May 20, 1930. W. LONSDALE 1,759,582

HEAT EXCHANGER

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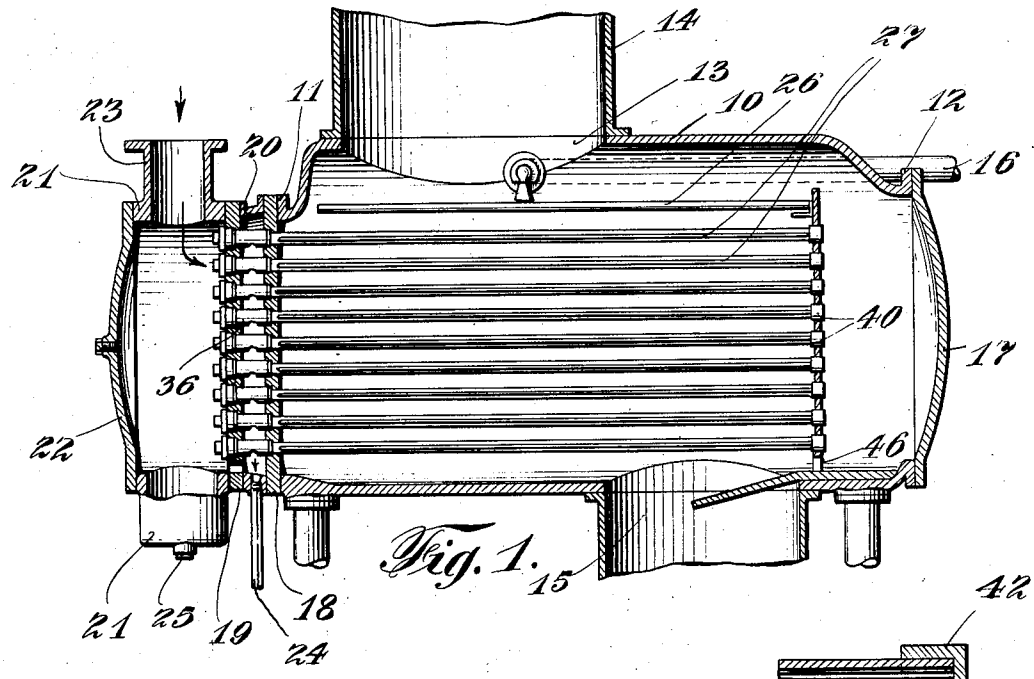


Fig. 1.

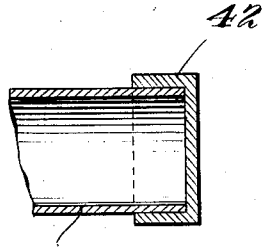


Fig. 8.

Fig. 2.

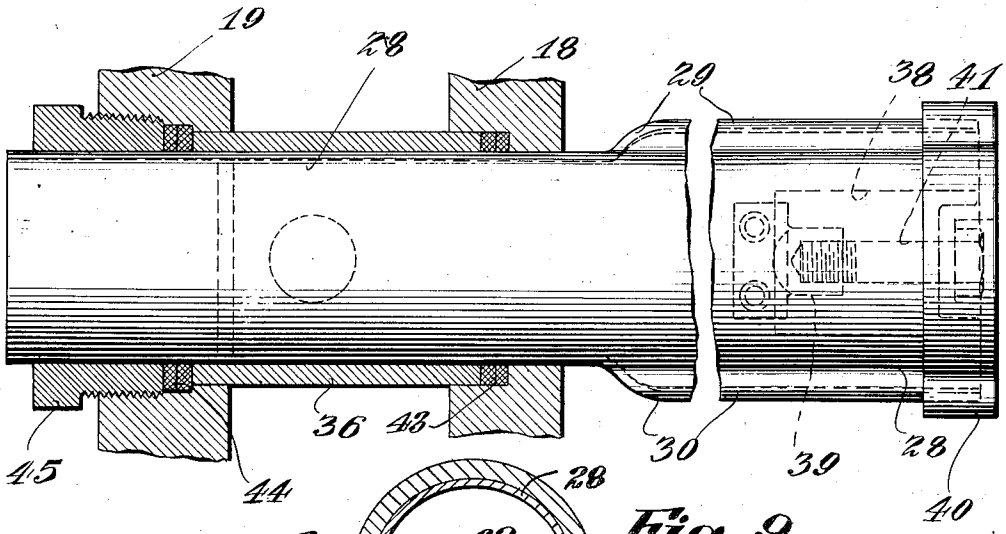
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Fig. 3.



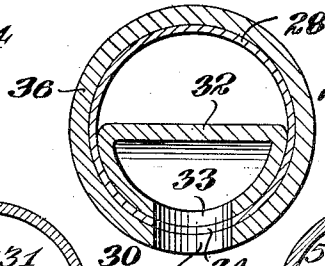


Fig. 9.

