

Nov. 19, 1963

A. HUET

3,111,168

HEAT EXCHANGERS

Filed Nov. 14, 1955

2 Sheets-Sheet 1

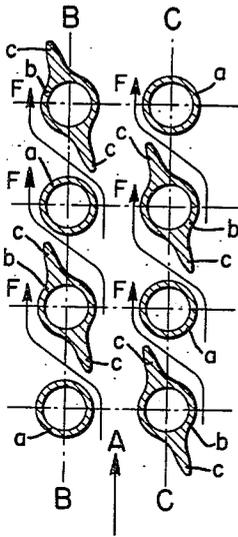


FIG. 1

FIG. 11

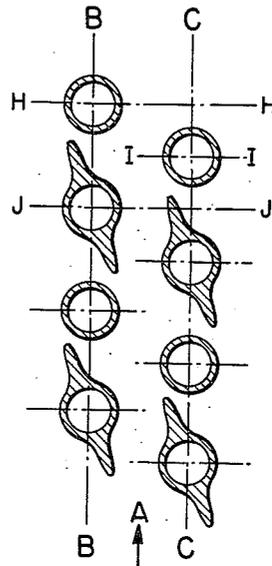
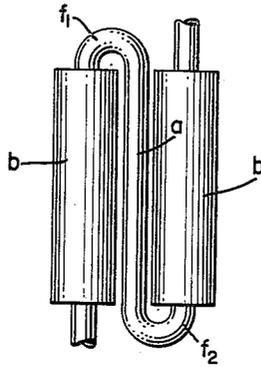


FIG. 2

FIG. 3

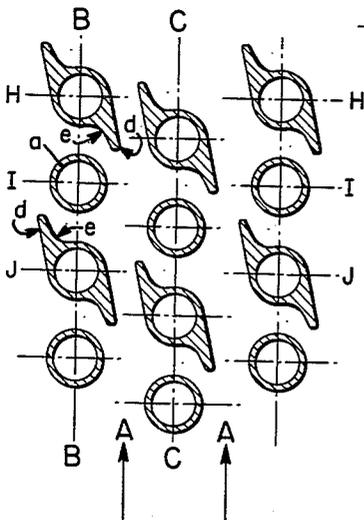
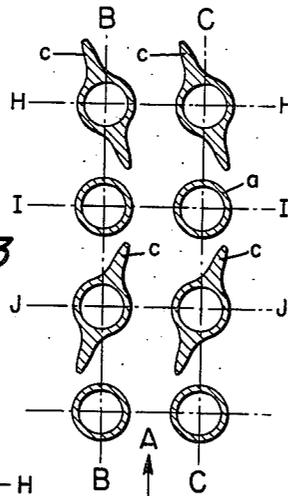


