May 22, 1962 R. GREGORIG 3,035,818

HEAT EXCHANGER

Filed June 2, 1958 2 Sheets-Sheet 1

Fig.1

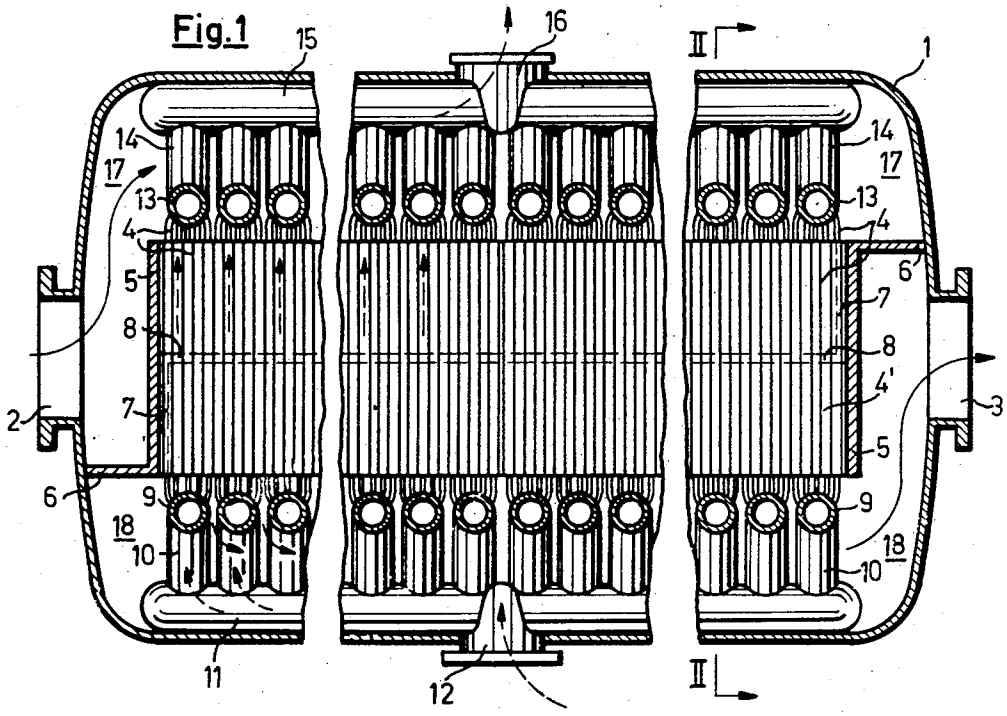
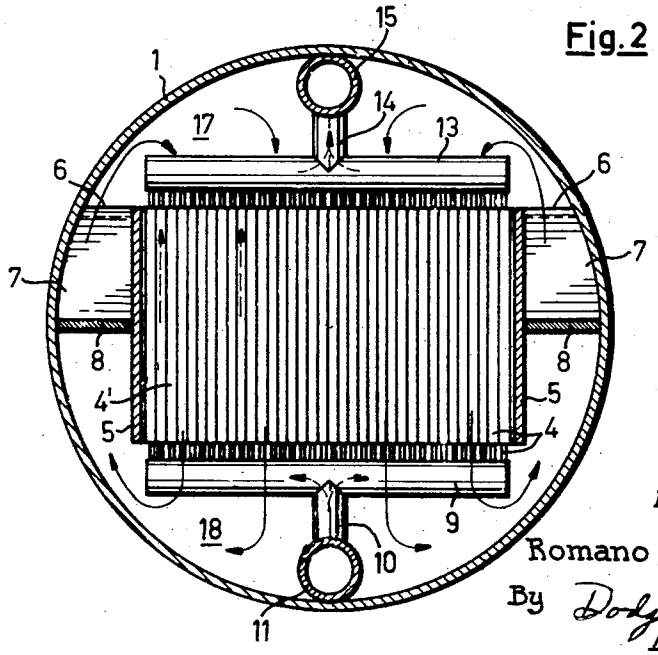


Fig.2



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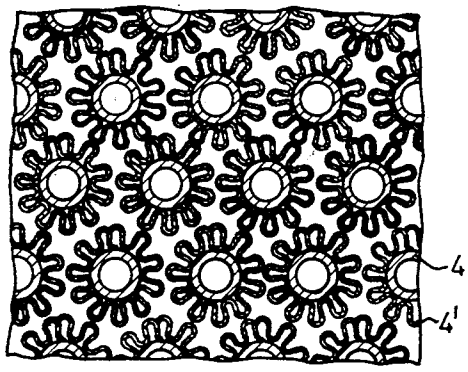


