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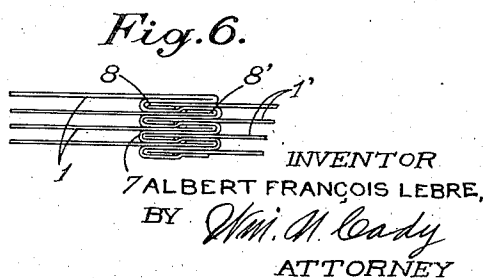
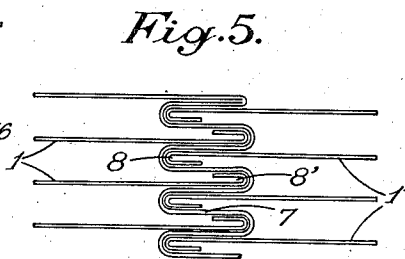
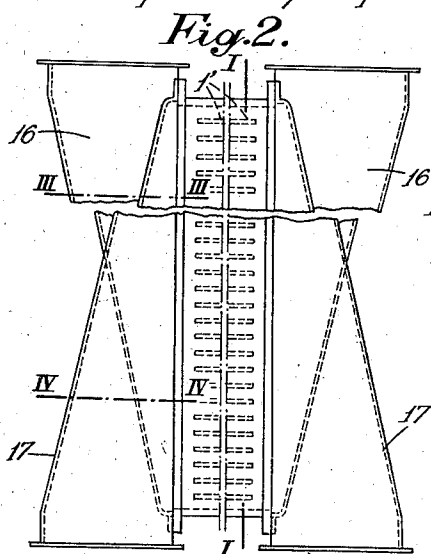
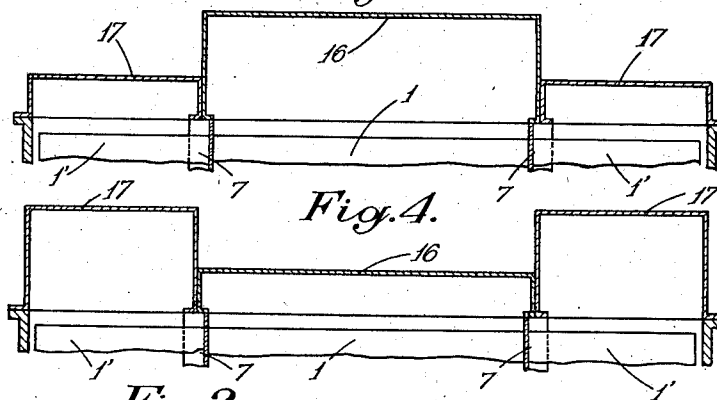
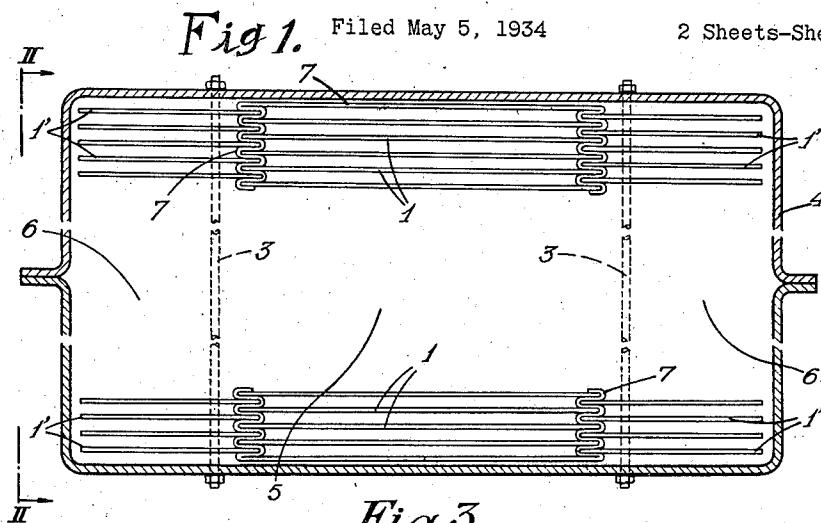
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2,058,022

HEAT EXCHANGER

Filed May 5, 1934

2 Sheets-Sheet 1



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HEAT EXCHANGER

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2 Sheets-Sheet 2

Fig. 7.