FIG. 9

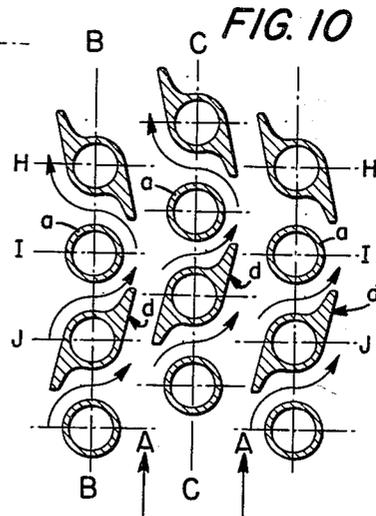


FIG. 10

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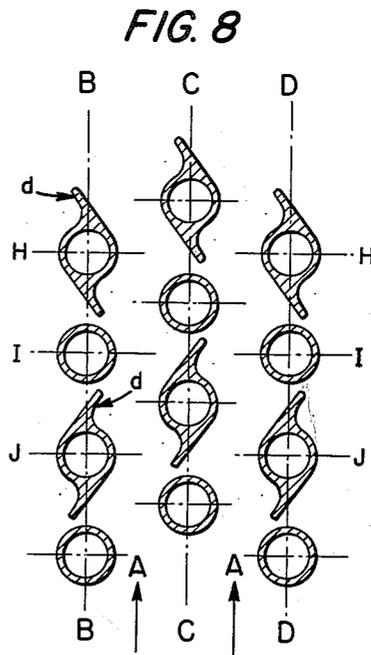
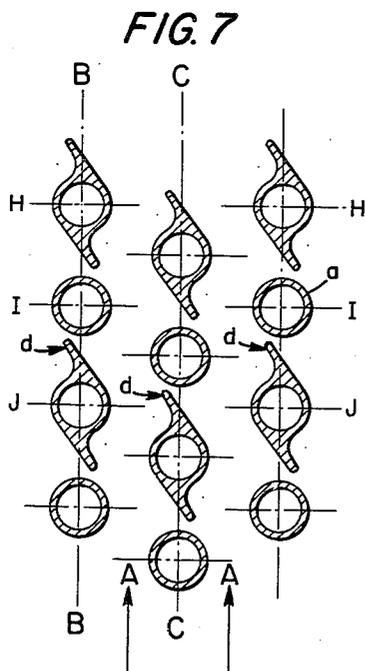
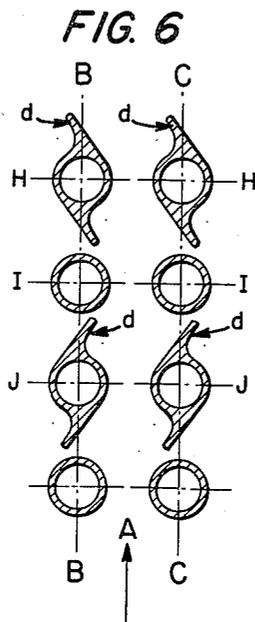
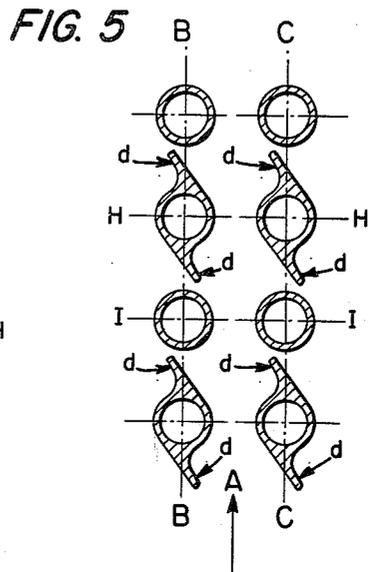
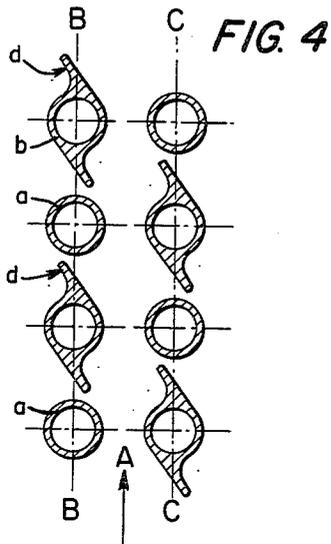
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1

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HEAT EXCHANGERS

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8 Claims. (Cl. 165-165)

This invention relates to tubular heat exchangers and more especially those which include both tubes with longitudinal fins and plain tubes.

The special feature of the exchanger lies in that the distribution and the arrangement of the finned tubes in relation to the plain tubes, is such that the fins, the surface of which contributes towards effecting the transmission of heat, canalise and direct the flow of the fluid flowing externally of the tubes, so as to force it to bathe the surface of the plain tubes.

To this end, the tubes being disposed either in regular rows, or regularly or irregularly staggered, the rows of finned tubes and plain tubes are alternated, or else, in one and the same row, the finned tubes and plain tubes are alternated. Finally, the finned tubes and the plain tubes may be of different diameters.

In the case of tubes having diametral fins, that is to say fins the plane of which passes through the axis of the tube, the finned tube is so disposed that the plane of symmetry of the fin will be approximately tangential to the surface of the plain tube with which it cooperates. In addition, in the same row, or in one row out of two, the direction of the inclination of the fin can be modified so as to be directed sometimes to the right, and sometimes to the left of the plain tube. In the case of tangential fins having a thick base, that is to say fins having a plane face tangential to the surface of the tube and a concave face adjoining the surface of the tube, the plane face can be directed towards the plain tube, or on the contrary the curved face may be so directed. In the case of the plane face, it must comply with the same conditions as those set forth above for the diametral fins. It may also be directed sometimes to the right, and sometimes to the left of the plain tube. In the case of the curved face, it may also be directed sometimes to the right, and sometimes to the left.

In this way, in the walls of the corridors formed between the rows or columns of tubes in the exchanger there are free spaces, into which a portion of the flow of the outer fluid is directed, so that the latter passes from one column to the neighbouring columns while bathing the surface of the plain tubes which separate them.

The bathing of the plain tubes is then so completely effected that the performance of the exchanger is practically equal to that of an exchanger in which all the tubes are finned.