Fig. 4

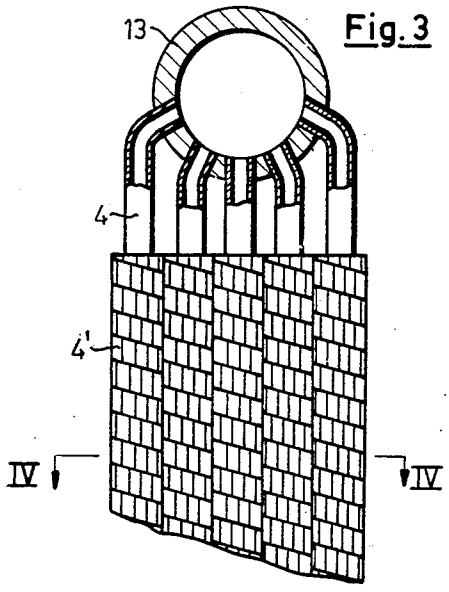


Fig. 3

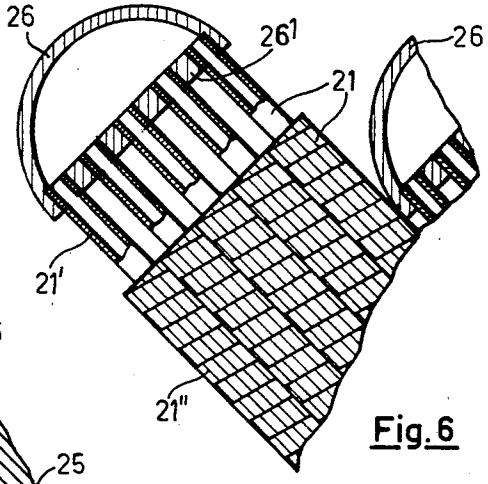
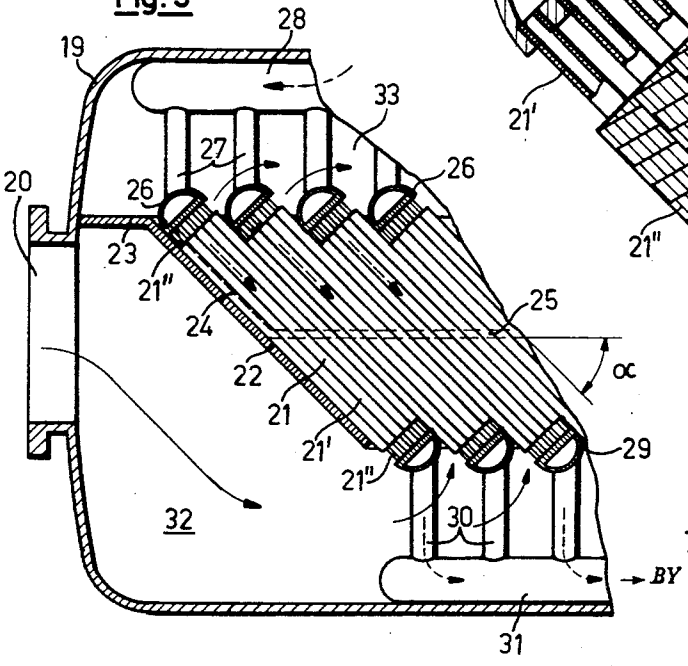


Fig. 6

Fig. 5



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HEAT EXCHANGER

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9 Claims. (Cl. 257—235)

This invention relates to a heat exchanger having a housing of circular cylindrical form, for heat exchange between two media, comprising a large number of tubes as heat exchange elements, the inner and outer walls of which are washed by the media in the axial direction of the tubes and which are connected in parallel with one another.

The heat transfer coefficient of a medium whose state of aggregation does not change during the flow along the heat-transmitting wall can be increased under otherwise constant conditions by increasing its speed of flow. However, the pressure loss is thus also increased by reason of the flow resistances.

Therefore, in heat exchange elements to which special measures have been applied for increasing the surfaces washed by the heat carrier, for example in the case of finned tubes having fins of small dimensions, economic considerations have led to the use of a large number of tubes of relatively short length.

However, this has hitherto resulted in tube assemblies of very large diameter when coaxial housings of circular cylindrical form, which are advantageous from the viewpoint of stress, have been employed for the heat exchangers. The housings have thus been heavy and costly and their dimensions have sometimes been such that they could not be transported by railway. It is true that the diameter can be reduced as desired by dividing them into a number of smaller parallel-connected heat exchangers, but the cost of production and the space required could not thereby be reduced.