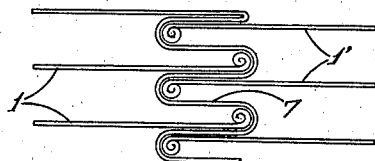


Fig. 8.

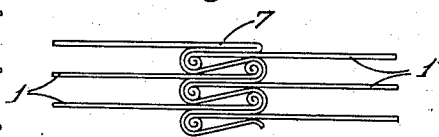


Fig. 9.

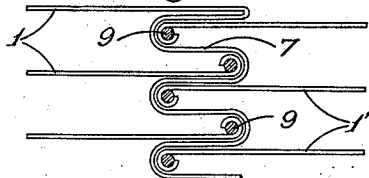


Fig. 10.

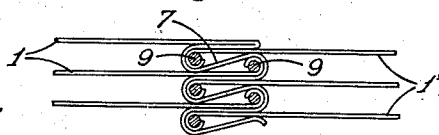


Fig. 11.

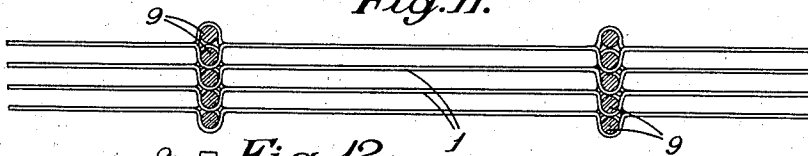


Fig. 12.

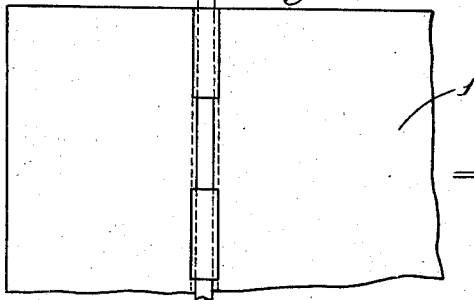


Fig. 13.

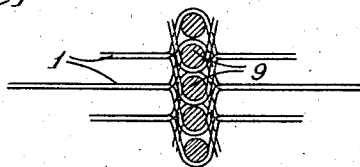


Fig. 14.

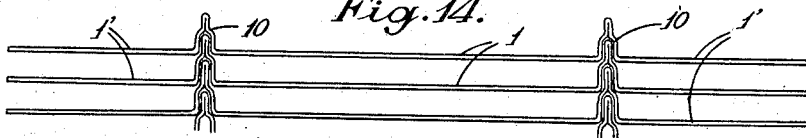


Fig. 15.



Fig. 16.



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HEAT EXCHANGER

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Application May 5, 1934, Serial No. 724,045
In France May 20, 1933

15 Claims. (Cl. 257—245)

This invention relates to plate heat-exchangers for fluids.

In apparatus for the exchange of heat between two fluids it is desirable to obtain a contact area which will be as large as possible per unit volume, or per unit weight of metal.

To this end, in one type of apparatus each of the two fluid currents have been divided into a large number of partial currents circulating in tubes or between plates or partitions. In another type of apparatus, the plates or surfaces separating the fluids have been associated with additional surfaces entirely immersed in one of the fluids. These additional surfaces, usually in the form of fins or gills, are designed to transmit heat by conduction.

The apparatus of the latter type have advantages, as regards convenience of construction, owing to the fact that the additional surfaces are not required to separate the two fluids and consequently, they are not required to fulfil the conditions of fluid-tightness and mechanical strength which are imposed on separating surfaces. Such apparatus, of which a gilled tube is a well known example, are particularly adapted for heat-exchange between fluids having very different heat-transfer coefficients, as for example water and air, whereas apparatus of the first mentioned type are generally more suitable for use with fluids having heat-transfer coefficients of the same order.