This arrangement furthermore affords an advantage from the manufacturing point of view, because when the tubes are traversed internally in series by the inner fluid, it is possible to produce, without welding, the plain tube together with the two terminal bends which connect it to the finned tubes with which it is to be assembled, thereby reducing the total number of tube welds. In addition, the plain tubes are less expensive than finned tubes, so that the cost of the exchanger is reduced.

The description which follows, with reference to the accompanying drawings, which illustrate the invention by way of example, will enable the manner in which the invention can be performed to be better understood.

In the drawings:

FIGURES 1 to 3 illustrate in cross-section portions of the bundle of tubes of an exchanger, comprising tubes having diametral fins and plain tubes.

FIGURES 4, 5, and 6 illustrate in cross-section a com-

2

bination of tubes having tangential fins and plain tubes, in the case of an arrangement in regular rows.

FIGURES 7 and 8 illustrate the case of an arrangement of tubes in staggered formation.

FIGURES 9 and 10 relates to an arrangement of tubes in staggered formation with tangential fins, the concave side of which is turned towards the plain tube.

Finally, FIGURE 11 shows in plan view the association of three tubes in series, and the junction of the plain tube with the two adjoining finned tubes.

As is seen in FIGURE 1, the bundle of tubes of the exchanger is constituted by a mixture of plain tubes *a* and tubes *b* having diametral fins. The fins *c* of the tubes *b* are so directed that (when the outer fluid circulates in the direction of the arrow *A*) the plane of the fin *c* will as a maximum be approximately tangential to the surface of the plain tube *a* with which it cooperates, either upstream or downstream of said fin. Between the columns of tubes *BB*, *CC*, there are thus formed corridors having changes of direction and variations of section, and moreover, in these columns, open passages traversed by the fluid in the direction of the arrows *F*, which has the effect that the fluid passes from one corridor to the neighbouring corridor while bathing, in the direction of the arrows *F*, the surface of the plain tubes *a* of the exchanger.

In FIGURE 2 the same arrangement is shown, but in a case where the rows of tubes *HH*, *II* are staggered, which enables a different profile to be given to the section of the corridor formed between the columns *BB*, *CC*. The staggering may be irregular, that is to say with variable intervals between the rows of tubes.

Instead of being directed, as in the preceding cases, in the same manner in relation to the plain tubes *a*, the fins *c* may be alternately directed to the right or to the left of the plain tube *a*, as seen in FIGURE 3. In the row *JJ* the fins *c* are directed to the right of the tube *a* situated downstream and, in the row *HH*, they are directed towards the left. In this case a regular or irregular staggered arrangement could also be adopted.

Instead of using tubes having diametral fins, it is possible to use tubes having tangential fins with a thick base, as shown in FIGURE 4. In this case, the plane face of the fin *d* is so directed as to be approximately tangential to the plain tube *a* with which it cooperates. The arrangement illustrated in FIGURE 4 is one in which in each column *BB*, *CC*, and so on, the plain tubes alternate with the finned tubes.

In the arrangement comprising regular rows illustrated in FIGURE 5, the rows *HH*, *II* of the tubes are such that one row comprises finned tubes and the other plain tubes. All the fins *d* are directed in the same direction in FIGURES 4 and 5, but an arrangement can be adopted in which the fins are directed in some cases to the right and in others to the left of the plain tubes, as illustrated for example in FIGURE 6, in which the fins are directed to the right for the row *JJ* and to the left for the row *HH*.

The arrangements described hereinabove comprise regular rows, but it is also possible to adopt a staggered arrangement, as illustrated in FIGURES 7 and 8. As can be seen, in this case the fins *d* can all be directed to the left of the plain tubes *a*, as illustrated in FIGURE 7, or alternately to the right (row *JJ*) and to the left (row *HH*, FIGURE 8).

The advantage of an arrangement with the fins in alternate direction lies in that the profile of the corridors provided between the columns of tubes *BB*, *CC*, *DD* is different, and that in addition the passages *F* provided for the fluid *A* between adjoining corridors are traversed by the fluid sometimes towards the right and sometimes towards the left, thereby equalising the flow in the corridors.

3

Finally, in the arrangement illustrated in FIGURES 9 and 10, the concave face *e* of the thick-based tangential fins *d* has been turned towards the plain tube *a*. In FIGURE 9, a staggered arrangement is illustrated, with alternation of the plain tubes and finned tubes in rows HH, II, and so on, the plane faces of the tangential fins being all positioned in the same direction. On the other hand, in the case of FIGURE 10, a staggered arrangement is shown in which the plane faces *d* of the tangential fins are directed towards the right of the tubes *a* with which they cooperate downstream, in the case of the row JJ, while in the case of the row HH they are directed to the left.

