-tubes may serve as a return connection for the outer tubes, or, if desired, some other return connection may be provided. The header may be provided with a pair of compartments between the front and rear walls above referred to, one compartment serving to direct fluid into one of the outer tubes and the other compartment serving to receive fluid discharged from the other outer tube. If desired, the header may have an additional pair of compartments or chambers for receiving the fluid supplied to the U-shaped tubes. Suitable inlets and outlets are provided for the several compartments in the header and these fluid connections are preferably arranged so that a number of the units may be stacked one above another with the fluid outlets of one unit communicating with the fluid inlets of adjacent units. The detachable connections for the ends of the U-shaped tube preferably comprise bushings permanently secured

to the ends of the tubes and having shoulders engaging the front face of the rear wall and having threaded portions extending beyond the other face of this wall and adapted to receive nuts which can be tightened to clamp the bushings firmly against the rear wall. If the header is provided with a pair of chambers communicating with the U-shaped tubes these chambers are preferably sealed by means of a detachable cover plate which can be readily removed to permit access to these chambers and to the interior of the U-shaped tubes.

In order to insure the most efficient transfer of heat between the separate fluids the U-shaped tubes are preferably provided with longitudinally extending fins which may extend into close proximity with the inner surfaces of the outer tubes. This greatly increases the effective heat transferring surface of the inner tubes.

Our improved apparatus may be employed wherever it is necessary to effect an exchange of heat between two or more fluids and it is particularly useful in the oil refining industry where frequent cleaning of some or all of the fluid passages is essential in order to remove accumulated deposits which would otherwise seriously impair the efficiency of the apparatus. The separate fluids may be passed through the apparatus in concurrent or countercurrent relation as may be desired. In some instances it may be desirable to supply the hot fluid to the outer tubes and to supply one or more cold fluids to the inner U-shaped tubes and to spray a cold fluid over the outer surfaces of the outer tubes. In this manner the hot fluid may be readily cooled by transfer of heat through the walls of the outer tubes and through the walls of the inner tubes.

The various objects and advantages of our invention will be more apparent upon considering the following detailed description of certain embodiments of the invention illustrated in the accompanying drawings in which

Fig. 1 is a vertical section view (taken on line 1—1 of Fig. 2), of one form of apparatus embodying our improvements;

Fig. 2 is a plan view of the apparatus shown in Fig. 1;

Fig. 3 is an enlarged transverse section view of a portion of the apparatus shown in Figs. 1 and 2, Fig. 3 being taken on line 3—3 of Fig. 1;

Fig. 4 is a vertical section view of another embodiment of our invention.

The apparatus illustrated in Figs. 1, 2 and 3 of the accompanying drawings comprises two

superimposed heat exchanger units A and B. Each unit includes a series of pairs of outer tubes 1 and 2 secured at one end to a tube sheet 3 and at the other end to the front wall 4 of a header 5. The outer tubes may be expanded into grooved openings in the tube sheet 3 and in the header, or otherwise permanently secured to these supporting members. Each header 5 has what may be characterized as a rear wall or partition 6, the header being constructed so as to provide a pair of chambers 7 and 8 between the front and rear walls 4 and 6. These chambers are separated by a partition 9. A fluid inlet 10 communicates with the chamber 7 and a fluid outlet 11 communicates with the chamber 8.

The tubes 1 and 2 of each pair of outer tubes separately enclose the legs of a U-shaped tube 12 having a return bend 13, either detachably connected to the leg portions as by couplings 14, or integral therewith as shown in Fig. 4.

An end cap 15 bolted or otherwise detachably secured to the tube sheet 3 encloses all of the bends of the several U-shaped tubes in each unit and it may serve as a means for interconnecting the several outer tubes 1 with the several outer tubes 2, thus providing a return bend conduit for these outer tubes.

The ends of the several U-shaped tubes are detachably mounted in the header 5 of each unit and preferably by means cooperating with the rear wall or partition 6. The end of each U-shaped tube may be provided with a bushing 16 having a shoulder 17 engaging a portion of the front face of the rear wall 6 and the bushing may have a portion extending through an opening in this rear wall and externally threaded to accommodate a nut 18 whereby the bushing may be clamped firmly in place with its shoulder 17 resting against the front face of the wall 6. The bushings 16 may be secured to the ends of the U-shaped tubes in any suitable manner, for example, by expanding the ends of the tubes into the bushings. The inner surface of each bushing may be provided with a series of grooves so that when the expanding operation is performed the metal of the tube will be pressed into these grooves, thus permanently bonding the bushings to the ends of the tubes. The bushings are of smaller diameter than the inside diameter of the outer tubes 1 and 2 and accordingly each U-shaped tube may be removed as a unit from the pair of outer tubes associated therewith by merely removing the end cap 15 and disconnecting the ends of each U-shaped tube by removing the nuts 18.