The present invention has for its object to obviate the aforesaid disadvantages without sacrificing the advantages of the circular cylindrical housing form and of the cheap and readily inspected single-housing type of construction. In accordance with the invention, for this purpose, in a heat exchanger of the type described at the beginning the heat exchange tubes extend in parallel with one another in a direction forming an angle of at least 30° with respect to the the longitudinal direction of the housing, and the whole assembly of the heat exchange tubes is laterally surrounded, at least over part of the tube length, by a frame which is so connected to the housing by means of partitions that there are formed in the housing two compartments which communicate with one another only through the frame aperture but are otherwise separated from one another. The heat exchange tubes are connected in groups to subsidiary headers which in turn are connected to main headers provided with inlet and outlet branches.

Constructional examples of the subject of the invention are illustrated in simplified form in the drawings, in which:

FIGURE 1 is an axial longitudinal section through a heat exchanger.

FIGURE 2 is a section along the line II—II of FIGURE 1.

FIGURE 3 shows on a larger scale one end of a group of tubes of the heat exchanger illustrated in FIGURE 1.

FIGURE 4 shows on a even larger scale a section through tubes of the group along the line IV—IV of FIGURE 3.

FIGURE 5 is an axial longitudinal section through a part of another heat exchanger, and

FIGURE 6 shows on a larger scale a section through a subsidiary header of the heat exchanger illustrated in FIGURE 5.

In the constructional example illustrated in FIGURES 1 to 4, in a housing **1** of circular cylindrical form having an inlet branch **2** arranged longitudinally at one end and an outlet branch **3** at the other end thereof, there are disposed a large number of heat exchange tubes **4** provided with longitudinal fins **4'**. The whole assembly of these tubes is laterally surrounded by a frame or duct **5** connected to the housing **1** by means of partitions **6, 7, 8.** The one ends of the tubes **4** open into subsidiary inlet headers **9** which in turn are connected by means of tubes **10** to a main inlet header **11** having an inlet branch **12.** The other ends of the tubes **4** open into subsidiary outlet headers **13** which are connected by means of tubes **14** to a main outlet header **15** having an outlet branch **16.** The heat exchange tubes **4** are assembled in groups, each group being associated with one of the subsidiary inlet headers and one of the subsidiary outlet headers.

The main inlet and outlet headers **11, 15**, respectively, are formed as tubes extending in the longitudinal direction of the housing and are situated inside and adjacent the housing in diametrically opposite positions. The branches **12, 16** traverse the housing. The subsidiary headers **9, 13** are tubes which extend perpendicularly to the main headers and are disposed within the housing in two parallel rows extending in the longitudinal direction of the housing, one row comprising the subsidiary inlet headers **9** and the other row the subsidiary outlet headers **13.** The tubes **4** extend substantially at right angles with respect to the longitudinal direction of the housing and to the subsidiary headers.

The partitions **6** and **8** extend in the longitudinal direction of the housing and, together with the intermediate partitions **7,** divide the space between the frame **5** and the housing into two compartments **17, 18,** the first communicating with the inlet branch **2** and the upper aperture of the frame **5** and the other with the lower aperture of the frame **5** and the outlet branch **3.**

One of the heat exchanging media enters the compartment **17** of the housing **1** through the inlet branch **2** and is thus caused to flow through the interior of the frame **5** between the heat exchange tubes **4** in the longitudinal direction thereof and then to discharge through the compartment **18** of the housing and the outlet branch **3.** The other heat exchanging medium which enters the main inlet header **11** through branch **12** is led in parallel through the subsidiary inlet headers **9,** the tubes **4** and the subsidiary outlet headers **13,** and is then collected by the main outlet header **15** and finally discharged through branch **16.**

As shown in FIGURES 3 and 4, the longitudinal fins **4'** of the tubes **4** are formed by helically wound corrugated strips which are connected to the tubes. In order to facilitate the entrance of the medium from the compartment **17** of the housing into the space between the tubes **4,** the end portions **4''** of the tubes, which are connected to the subsidiary headers **13,** are bare. The other ends of the tubes **4** are connected to the subsidiary headers **9** as shown in FIGURE 3 for the subsidiary headers **13.**

With the described constructional form it is thus possible to dispose the necessary number of heat exchange tubes in a relatively long prismatic space the form of which can be adapted to the existing conditions, and nevertheless to retain the favorable circular cylindrical housing form. The closed long hollow cylinder has the advantage over the short cylinder of large diameter that it has lower weight with the same capacity, while being loaded by the same internal pressure. The entire space situated outside

the frame 5 within the housing 1 is utilized for the admission and the discharge of the medium flowing outside the tubes 4, and there exist substantially no spaces containing stagnant medium.

