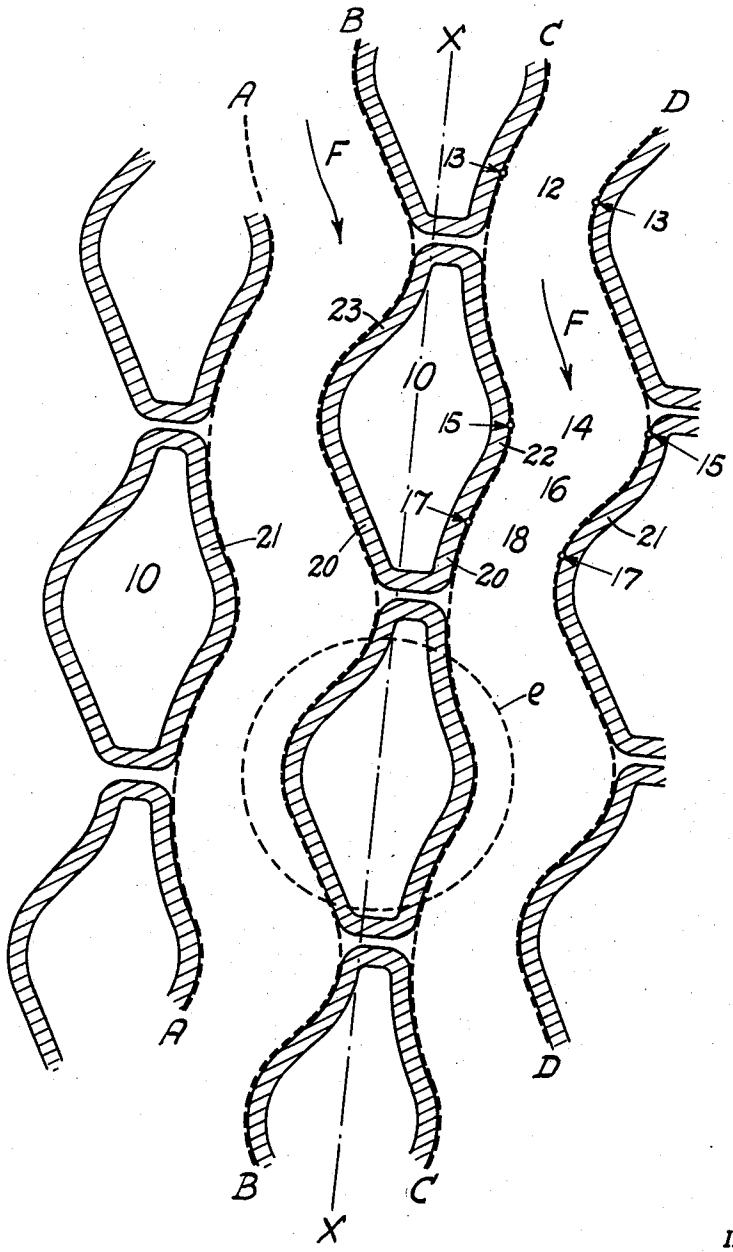
Nov. 3, 1959 A. HUET 2,911,199

HEAT EXCHANGER

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FIG. 1



INVENTOR.
ANDRE HUET

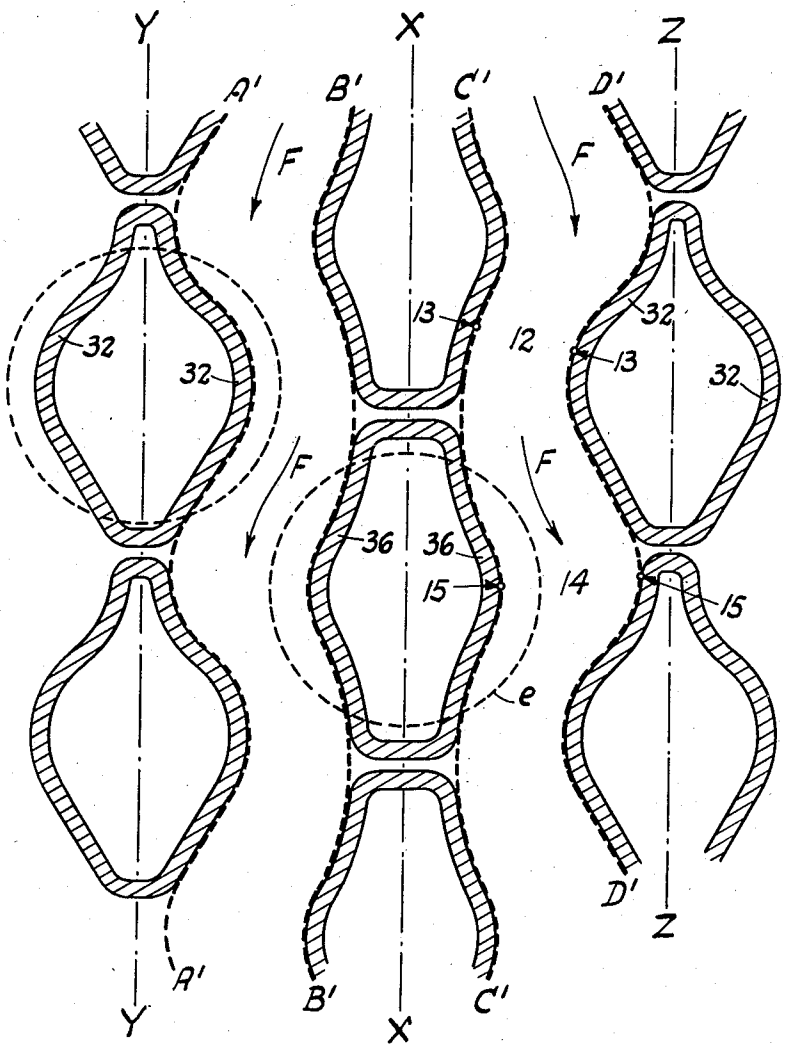
BY James J. Wheeler

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HEAT EXCHANGER

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FIG. 2



INVENTOR.
ANDRE HUET
BY

United States Patent Office

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HEAT EXCHANGER

André Huet, Paris, France

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3 Claims. (Cl. 257—236)

The present invention relates to heat exchange apparatus and particularly to an improved form of tubular heat exchanger for absorption of heat from a gaseous fluid contacting the exterior surfaces of the tubes.

In his previous patents and in particular in his Patent No. 2,677,532, of May 4, 1954, the applicant has described heat exchangers between fluids, at least one of which is gaseous. The novelty in these exchangers resides in that the gas lanes in the exchanger are bounded by walls or surfaces that present a special profile favorable to the efficiency of the heat exchanger.

The profile of each of these gas lanes is sinuous and variable in section, that is to say, each lane has changes in direction and narrowings in section or frontal area and its novelty resides in that each narrowing and/or change of direction, is followed by a gradual widening of the section offered to the passage of the fluid, in general in the form of a divergent, this widening continuing to the next change in direction and/or narrowing of lane.

Experiments have shown that this profile of gas lane leads to an improved efficiency of heat exchanger, due principally to the fact that one retards in the flow of the fluid, the moment when passing from a laminary flow to a turbulent flow.