The header 5 of each unit is preferably, although not necessarily, constructed so as to provide a second pair of chambers such as those shown at 19 and 20, these chambers being separated by a partition 21. These chambers are normally closed by a cover plate 22 bolted or otherwise detachably secured to the body portion of the header. The chamber 19 may serve as a fluid inlet chamber for the U-shaped tubes and fluid may be supplied to chamber 19 through one or more inlets 23. In like manner the chamber 20 may serve as a fluid outlet for the U-shaped tubes, the fluid being discharged from the chamber 20 through suitable connections 24. We have illustrated two such outlet connections 24 and it will be understood that a similar number of inlet connections 23 may be employed. If desired, a partition 25 may be provided dividing each of the chambers 19 and 20 into two separate compartments each of which communicates with a fluid inlet 23 and with a

fluid outlet 24. This makes it possible to supply two separate fluids to the U-shaped tubes.

The leg portion of each U-shaped tube may be provided with longitudinally extending fins 26 which may be attached to these tubes in any suitable manner. We prefer to mount the longitudinal fins in grooves in the external surface of the U-shaped tubes with the edges of the grooves crimped against the base portion of each fin. This provides an efficient bond between the fins and the tubes and insures efficient heat transfer. The fins serve to increase the effective heat transferring surface of the U-shaped tubes and it is desirable to have the fins substantially fill the space between the inner tubes and the outer tubes so that the fluid passing through the outer tubes will come in intimate contact with the fins as it passes through the outer tubes. Enough clearance should be provided between the fins and the inner surfaces of the outer tube so that the U-shaped tubes may be readily inserted in the outer tubes.

In Fig. 1 the arrows show the flow of the separate fluids through the heat exchanger units with the fluids flowing in countercurrent relation. It will be understood however that the connections for supplying one of the fluids may be reversed so that the fluids flow in concurrent relation. As shown in Fig. 1, one of the fluids is supplied to the inlet 10 from which it flows into the manifold chamber 7 which supplies the fluid to the several outer tubes 1. From the outer tubes 1 this fluid is discharged into the end cap 15 which delivers the fluid into the series of outer tubes 2 and from these tubes the fluid is discharged into the chamber 8 and this fluid then passes through the outlet 11. The other fluid is supplied to the chamber 19 through the inlet or inlets 23 and from the chamber 19 this fluid flows through the lower sections of the several U-shaped tubes then through the return bends 13 to the upper sections of these tubes. This second fluid is then discharged into the chamber 20 and flows out through the outlets 24. The fluid inlets and outlets for the headers are preferably arranged so that several units may be stacked one above another with the inlets for one unit registering with the outlets for the adjacent units. The units A and B shown in Fig. 1 are arranged in this manner and it will be noted that the outlet 11 of unit A communicates with the inlet 10 of unit B and the outlets 24 of unit B communicate with the inlets 23 of unit A. These connections may be bolted together as shown at 27. Where several units are arranged in this manner brackets 28 may be provided on the tube sheets 3, the brackets being provided with slots for receiving bolts 29, whereby the brackets may be fastened together. The brackets may be welded or otherwise permanently secured to the tube sheets and it will be understood that the brackets serve as a supporting means for the several tube sheets and the parts associated therewith. The several brackets 28 with the slotted bolt holes therein provide sufficient flexibility to accommodate any unequal expansion of the several units.

The apparatus illustrated in Fig. 4 is the same as that shown in the other figures except for the fact that the U-shaped tube 12 has an integral bend 13 instead of a separate return bend connected to the leg portions by couplings, or the like.

As stated above, our improved apparatus can be used for a variety of purposes. One particularly advantageous use of the apparatus is for

cooling a fluid supplied to the outer tubes, the cooling media being supplied to the U-shaped tubes and also to the outer surfaces of the outer tubes. Where several units are arranged in superimposed relation a cooling fluid, for example, water, may be sprayed down over the external surfaces of the outer tubes, this cooling fluid coming in contact with the several series of the outer tubes of the superimposed units.

All parts of the apparatus are readily accessible for cleaning and making repairs and it is entirely feasible to open up any one series of passages for such purposes without interrupting the supply of the fluid supplied to the other passages. For example, by removing the cover plates access is provided to the U-shaped tubes and by merely removing the caps access is provided to the interiors of the outer tubes. Each pair of inner tubes may be removed as a unit by disconnecting the connections at the ends of these tubes and removing the cap.

It is to be understood that our invention is not limited to the particular embodiments illustrated and described but includes such modifications thereof as fall within the scope of the appended claims.