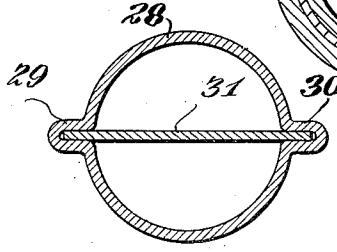


Fig. 4

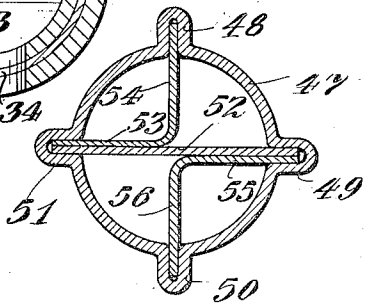


Fig. 5.

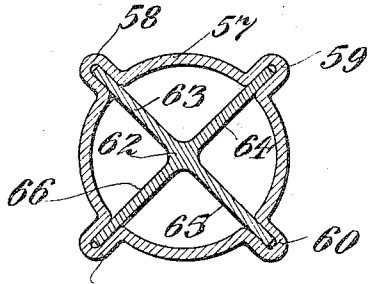


Fig. 6.

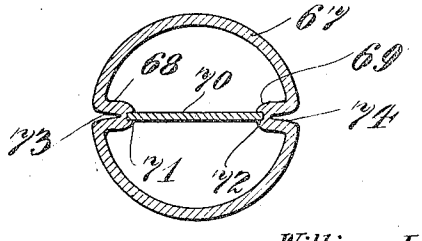


Fig. 7

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Patented May 20, 1930 1,759,582

UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Application filed January 24, 1928. Serial No. 248,990.

This invention relates to a heat exchange apparatus, particularly of the type utilized as evaporators, and the invention more particularly relates to the tube structure employed in such devices. Heretofore in certain types of evaporators it has been customary to employ sets of tubes arranged in a shell or casing in such a manner that steam or other heating mediums may be passed through the tubes and the substance to be evaporated is circulated and re-circulated to and through the shell. Such a structure is commonly employed in evaporators of both the submerged and the film type. The heater tubes in these evaporators are customarily employed in pairs connected at corresponding ends in a tube plate, and at the other ends by return bends, the steam being admitted at one end and drained from the corresponding adjacent end of the return tube in a space between the tube sheets provided for this purpose. This construction necessitates brazing the necessary connection to form a return bend, and it also necessitates the expansion of the open ends of the tubes in the tube plates.

In carrying out the present invention the object thereof is the provision of a single tube to perform substantially the same work as the double or return tube structure as heretofore employed. To this end the tube to which the invention particularly relates is provided with a partition wall dividing the interior thereof into a plurality of passages, into one or more of which the heating medium may be conducted and from one or more of which this heating medium after doing its work may be drained. In addition to the single tube performing substantially the same work as the double or return tube it also materially lessens the cost of manufacture in forming and assembling the parts of the apparatus because of the elimination of the brazed joints at the return end of the tubes and also the expansion of the tubes at their open ends in the tube plates. A tube made in accordance with my invention and an evaporator in which the same is adapted for use will be hereinafter more particularly described.

In the drawing Figure 1 is a central longitudinal section illustrating an evaporator fitted with tubes made in accordance with this invention,

Figure 2 is an enlarged section illustrating the construction of the tube and the manner in which the same is connected in the tube plates,

Figure 3 is a view similar to Figure 2 with the parts illustrated in a position 90° from that shown in Figure 2,

Figure 4 is a transverse section of one form of tube,

Figure 5 is a transverse section of another form of tube,

Figure 6 is a transverse section of still another form of tube,

Figure 7 is a transverse section of a fourth form of tube,

Figure 8 is a section at one end of a tube showing a modified form of cap therefor and Fig. 9 is a section on line 9—9, Fig. 2.

The tube structure to which the present invention more particularly relates is especially adapted for use in an evaporator although, as will be understood, it may be utilized for other purposes, that is, the tube is not specifically limited to use in an evaporator. As illustrated I have shown an evaporator comprising a shell 10 which may be of a suitable transverse cross-section and is provided at its ends with flanges 11 and 12. In a suitable position in the body of the shell there is an opening 13 for the escape of the vapors which may leave the same by way of a pipe 14 or otherwise to be conveyed to a condenser or other apparatus. Also in a suitable position the body of the shell is provided with an opening 15 for the outlet of the unevaporated liquid under treatment which may pass through this opening into a suitable reservoir from which, by a pump or otherwise, it may be circulated through a pipe 16 to the interior of the shell.