Moreover, by reason of the incorporation of the subsidiary headers 9, 13 and the main headers 11, 15 in the interior of the housing 1, the space situated between these headers is also utilized for guiding the medium flowing outside the tubes 4. The housing encloses the entire arrangement and only the inlet and outlet branches for the two media project from the housing.

In the constructional form illustrated in FIGURES 1 and 2, the heat exchange tubes 4 extend in a direction forming an angle of 90° with the longitudinal direction of the housing. This positioning of the tubes 4 has the advantage that the installation of parts within the housing is simplified and that the entire heat exchanger occupies a relatively small space in the longitudinal direction of the housing.

FIGURE 5 shows another arrangement of the heat exchange tubes. The heat exchanger comprises a circular cylindrical housing 19 having an inlet branch 20 longitudinally at one end thereof. Heat exchange tubes 21 having a finned portion 21' and bare end portions 21'' are laterally surrounded by a frame 22, which is connected by means of partitions 23, 24, 25 to the housing 1. The one ends of the tubes 21 open into subsidiary inlet headers 26 which are connected, by means of tubes 27, to a main inlet header 28, and the other ends of the tubes 21 into subsidiary outlet headers 29 which are connected, by means of tubes 30, to a main outlet header 31. The main headers 28 and 31 are arranged similarly to the main headers 11 and 15 of FIGURE 1, and are provided with an inlet and an outlet branch respectively (not shown).

In contradistinction to the arrangement according to FIGURE 1, the heat exchange tubes of the embodiment shown in FIG. 5 extend in a direction which forms an angle α which is less than 90°, namely about 45°, with respect to the longitudinal direction of the housing 17, so that the rows of the subsidiary headers 26 and 29 are offset in relation to one another in the longitudinal direction of the housing 17.

The opposite end of the heat exchanger is constructed similarly to that shown in FIGURE 5 and would be illustrated by turning FIGURE 5 about an angle of 180° and reversing the arrows showing the flow of the heat exchanging media.

The partitions 23, 24, 25, again, divide the housing into two compartments 32 and 33, whereby the heat exchanging medium entering the compartment 32 through inlet branch 20 is caused to flow through the interior of the frame 20 longitudinally of the tubes 21 and to discharge through the compartment 33 and the outlet branch (not shown) situated at the other end of the housing. The other heat exchange medium flows through the main inlet header 28, then in parallel through the subsidiary inlet headers 26, the heat exchange tubes 21, the subsidiary outlet headers 29 and is finally collected by the main outlet header 31 and discharged.

The staggered arrangement of the different groups of the heat exchange tubes 21 associated with respective pairs of subsidiary headers 26, 29 allows to give the subsidiary headers plane walls facing toward the heat exchange tubes, without obstructing the passage of the heat exchange medium flowing outside the tubes 21. It is then possible to use straight tubes having all the same length as heat exchange elements.

As shown in FIGURE 6, the subsidiary headers 26 have plane walls 26^1 extending perpendicularly to the tubes 21. The said walls 26 are provided with apertures 34 into which the tube ends 21'' open. Although these plane walls 26^1 extend over the entire cross-section of the associated group of tubes 21, the staggered arrangement allows the medium flowing outside the tubes to discharge laterally from between the bare tube ends 21''. The same applies for the inflow of the medium between the bare tube ends 21'' connected to the subsidiary headers 29.

In both constructional examples the whole assembly of the heat exchange tubes occupies a prismatic space so that the frame 5 or 22 accordingly has a rectangular aperture and consists of plane walls. It can therefore be very simply constructed.

What is claimed is:

1. A heat exchanger comprising a housing having a wall formed with a cylindrical portion of circular shape in transverse cross-section and end portions closing opposite ends of the cylindrical portion; a longitudinally extending partition connected with the housing and dividing it into two closed chambers; inlet and outlet headers located on opposite sides of the partition; a chamber inlet branch connected with one of the chambers and a chamber outlet branch connected with the other of the chambers, each of said chamber inlet and outlet branches passing through the wall of the housing; a header inlet branch connected with the inlet header and a header outlet branch connected with the outlet header; an aperture formed in the partition; and a plurality of heat exchange tubes connected at their opposite ends to the inlet and outlet headers and passing through the aperture, the axes of the tubes being parallel and forming an angle of at least 30° with the longitudinal axis of the housing, the tubes being closely spaced from one another to define parallel paths extending substantially longitudinally of the heat exchange tubes and interconnecting the two chambers.