The advantages of both types of apparatus may be combined when the metal plates are extended across the two fluid currents at different temperatures, and the arrangement is such that the metal plates do not act as partitions between the fluid currents, but as fins or gills on both sides of members which form separating partitions between such currents. It has already been proposed to use as separating members narrow plates or bars inserted and pressed between successive plates in alternate relationship therewith, but with this arrangement it is difficult to obtain fluid-tight joints between the contacting faces of the separating members and of the metal plates.

The objects of my present invention are to make it possible to obtain a more satisfactory fluid-tightness and at the same time to increase the mechanical strength and rigidity of the apparatus.

With these objects in view, the heat-exchanger according to my invention comprises a plurality of adjacent or piled up parallel plates extending on both sides of partitions which separate the

fluid currents at different temperatures, and it is characterized in that said partitions are formed of folded parts either distinct from or integral with the parallel plates, said folded parts having at the juncture between said partitions and plates an interlocking engagement with each other or with said plates whereby the piled up plates are correctly spaced and form a rigid whole.

In the preferred embodiment of my invention, one or more partitions are formed of a continuous plate folded zigzag fashion and alternately enclosing in its successive folds the edges of adjacent piles of plates or gills on both sides thereof. With this arrangement the plates are interrupted where they meet the partition and complete fluid-tightness between the conduits on both sides of the partition is obtained without soldering or welding.

In other constructions the plates are continuous and the partitions are formed of folded portions of the plates themselves or of other parts engaged by folded portions of the plates.

In all these constructions the piled metal plates forming the gills are not used to separate the different fluids in which they are immersed. They may accordingly be as thin and as close together as is desired, so that a very large contact area per unit volume, or per unit weight of metal may be obtained even if the fluids are at different pressures, or have different chemical compositions, since such fluids are completely separated by the partitions braced by said plates. This renders the apparatus particularly suitable for performing heat-exchange with very small temperature differences, to recuperate waste heat for example from combustion gases, to carry out the cooling of compressed gases in stage compression and generally to perform heat exchanges with gases considered unsuitable on account of the small heat-transfer coefficient from the gases to a metal.

In the accompanying drawings which illustrate by way of example, various constructional forms of my invention:

Fig. 1 is a cross-section, on line I—I of Fig. 2, showing a heat exchanger according to my invention, the section being at right angles to the direction of flow of the fluids at different temperatures.

Fig. 2 is a side elevation viewed from line II—II of Fig. 1, and

Figs. 3 and 4 are part sections on line III—III and IV—IV respectively of Fig. 2.

Figs. 5 and 6 illustrate on a larger scale a

manner of engaging with each other the end of the plates or gills and the folds in the partition, before and after the pile is pressed.

Figs. 7 and 8 are views similar to the two preceding figures and show a modification.

Figs. 9 and 10 likewise show another modification.

Fig. 11 is a cross-sectional view and Fig. 12 a top view showing a further constructional form, Fig. 13 being a modification of the form shown in Fig. 11.

Figs. 14, 15 and 16 are cross-sectional views showing still further constructional forms with different manners of forming partitions within the piled plates.

In the example illustrated in Figs. 1 to 4, the piled up plates form inner gills 1 and outer gills 1' the adjacent edges of which are engaged in alternate folds of a sheet metal plate 7 folded zigzag fashion. The plates are surrounded by a casing 4 the two parts of which are clamped together by means of bolts 3.

The plate 7 forms a continuous partition enclosing on both sides a central conduit 5 and separating it from two side conduits 6. The fluids to be subjected to heat-exchange are circulated, one in conduit 5, the other in the two conduits 6.

The arrangement shown lends itself to the parallel and symmetrical circulation of the two fluids, with a methodical or a counter-current heat-exchange, the gills 1, 1' conducting heat in a direction at right angles to the direction of flow of the fluids. Thus, for example, the heat collected by the central gills will separate into two currents of opposite directions, flowing towards both ends, across the respective partitions.