To make this lane profile, the applicant proposed, in the above patent, either imparting undulations of suitable shapes to the plates of sheet metal forming envelopes confining one of the fluids and separating it from the other fluid in the envelope type exchangers; or, in the case of a tubular exchanger whose tubes arranged in rows have fins, preferably tangential ones, determining the profile of the fins so that the lanes for the circulation of the outside fluid, perpendicular to the axis of the tubes between the rows of tubes will assume the form indicated. This involves providing on each tube, two fins, slightly dissimilar, and in slanting them differently on the tube.

The present invention contemplates an exchanger of the tubular type in which the lanes for the passage of the gaseous fluid in the direction perpendicular to the axis of the tubes, have a favourable profile formed by suitable conformation of smooth cylindrical tubes, the said tubes being in general flattened and suitably rounded so that the walls of the tube which delimit the lane follow the desired profile.

According to the invention one may use in the same exchanger either tubes which are all formed in the same way, or tubes formed in two or more different ways and judiciously distributed.

In the drawings:

Figure 1 is a transverse section of a portion of a tubular heat exchanger according to the invention.

Figure 2 is a similar section illustrating another embodiment of the invention.

The heat exchanger of the invention is a tubular type in which one fluid circulates inside the tubes and the other or exterior fluid flows in lanes arranged between the tubes, following a direction perpendicular to the axes of the tubes.