We claim:—

1. Apparatus of the type described comprising a header, a U-shaped tube, means for detachably securing the ends of said tube to the header, a pair of tubes secured to said header and separately enclosing each leg of said U-shaped tube and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube, whereby the same may be withdrawn as a unit from said pair of tubes after removing said cap and disconnecting the ends of said U-shaped tube from said header.

2. Apparatus of the type described comprising a header having a front wall and a rear wall and a pair of chambers therebetween, a U-shaped tube, means for detachably securing the ends thereof to said rear wall, a pair of tubes secured to said front wall and communicating with said pair of chambers, said pair of tubes separately enclosing each leg of said U-shaped tube, and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube, whereby the same may be withdrawn as a unit from said pair of tubes after removing said cap and disconnecting the ends of said U-shaped tube from said rear wall.

3. Apparatus of the type described comprising a header having two pairs of chambers therein and a partition separating said pairs of chambers, a U-shaped tube, means for detachably securing the ends of said tube to said partition, a pair of tubes secured to said header and communicating with one pair of chambers therein, said pair of tubes separately enclosing each leg of said U-shaped tube, and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube whereby the same may be withdrawn as a unit from said pair of tubes after removing said cap and disconnecting the ends of said U-shaped tube from said partition.

4. Apparatus of the type described comprising a header having a front wall and a rear wall and a pair of chambers therebetween, a U-shaped tube, a bushing secured to each end of said U-shaped tube each bushing having a shoulder engaging the front face of said rear wall, means for detachably securing said bushings to

said rear wall, a pair of tubes secured to said front wall and separately enclosing each leg of said U-shaped tube and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube.

5. Apparatus of the type described comprising a header having a front wall and a rear wall and a pair of chambers therebetween, a U-shaped tube, a bushing secured to each end of said U-shaped tube, each bushing having a shoulder engaging the front face of the rear wall and a threaded portion extending through said wall, nuts engaging said threaded portions for securing said bushings to said rear wall, a pair of tubes secured to said front wall and communicating with said pair of chambers, said pair of tubes separately enclosing each leg of said U-shaped tube, and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube.

6. Apparatus of the type described comprising a header, a plurality of U-shaped tubes, means for detachably securing the ends of said tubes to the header, a plurality of pairs of tubes secured to said header with the tubes of each pair separately enclosing each leg of each of said U-shaped tubes and a single detachable cap enclosing the bends of the several U-shaped tubes and removable independently thereof, whereby each U-shaped tube may be withdrawn as a unit from the pair of tubes enclosing the same, after removing said cap and disconnecting the ends of said U-shaped tube from said header.

7. Apparatus of the type described comprising a pair of headers each having a front wall and a rear wall with a pair of chambers therebetween, a fluid inlet for one chamber of each header and a fluid outlet for the other chamber thereof, a U-shaped tube for each header, means for detachably securing the ends of the U-shaped tubes to the headers, a pair of tubes secured to each header and separately enclosing each leg of each of said U-shaped tubes and detachable caps enclosing the bends of the U-shaped tubes and removable independently of said U-shaped tubes, said headers being arranged so that the fluid inlet of one header communicates with the fluid outlet of the other header.

8. Apparatus of the type described comprising a header having a front wall and a rear wall and a pair of chambers therebetween, a pair of tubes secured to said front wall and communicating with said pair of chambers, a U-shaped tube extending within said pair of tubes and having longitudinally extending fins extending substantially across the space between the U-shaped tube and the inner surface of said pair of tubes, detachable means for securing the ends of said U-shaped tube to said rear wall, and a detachable cap enclosing the bend of the U-shaped tube and removable independently of said U-shaped tube.

9. Apparatus of the type described comprising a header having two pairs of chambers therein and a partition separating said pairs of chambers, a plurality of U-shaped tubes, means for detachably securing the ends of said tubes to said partition, a plurality of pairs of tubes secured to said header and communicating with one pair of chambers therein, the tubes of each of said pairs separately enclosing each leg of one of said U-shaped tubes, a partition dividing each chamber of one of said pairs of chambers into a plurality of compartments, means for supplying

separate fluids to two of said compartments and for discharging the separate fluids from the other compartments, the said compartments being in communication with said U-shaped tubes and a detachable cap enclosing the bends of the U-shaped tubes and removable independently thereof.

10. Apparatus of the type described comprising a plurality of units each unit including a header,

a tube sheet, a pair of tubes secured to the header and tube sheet and a U-shaped tube extending within said pair of tubes and communicating with the header; means for securing the headers together in superimposed relation and flexible supporting means interconnecting the tube sheets to accommodate unequal expansion of the units.

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