When the fluids have the same heat-transfer coefficient, and have to undergo temperature variations of the same order while they flow through the heat-exchanger, I use the same number of gills 1 and 1' and make them of the same size whereas if the said coefficients and the temperature variations are not the same, the length of the gills or their number may be proportioned to the amount of heat to be transferred to the metal per surface unit by each fluid. This makes it possible to extend the use of my improved heat exchanger to the treatment of fluids of widely different natures, as a gas and a liquid.

The inner conduit 5 being braced by the gills extending therethrough, can receive gases at high or low pressures, the gills or plates cooperating with the partitions in order not only to transmit the heat, but also to afford the necessary mechanical strength to ensure the separation of gaseous fluids even when said fluids are at very different pressures.

The plate 7 being continuous, affords complete fluid-tightness between the conduits 5 and 6. Although the gills are not continuous, it is possible to obtain by suitable pressure, such a good contact between the ends of the gills and the folds of the plate 7, as to cause the heat transfer to take place in a manner just as satisfactory as if the gills were continuous. Instead of a single plate 7 forming both partitions as shown, each partition may of course be formed of a separate folded plate corresponding to the folded end portions of the plate 7 unconnected to one of the parallel plates.

Similar folded plates can also be used to close the lateral conduits 6 on their outer sides, if desired.

Figs. 5 and 6 respectively show, before and after pressure is applied, how a good contact can be

secured, the plate 7 being bent around the folded edges 8, 8' of the gills 1, 1'. In the example of Figs. 7 and 8, the plate 7 is bent about the in-turned edges of the gills 1, 1', while in the slightly modified form illustrated in Figs. 9 and 10, the edges of the gills 1, 1' are turned around wires or rods 9.

In order to ensure a good contact with the partitions 7 when the plates 1, 1' forming the gills are folded, turned or bent at their edges, it is of advantage to make such plates of cold-worked metal and to make the zigzag partitions of hard metal so that after the parts have been pressed together, the resiliency of the metal co-operates in maintaining a good contact.

Figs. 11 and 12 illustrate an arrangement which provides a hooking engagement between the plates 1 and rods or wires 9 which, when superposed, form the separating partitions. At the places where the partitions are to be formed, the plates are folded or creased like certain hinge elements which comprise sections alternately curved upwards and downwards, the wires or rods, numbering two or more to each plate, passing through the creases like the pins of a hinge, the creases of adjacent plates mutually fitting within one another. In Fig. 11 the creases enfold two and in Fig. 13 three wires or rods.

In Fig. 14 is illustrated an arrangement which preserves the continuity of the gills, the plates 1, 1' having creases with a double curvature adapted to fit within each other so as to form the separating partitions.

In another modification (Fig. 15) the plates 11, 12, 13 forming the gills are themselves bent zigzag fashion and fitted so that they form, two by two, by the superposition of their folds in alternating relation, the partitions necessary for separating the conduits 5 and 6.

I may also use corrugated plates for forming the gills. Fig. 16 shows an arrangement in which corrugated metal sheets 14 are combined with rods or wires 15 which, by their superposition, form the lateral partitions. It will of course be understood that the use of corrugated plates may be combined with any of the methods of forming the separating partitions above referred to by way of example.

The heat exchange elements constructed in accordance with my invention may be made of any suitable metal, for example aluminium, which metal combines with a light weight the advantage of a good thermal conduction, or copper which is suitable for welding or soldering, or iron which is cheap and suitable for galvanization.

When such heat exchange elements are enclosed in an outer casing, it may be advantageous to arrange such casing as shown in Figs. 1 to 4 so that the piled up plates are pressed together while being able to expand freely, independently of the casing. To both ends of the casing I may connect headers as shown in Figs. 2 to 4, comprising a central conduit 16 and two sides conduits 17 decreasing in cross-section, so as to ensure a uniform flow of fluid towards and from the piled plates.

Other modifications may of course be made within the scope of my invention as defined by the following claims:

I claim:

1. In a heat-exchange apparatus for fluids, the combination of piled up parallel plates with partitions extending transversely of said plates, said partitions being formed of folded parts having

an interlocking engagement with said plates, said partitions being adapted to separate fluid currents at different temperatures, said plates extending in the manner of gills on both sides of said partitions.