In Figure 1 there is shown in dashes, the contours AA, BB, CC and DD of two lanes formed inside the heat exchanger for the gaseous exterior fluid which circulates in the direction of arrows F. To be specific, in the lane extending perpendicular to the axes of the rows of tubes **10** and delimited by contours CC, DD it may be seen that this lane comprises a narrowing **12** located at a point of change of direction of flow followed by a widening up to section **14**, so that the two walls of the lane will gradually bell out between points **13**, **15** and constitute a divergent between sections **12** and **14**. After this at **16** there is a change in direction up to the points **17** where the flow reaches another narrowed section **18**, and the profile is thus repeated from end to end of the lane.

In Figure 1 note that the two contiguous lanes bounded by walls AA, BB on the one hand and CC, DD on the other are arranged in the same way but slightly staggered or offset, the right hand lane being staggered toward the base of the figure with respect to the left hand lane.

According to the invention the tubes **10**, originally cylindrical are reformed with an extended profile so that, with the tubes staggered, the lower part **20** of a tube comes almost into the vicinity of the upper part **21** of the adjacent tube in each contiguous vertical row. The walls of the tubes which delimit the profile of the lanes are rounded to fit into contour BB, CC. This leads to giving each tube an asymmetrical shape in the sense that the face **22** of the tube forming part of the wall contour CC is less rounded than the opposing face **23** located in the contour BB.

To form the tubes of the exchanger, one starts with a cylindrical tube of circular section which is suitably molded to impart to it the desired form. It is preferable to leave the ends of the tube in their circular form in order to permit easy attachment on the tube plate. Likewise, I leave in place on the tubes, short sections, circular in form which facilitates the possible mounting of cross braces at these points. In the figures the dotted circle *e* represents the circular section of the original tube.

Thanks to this arrangement I have a heat exchanger whose efficiency is improved due to the fact that it offers to the flow of the outside fluid, a favourable profile which reduces the losses of pressure while improving the coefficient of transmission.

In Figure 2 is shown a variation of the heat exchanger in which are used tubes formed in two different ways. For this I adopt, for the profile of lanes A'A', B'B' on the one hand and C'C', D'D' on the other, an arrangement such that lane A'A', B'B' and neighboring lane C'C', D'D' are symmetrical with respect to the axis X—X of a vertical row of tubes. Moreover, the profile of each lane is the same as that in the Figure 1, that is to say it passes gradually from a change in direction and/or narrowing **12** to an enlargement in section **14**, by a divergence **13**, **15**, after which there is a change in direction and so forth.

The arrangement adopted for the lanes of Figure 2, lead to the advantage that it can be formed by means of tubes having a plane of symmetry, plane X—X for example. The tubes of the median vertical row in Figure 2 are, as we see, symmetrical with respect to plane X—X and have on their opposing faces, roundings **36** of equal size. However, the arrangement requires the use of two different types of tubes and the tubes of the adjacent vertical rows Y—Y, Z—Z which are also symmetrical with respect respectively to planes Y—Y and Z—Z, have nevertheless, roundings **32** which are more accented than the roundings **36** of the tubes of the row X—X.

Naturally the invention is not limited to the profile which has just been described but may utilize any profile shown favorable to the flow in heat exchangers. Furthermore, although the invention is particularly important

in the case where the outer fluid which circulates in the lanes between tube rows is gaseous, it can apply also to a heat exchanger between two liquids.

What I claim is:

1. A two-fluid tubular heat exchanger in which one fluid circulates through the tubes and the other in lanes between and perpendicular to the axes of the tubes with the tubes disposed in parallel columns and each having a substantially constant wall thickness and an oblong transverse section with undulated sides whose crests are substantially opposite each other, the tubes being staggered in adjacent columns and being disposed in such fashion that the large axes of the transverse tube sections are in alinement and the extremities of the transverse sections of each tube come nearly in contact with the extremities of the following tube in the same column, whereby the flow lanes formed between the columns of tubes are limited by undulating boundaries constituted by the sides of the tubes, and the crests of the boundary undulations on one side of each lane being less pronounced than the crests of the other undulating boundary at the opposite side of the same lane, the undulations in the sides of a particular tube being asymmetrical and the undulations on one side of the tube being greater in depth than the undulations on the other side of the tube.

2. A heat exchanger as defined in claim 1 wherein the undulation forming crests of the tubes merge into fin-like hollow portions disposed on the elongated axis of the tube cross-section.

3. A heat exchanger as recited in claim 1 wherein the tubes in columns at opposite sides of a lane have undulations of different contour in their side walls and the tubes forming each column are similar in shape.

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