In the drawings plain tubes and finned tubes having the same diameter have been shown, but their diameters could be different.

Amongst other advantages offered by the different combinations which have just been described, and which enable any profile desired for the flow of the outer fluid to be obtained at the same time as the sweeping of the surfaces of the plain tubes, it is seen that, in the case where the tubes are associated in series as illustrated in plan view in FIGURE 11, a plain tube *a* being traversed by the interior fluid between two neighbouring finned tubes *b*, since it is possible in a single operation and without welding to produce the straight tube *a* with its two connecting bends *f1* and *f2*, it is thus possible to reduce the number of welds to be made for the connection of the tubes to one another. Moreover, the sweeping of the plain tubes effected by the arrangements forming the subject of the invention has the effect that the performance of the exchanger is comparable to that given by an exchanger in which all the tubes are finned, so that, by using plain tubes for half of the tubes in the exchanger, a considerable saving in the cost is obtained at the same time.

It is obvious that modifications of detail can be made to the performance of this invention, without departing from its scope as defined in the following claims.

What I claim is:

1. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, a plain tube being disposed adjacent each finned tube and each fin of each finned tube extending in a plane different from the plane passing through the center of the immediately adjacent plain tube and each fin being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium to define a flow path between each finned tube and its adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

2. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, said plain tubes being arranged in rows and said finned tubes being arranged in rows, said tubes being disposed in alternating relationship with a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium

4

to define a flow path between each finned tube and its adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

3. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, said plain tubes being arranged in rows and said finned tubes being arranged in rows, said tubes being disposed in alternating relationship with a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium to define a flow path between each finned tube and its adjacent plain tube, with the planes of the fins of each of the finned tubes being approximately tangential to the surface of the adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

4. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, said plain tubes being arranged in rows and said finned tubes being arranged in rows, said tubes being disposed in alternating relationship with a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium adjacent each finned tube and the fins being disposed to define a flow path between each finned tube and its adjacent plain tube, with the planes of the fins of each of the finned tubes being approximately tangential to the surface of the adjacent plain tube, said planes of the fins in the bank being alternately inclined to the left and to the right of the adjacent plain tubes, the ends of the said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

5. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, the outer diameter of the plain tubes being different from the outer diameter of the second finned tubes, a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium to define a flow path between each finned tube and its adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes

5

and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

6. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium to define a flow path between each finned tube and its adjacent plain tube, said fins having a thick base and a plane face which is tangential to the surface of the tube, the plane face of the fin being approximately tangential to one side of the adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes.

7. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, a plain tube being disposed adjacent each finned tube and the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium to define a flow path between each finned tube and its adjacent plain tube, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes, said fins increasing in thickness as they merge with the second tubes

6

and at least one side of each fin curving outwardly from the fin axis as it merges with the associated tube.

8. A tubular heat exchanger comprising a bank of tubes disposed with their longitudinal axes substantially parallel and at right angles to the principal direction of flow of the external heat exchange medium through the exchanger, said bank of tubes including a plurality of plain tubes having cylindrical surfaces and a plurality of second tubes having longitudinal fins extending from their outer surfaces, said plain tubes being arranged in rows and said finned tubes being arranged in rows, said tubes being disposed in alternating relationship with the fins of each finned tube extending linearly in a direction away from the center of the adjacent plain tube and being disposed obliquely with respect to the principal direction of flow of the external heat exchange medium adjacent each finned tube and the fins being disposed to define a flow path between each finned tube and its adjacent plain tube, with the planes of the fins of each of the finned tubes being approximately tangential to the surface of the adjacent plain tube, said planes of the fins in the bank being alternately inclined to the left and to the right of the adjacent plain tubes, the ends of said fins being substantially spaced from the surfaces of said plain tubes and leaving a free flow path over the entire surfaces of said plain tubes whereby the external heat exchange medium flows across the opposed surfaces of both the finned tubes and the plain tubes, said fins increasing in thickness as they merge with the second tubes, one side of each fin curving outwardly from the fin axis as it merges with the associated tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,710,676	Wolfe	Apr. 23, 1929
1,757,621	De Lorenzi	May 6, 1930
1,884,777	Lucke	Oct. 25, 1932
1,942,676	Williams	Jan. 9, 1934
2,167,333	Foss	July 25, 1939
2,547,021	Lassiat et al.	Apr. 3, 1951
2,650,802	Huet	Sept. 1, 1953
2,677,532	Huet	May 4, 1954
2,828,723	Miller	Apr. 1, 1958

FOREIGN PATENTS

493,130	Great Britain	Dec. 31, 1936
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