2. In a heat-exchange apparatus for fluids, the combination of piled up parallel plates with partitions extending transversely of said plates, said partitions being formed of folded parts distinct from and having an interlocking engagement with said plates, said partitions being adapted to separate fluid currents at different temperatures, said plates extending in the manner of gills on both sides of said partitions.

3. In a heat-exchange apparatus for fluids, the combination of piled up parallel plates with partitions extending transversely of said plates, said partitions being formed of folded parts integral with at least one of said plates and having an interlocking engagement with the other of said plates, said partitions being adapted to separate fluid currents at different temperatures, said plates extending in the manner of gills on both sides of said partitions.

4. In a heat-exchange apparatus for fluids, the combination, in a surrounding casing, of fluid-tight partitions dividing said casing into three parallel passages, adjacent plates extending in the manner of gills on both sides of said partitions and across said passages, said partitions being formed of folded parts having interlocking engagement with the edges of said plates.

5. In a heat-exchange apparatus for fluids, the combination of two piles of parallel plates with a transverse partition therebetween adapted to separate two gas currents at different temperatures, said partition comprising a sheet folded zigzag-fashion and alternately enclosing in its folds the edges of plates on both side thereof.

6. In a heat-exchange apparatus for fluids, the combination, in a surrounding casing, of three adjacent piles of parallel plates with two transverse partitions, each of said partitions comprising a sheet folded zigzag-fashion and alternately enclosing in its folds the edges of plates of two of said adjacent piles.

7. In a heat-exchange apparatus for fluids the combination of a thin metal plate folded zigzag-fashion, a series of parallel flat plates on each side of said folded plate, said folded plate alternately clamping in its folds the edges of the flat plates on either side thereof, said flat plates thus being spaced from each other and forming a rigid unit with said folded plate, a casing surrounding said unit, said casing being open at both ends, said folded plate forming a fluid-tight longitudinal partition within.

8. In a heat-exchange apparatus, the combination of piled up parallel plates with partitions

extending transversely of said plates, said partitions having an interlocking engagement with said plates, said partitions being adapted to separate fluid currents at different temperatures, said plates extending in the manner of gills on both sides of said partitions.

9. In a heat exchange apparatus for fluid, the combination of a plurality of plates and partitions extending transversely of the plates, said partitions being formed of folded parts for holding said plates in spaced relation and to separate fluid currents at different temperatures.

10. In a heat exchange apparatus for fluid, the combination of a plurality of plates and partitions extending transversely of said plates, said partitions being formed of folded parts adapted to separate fluid currents at different temperatures, said plates extending in the manner of gills on both sides of said partitions.

11. In a heat exchange apparatus for fluid, the combination of a plurality of plates and partitions extending transversely of said plates, said partitions being formed of folded parts distinct from and having an interlocking engagement with said plates, said partitions being adapted to separate fluid currents at different temperatures.

12. In a heat exchange apparatus for fluid, the combination of a plurality of plates and partitions extending transversely of said plates, said partitions being formed of folded parts integral with one of said plates and having an interlocking engagement with the other of said plates, said partitions being adapted to separate fluid currents at different temperatures.

13. In a heat exchange apparatus for fluid, the combination in a surrounding casing, of adjacent piles of plates separated by transverse partitions, each of said partitions comprising a sheet folded zigzag fashion and alternately enclosing in its folds the edges of plates of two of said adjacent piles.

14. In a heat exchange apparatus for fluid, the combination in a surrounding casing, of adjacent piles of plates terminating in enlarged edge portions separated by transverse partitions, each of said partitions comprising a sheet folded zigzag fashion and alternately enclosing in its folds the edges of plates of two of said adjacent piles.

15. In a heat exchange apparatus for fluid, the combination in a surrounding casing, of adjacent piles of plates the adjacent edges of which terminate in folds separated by transverse partitions, each of said partitions comprising a sheet folded zigzag fashion and alternately enclosing in its folds the folded edges of plates of two of said adjacent piles.

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