Sept. 1, 1953 A. HUET 2,650,802

COUNTERCURRENT HEAT EXCHANGER

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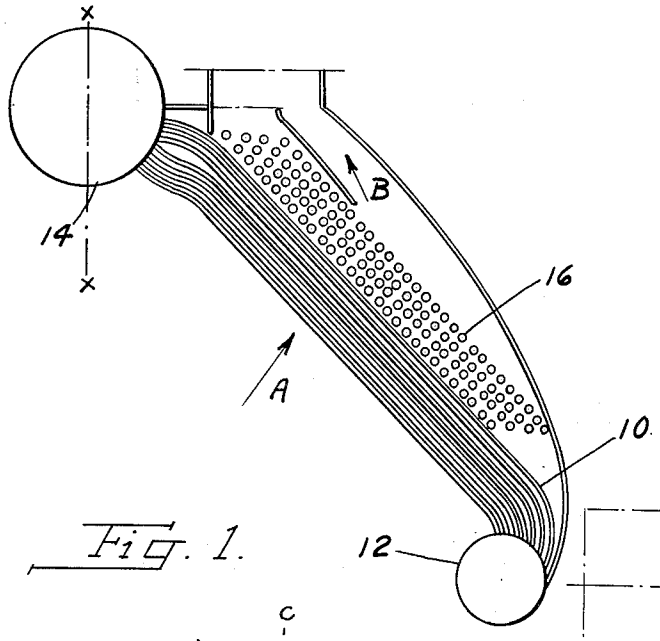

Fig. 1.

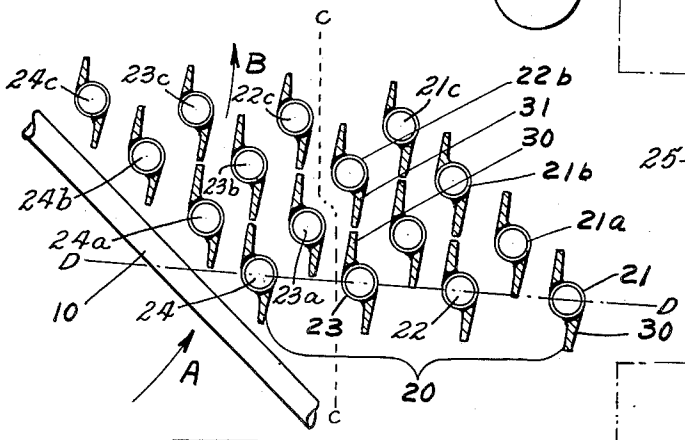

Fig. 2.

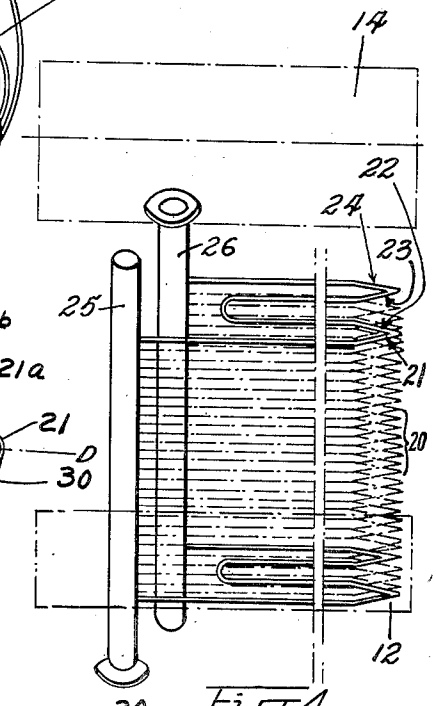

Fig. 4.

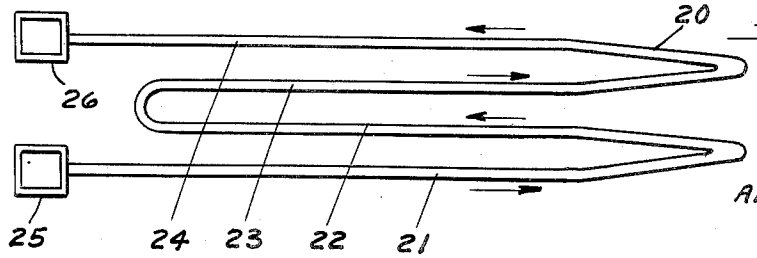

Fig. 3.

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COUNTERCURRENT HEAT EXCHANGER

André Huet, Paris, France

Application September 8, 1948, Serial No. 48,179
In France September 19, 1947

1 Claim. (Cl. 257—248)

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This invention relates to an improved countercurrent heat exchanger having a tube bundle traversed interiorly as by water and disposed in a stream of hot gases so that the warmer gases first encounter tubes traversed by the warmed water and that the coolest gases subsequently contact tubes traversed by the coolest water.

In particular the present invention contemplates that the tubes of the tube bundle which constitute the heat exchanger are disposed with respect to one another so that while retaining the principle of counter-flow the water inside the tubes flows nevertheless in the tube bundle as a whole in the same general sense as the gases. For example, in the case of the application of the invention to an economizer of a water tube boiler the tubes of the economizer are disposed in the usual manner on the path of the rising hot gases, but they are associated among themselves to realize an internal circulation in such fashion that the discharge tubes of the economizer which contain the hottest water are in contact with the hottest portion of the rising gases while the admission tubes of the economizer which contain the coldest water are in contact with the coolest gases, all in realizing a circulation of the water which permits it to rise as it becomes heated.