2. A heat exchanger comprising a housing having a wall formed with a cylindrical portion of circular shape in transverse cross-section and end portions closing opposite ends of the cylindrical portion; a longitudinally extending partition connected with the housing and dividing it into two closed chambers; inlet and outlet headers located on opposite sides of the partition; a chamber inlet branch connected with one of the chambers and a chamber outlet branch connected with the other of the chambers, each of said chamber inlet and outlet branches passing through the wall of the housing; a header inlet branch connected with the inlet header and a header outlet branch connected with the outlet header; an aperture formed in the partition; a plurality of heat exchange tubes connected at their opposite ends to the inlet and outlet headers and passing through the aperture, the axes of the tubes being parallel and forming an angle of at least 30° with the longitudinal axis of the housing, the tubes being closely spaced from one another to define parallel paths extending substantially longitudinally of the heat exchange tubes and interconnecting the two chambers; and a duct connected to the partition and passing through the aperture formed in it, the duct surrounding the heat exchange tubes over a substantial portion of the length of these tubes.

3. The heat exchanger defined in claim 2 in which the heat exchange tubes are arranged in groups; and in which the inlet and outlet headers each comprise a main header of tubular shape which extends longitudinally of the housing and which communicates with one of the header branches, a plurality of subsidiary headers of tubular shape, one connected with each group of heat exchange tubes, and flow connections between each subsidiary header and the main header.

4. The heat exchanger defined in claim 3 in which the main headers are located inside and adjacent the housing in diametrically opposite positions, and the header branches connected with these main headers traverse the wall of the housing.

5. A heat exchanger comprising a housing having a wall formed with a cylindrical portion of circular shape in transverse cross-section and end portions closing opposite ends of the cylindrical portion; a longitudinally extending partition connected with the housing and dividing it into two closed chambers; a main inlet header

of tubular shape located in one chamber adjacent the cylindrical wall portion and extending longitudinally of the housing; a main outlet header of tubular shape located in the other chamber adjacent the cylindrical wall portion at a position diametrically opposite the main inlet header and extending longitudinally of the housing; a plurality of subsidiary inlet headers of tubular shape located in said one chamber and connected with the main inlet header, the axes of the subsidiary inlet headers lying in a first common plane; a plurality of subsidiary outlet headers of tubular shape located in said other chamber and connected with the main outlet header, the axes of the subsidiary outlet headers lying in a second common plane parallel with the first common plane, each subsidiary outlet header being paired with one subsidiary inlet header and the axes of the headers in each pair lying in a plane that intersects the longitudinal axis of the housing, the planes of said paired axes being spaced from each other along the longitudinal axis of the housing; a chamber inlet branch connected with one of the chambers and a chamber outlet branch connected with the other of the chambers, each of said chamber inlet and outlet branches passing through the wall of the housing; a header inlet branch connected with the main inlet header and a header outlet branch connected with the main outlet header, each of said header branches passing through the wall of the housing; an aperture formed in the partition; a plurality of groups of heat exchange tubes passing through the aperture, the opposite ends of the tubes in each group being connected with the subsidiary inlet and outlet headers of one of said pairs of subsidiary headers, the axes of the heat exchange tubes being parallel and forming an angle of at least 30° with the longitudinal axis of the housing and the tubes being closely spaced from one another to define parallel paths extending substantially longitudinally of the tubes and interconnecting the two chambers; and a duct connected to the partition and passing through

the aperture formed in it, the duct surrounding the heat exchange tubes over a substantial portion of the length of these tubes.

6. The heat exchanger defined in claim 5 in which the planes containing the pairs of subsidiary headers associated with each group are normal to the longitudinal axis of the housing, whereby the axes of the heat exchange tubes form angles of 90° with the longitudinal axis of the housing.

7. The heat exchanger defined in claim 5 in which the planes containing the pairs of subsidiary headers associated with each group form angles of less than 90° with the longitudinal axis of the housing; and in which the subsidiary headers have approximately plane walls facing toward the associated groups of heat exchange tubes, these walls containing apertures into which the ends of the tubes open; and the heat exchange tubes are straight.

8. The heat exchanger defined in claim 2 in which the heat exchange tubes are provided with longitudinal fins in the region in which they are surrounded by the duct.

9. The heat exchanger defined in claim 5 in which the chamber inlet and outlet branches connected with the two chambers pass through the end portions that close the ends of the cylindrical portion.

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