At one end of the shell there is a cover 17 which by bolts or otherwise is adapted to be connected to the flange 12. At the opposite end of the shell there are tube plates 18 and 19 spaced by a suitable box 20. At this end of the apparatus there is also a box 21 and

a cover or bonnet 22 therefore. The box 21 is provided with a nozzle 23 for the inlet of steam or other suitable heating mediums, while the box 20 is provided with a drain outlet 24, and the box 21 with a plugged tap 25 by which it may also be drained when necessary. It will be understood that the tube plate 18 is secured in position between the flange 11 and the box 20 by bolts or other suitable means, and also that the tube plate 19 is similarly secured between the boxes 20 and 21, while the cover 22 is suitably connected to the box 21. Within the shell there is a distributing plate 26 placed above the banks of tubes 27 for receiving and spreading the fluid to be evaporated.

Each of the tubes is preferably constructed in a similar manner and for this reason a single tube will be described in detail. Each of these tubes comprises a cylindrical body 28. In suitable positions, preferably diametrically opposite, the body of the tube is provided with longitudinal flanges 29 and 30 extending for a pre-determined distance from one end of the tube toward the opposite end thereof. These flanges may be formed by first drawing the tube to form a cylindrical body and then drawing the tube through another set of dies to provide the flanges therein. These flanges are so formed as to be adapted to receive in the spaces between the parts thereof a partition wall 31. This partition wall may be secured in position between the flanges by forcing the material forming the flanges on the adjacent portions of the partition wall by a suitable press or otherwise so as to form a joint sufficiently tight for working purposes. Adjacent one end of the tube the same is provided with a fitting 32. This fitting may be made in any suitable manner and is placed and secured in a tube while the same is being formed. This fitting is adapted to conform to a portion of the wall of the tube for approximately half the circumference thereof and is also constructed to provide a wall which extends diametrically across the tube, that is, the fitting is semicircular in transverse section. By this structure a chamber or compartment is provided by having one end of the fitting closed. Adjacent the closed end of the fitting there is a port 33 therein. The fitting is so placed in the tube that the port 33 registers with an opening 34 in the tube and also with an opening or port 35 in a spacer sleeve 36 to which reference will hereinafter be further made. The end of the transverse wall of the fitting is formed with a head 37 recessed to receive one end of the partition wall 31 which may be secured therein by any suitable means. The opposite end of the partition wall is preferably notched, as indicated at 38, and fitted with a socket member 39, which may be connected thereto in any suitable manner and preferably in a position centrally disposed relatively to the tube. At this end of the tube the same may be provided with a cap or cover 40 which is fitted with a bolt 41 adapted to pass through the cap 40 and to be turned down in the socket so that this end of the tube is closed, any suitable packing means being employed to accomplish this purpose. As will be understood the cap 40 may be readily removed for the purpose of cleaning the tube. This may not be necessary when the tube is used in an evaporator and steam is employed as a heating medium in which instance, as shown in Figure 8, a cap 42 may be brazed or otherwise permanently connected to this end of the tube.

As illustrated in Figures 2 and 3 the tube as hereinbefore described is fitted in apertures provided therefor in the tube plates 18 and 19 through both of which and the intervening chamber in the drain box 20 this end of the tube passes. The apertures in the tube plates are so formed that in the tube plate 18 provision is made for the use of packing washers 43 and the end of the spacer sleeve 36, whereas similar provision is made in the tube plate 19 for packing washers 44, the other end of the spacer sleeve 26, and also for the reception of a nut 45 which may be turned down into the tapped opening provided therefor in this tube plate to make tight joints between the tube and the tube plates.

As will now be understood, steam, for example, may be admitted through the nozzle 23 to the steam space or chamber in the box 21, and that the steam will pass in the direction indicated by the arrows, first into the space between the upper portion of the fitting 32 and the partition wall 31 and then through the opening provided by the notched portion 38 of the partition wall to the space beneath the partition wall and the lower side of the tube, from which the condensate and that portion of the steam which may remain uncondensed are drained through the apertures or ports 33, 34 and 35 to the drain chamber within the box 20 and thence by way of the outlet 24 from the apparatus. It will also be understood that at the tube plate ends the tubes are adequately supported therein, while at their opposite ends any suitable form of support 46 may be provided to insure the tubes being maintained in their proper positions in the shell.