As an example of carrying out this disposition, if an economizer had only two rows of tubes, each of these two rows of tubes would be constituted by a distinct multi-looped element made up of several parallel tubes interconnected by return bends and the discharge branches of the elements would constitute the first row of tubes reached by the hot rising gases, while the admission branches would constitute the second row of tubes which are located after the first in the direction of gas flow and the plane of each looped element would be slightly inclined from the horizontal plane to permit the discharge branch to be elevated slightly above the admission branch. The branch tubes of each element themselves may have a continuous slight slope favoring the flow of steam bubbles in case of vaporization.

To conveniently direct the current of hot gases the tubes are preferably provided with tangential fins conforming to my earlier application, Serial No. 748,561, filed May 16, 1947, now Patent No. 2,578,136, granted December 11, 1951, with the distinction that the fins of the several tubes of any particular looped element do not contact each other but are disposed in such fashion as to come in contact, or substantially in contact, with the fins of the tubes of another element in a manner to guide the passage of exterior gas,

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all in offering a staggered disposition of tubes to the streams of gases which produces in the flow of gases the successive effects of dilation, of compression, and of change of direction assuring the optimum heat exchange.

The invention will be best understood upon consideration of the following description when read in conjunction with the accompanying drawing in which:

Figure 1 is a schematic vertical sectional view of part of a water tube boiler equipped with an economizer embodying the invention.

Figure 2 is a view on a larger scale of part of the economizer shown in Figure 1.

Figure 3 illustrates in plan view one of the double-looped elements making up the economizer.

Fig. 4 is a diagrammatic plan view showing the manner in which the looped elements are connected to the inlet and outlet headers.

In the case for example of a water tube boiler of which half is represented at the right of the axis of symmetry X—X in Figure 1 the inclined bundle of water tubes 10 rises from the lower drum 12 to the upper drum 14. The economizer designated as a whole by numeral 16 is placed at the outlet side of this tube bundle in the path A—B of the hot gases from the furnace. The tubes forming the economizer lie in rows parallel to the general direction of the axes of the tubes 10 as one sees in the drawing. The economizer which has been shown comprises four rows of tubes but the number could be different.

The economizer is made up of double-looped elements 20 such as is shown in Figure 3 and consisting of four parallel tubes 21 to 24 connected for series flow therethrough by return bends, connecting adjacent ends of the tubes. When an element is mounted, its plane is slightly inclined from the horizontal following the line D—D in Figure 2. The cold water coming from the distributor 25 passes successively through the branches 21, 22, 23 and 24 of the element and the hot water is discharged into exits through the collecting header 26.

With the arrangement embodying the invention it may be seen that all the inlet branches 21, 21*a*, 21*b*, and 21*c* of the several elements 20 in the economizer make up the fourth row of tubes, that is to say the furthest from the hot gases A, the elements 22, 22*a*, 22*b*, and 22*c* make up the third row; the elements 23, 23*a*, 23*b* and 23*c* the second; and the elements 24, 24*a*, 24*b* and 24*c* the first, that is to say the row nearest to the water tubes 10 which is contacted by the hottest gases

A. Thus, as has already been explained the economizer functions in countercurrent but, because of the inclination of the elements in planes parallel to the line D—D of Figure 2, the water which traverses the branches 21 to 24 of each element rises within that element from the level of tube 21 to the level of tube 24, Figure 2, as it is heated, which favors the circulation within the element.

The branches of each element of the economizer are provided with tangential fins of the type described in my aforementioned Patent No. 2,578,136. As seen in Figure 2 the elements 20 are disposed so that their component tubes are staggered with respect to those of the adjacent elements and the fins come into contact with the fins of the elements situated not immediately below but two rows below, the fin 30 of the tube 23 in the first element, Figure 2, coming in contact with the fin 31 of the tube 22*b* in the second element above etc. so as to present sinuous channels C—C to the gases flowing in the general direction of the arrow A across the staggered arrangement of tubes, the general direction of channels C—C being that of the flow A. This arrangement produces in the gases the successive effects of dilation and of contraction, as well as change of direction, which assures the optimum of heat exchange. It is obvious that an economizer construction embodying the invention could have tubes that do not carry fins, or carry fins arranged in ordinary manner.

The invention is applicable equally to economizers whatever be their location within the boiler and more generally to all heat exchangers.

What I claim is:

In a heat exchange bank positioned to intercept an ascending stream of fluid which approaches the bank obliquely from one side of the bank below the latter; said bank comprising a plurality of individual looped elements disposed in superposed relation in parallel planes located generally transverse of general direction of flow of the fluid stream flowing through the bank and each consisting of a number of similarly spaced parallel tube lengths located in a row inclined slightly from the horizontal and having their contiguous ends interconnected by return bends for series fluid flow from an inlet tube at one end of the row to an outlet tube at the end of the row from which the stream of fluid approaches the bank with said superposed elements progressively offset in a direction toward the approaching fluid stream by increments substantially equal to one half the tube spacing in each row to stagger said tubes and dispose the several outlet tubes in a row inclined substantially from the vertical at that side of said bank from which the ascending fluid approaches and confronting the stream of fluid approaching the bank; inlet and outlet headers to which the lowest and highest tubes respectively of each element are connected; and longitudinally extending fins projecting from said tubes at substantially diametrically spaced points and so oriented vertically that the distal ends of fins on the respective tubes in alternate rows aline and are substantially in contact to form vertical flow directing baffles within said bank causing the fluid stream to change from a direction of flow normal to the plane of the outlet tubes of said elements and ascend substantially vertically through the back to contact different tube lengths of the respective rows forming each successively encountered element as the stream ascends through the bank.

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