In the preferred form of the invention the tube includes a single transverse partition wall, as hereinbefore described. Obviously, however, this divides the tube into compartments so as to make it a two pass structure. Never-the-less, the invention contemplates dividing the tube into as many compartments and a corresponding number of passes as may be necessary, for example, the body of the tube 47 as indicated in Fig. 5 may be

provided with longitudinally disposed flanges 48, 49, 50 and 51 placed in 90° positions from each other and the partition wall may include a transverse wall 52 having a part thereof bent back and formed at a right angle as indicated at 53 and 54, and also another part bent back and also at a right angle to form the parts 55 and 56 whereby the extremities of the partition so formed may be engaged between the parts of the flanges of the tube; or as shown in Figure 6 the tube 57 may be provided with flanges 58, 59, 60 and 61 also placed in 90° positions to each other, and the tube in this instance is fitted with a partition 62 having walls 63, 64, 65 and 66 adapted at their extremities to be engaged between the parts of the flanges 58 to 61 respectively in order to form a four pass tube similar to that shown in Fig. 5. In some instances, particularly in the use of the tube in the film type of evaporator, the exteriorly extending flanges on the tube may operate to prevent a certain portion of the fluid from properly reaching the under side of the tube, and in order to overcome this difficulty the tube, as indicated at 67 in Fig. 7, may be provided with internal longitudinally disposed flanges 68 and 69 between which a partition wall 70 extends, being received and secured in grooves 71 and 72 provided for this purpose in the internal flanges 68 and 69. In this structure the spaces or recesses 73 and 74 between the parts of the flanges on the exterior of the tube surface may be open as illustrated, or may be closed, depending upon circumstances. It is furthermore to be understood that the various forms of the tube as herein illustrated and described are more or less diagrammatic, as other similar and equivalent constructions may be employed without departing from the nature and spirit of the invention.

I claim as my invention:

1. A heat exchanger tube comprising a cylindrical body, one end thereof being open, longitudinal flanges extending from adjacent the open end of the tube to the opposite end thereof, a partition wall extending across the tube and secured in place between the parts of the said flanges, the said partition wall being notched at the said opposite end of the tube, a socket member secured to the notched end of the partition wall, a cap on the said opposite end of the tube, and a bolt passing through the cap and engaging the said socket to secure the cap in position on the tube.

2. A heat exchanger tube comprising a cylindrical body, a fitting secured in the tube adjacent one end thereof, oppositely disposed longitudinal flanges formed in the tube and extending from the said fitting to the opposite end of the tube, a partition wall extending from the said fitting and also across the tube, the said partition wall being secured in position between the parts of the said flanges, there being a port in the wall of the said fitting registering with a port in the wall of the tube to form an outlet opening, and means for closing the opposite end of the tube.

3. A heat exchanger tube comprising a cylindrical body open at one end, a fitting semicircular in a cross-section secured in the tube adjacent the open end thereof, the said fitting being closed at the end adjacent the open end of the tube and open at the other end thereof, oppositely disposed flanges in the wall of the tube extending from the open end of the fitting to the opposite end of the tube, a partition wall extending across the tube and from the said fitting to the said opposite end of the tube, the said partition wall being secured in place between the parts of the said flanges and being notched at the said opposite end of the tube, a socket member associated with the notch end of the partition wall, a cap fitting the said opposite end of the tube, and means co-operating with the socket member for securing the cap in position, the said fitting being provided with an aperture which registers with an aperture in the wall of the tube whereby the said apertures form a discharge port from the tube.

4. A heat exchanger tube comprising a hollow body completely open at one end and closed at the other end, longitudinal flanges formed in the wall of the tube and extending between points distant from the ends of the tube, a partition wall extending interiorly across the tube and secured in position between the said flanges, the said partition wall extending longitudinally of the tube a distance substantially coincident with the said flanges, and means connecting the closed end of the tube with the said partition wall.

5. A heat exchanger tube comprising a longitudinal body completely open at one end, a cover for closing the opposite end of the tube, longitudinally disposed flanges formed in the tube, a partition wall extending across the tube and secured in position between the said flanges, and means for connecting the said cover with the adjacent end of the said partition wall.

6. A heat exchanger tube comprising a longitudinal body completely open at one end, a cap closing the opposite end of the tube, oppositely disposed longitudinal flanges formed integrally in the tube, a partition wall extending across the tube and secured in position between the said flanges, the said partition wall extending longitudinally of the tube a distance substantially coincident with the said flanges, and means for connecting the said cap to the adjacent end of the said partition wall.

7. A heat exchanger tube comprising a longitudinal body completely open at one end at which it is adapted to be secured in a tube plate, a cap closing the opposite end of the tube, longitudinal flanges formed in the wall

of the tube and extending from adjacent the open end thereof to approximately the opposite end thereof, a partition wall extending across the tube and secured in place between the said flanges, the said partition wall extending longitudinally of the tube from a point within the same adjacent its open end to substantially the closed end and dividing the tube into longitudinal compartments, the opening to one of which is at the open end of the tube and the opening to the other of which is in the wall of the tube distant from the open end thereof, a cap for closing the opposite end of the tube, the said partition wall being notched adjacent the said cap, and means for connecting the cap to the partition wall.

Signed by me this 17th day of Dec. 1927.

WM. LONSDALE.