Aug. 9, 1966 P. LEGRAND 3,265,128

TUBULAR NEST FOR HEAT EXCHANGER AND EXCHANGER EQUIPPED THEREWITH

Filed Jan. 17, 1961 2 Sheets-Sheet 1

Fig. 1.

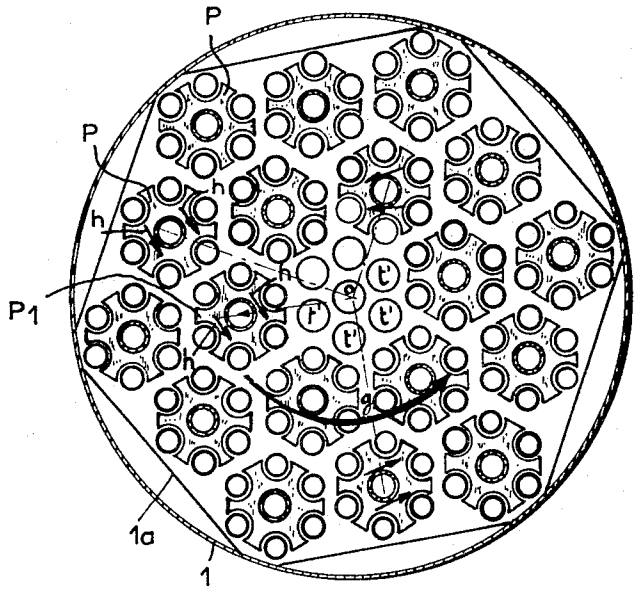
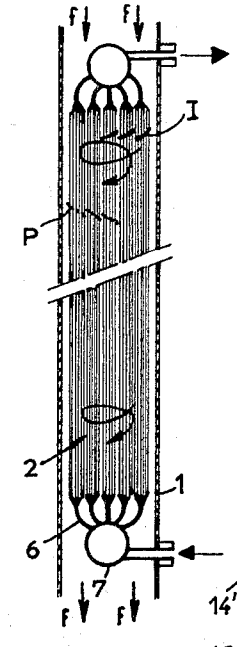


Fig. 2.



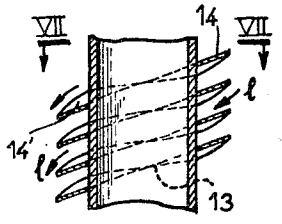


Fig. 6.

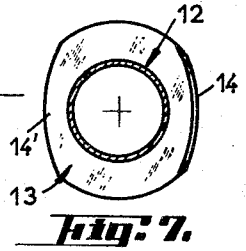


Fig. 7.

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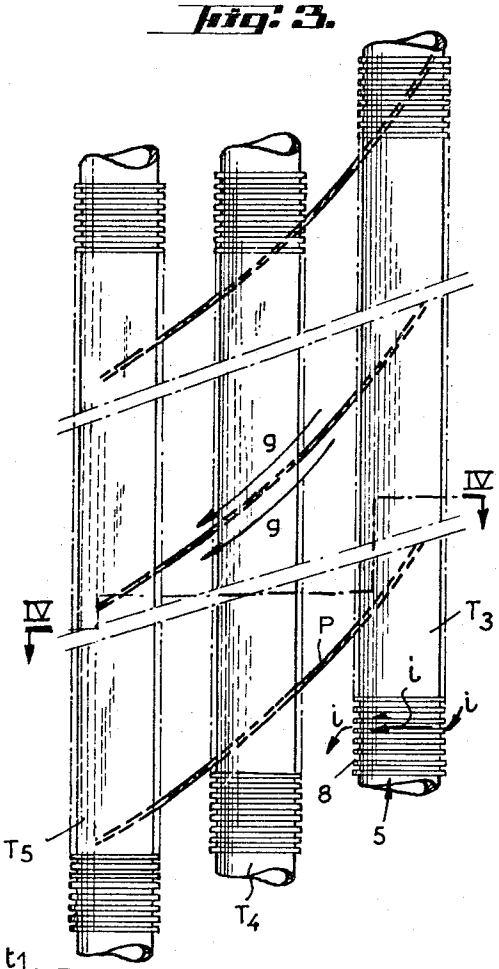
Fig: 3.



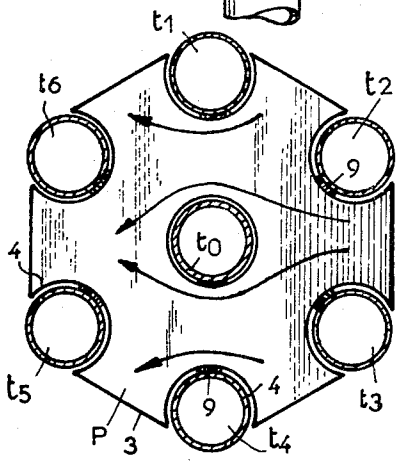
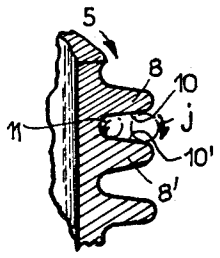


Fig: 4.

Fig: 5.



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3,265,128

TUBULAR NEST FOR HEAT EXCHANGER AND EXCHANGER EQUIPPED THEREWITH

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Claims priority, application France, Jan. 22, 1960, 816,539
6 Claims. (Cl. 165—159)

This invention relates to heat exchangers and has specific reference to improvements in tubular nests therefor.

In prior patent applications the applicant described tubular nests in which a transverse and/or gyratory motion is imparted by means of baffle or guide plates to the fluid circulating between the tubes constituting the nests.

It is an object of the present invention to provide, in a tubular nest of the type broadly set forth hereinabove means for imparting a general gyratory motion to the external fluid circulating between the tubes. A heat exchanger made in accordance with the present invention comprises a cylindrical casing for a fluid circulated in a general longitudinal direction, a nest of transversely finned straight tubes distributed according to substantialy regular intercommunicating mesh patterns to form a plurality of tube bundles arranged in concentric layers which are symmetrically disposed about a common longitudinal axis, guiding plate means fitting each bundle of each layer, said guiding plate means being so disposed along said tubes as to constitute with the relevant plate means of the other bundles of the layer concerned at least one discontinuous substantially helicoid surface winding about said longitudinal axis thereby imparting a transverse gyratory motion to said fluid in order to force the same between and along the fins provided on said tubes.

Other features and advantages of the invention will become evident from the following description with reference to the accompanying drawing illustrating diagrammatically by way of example typical forms of embodiment of the invention. In the drawing:

FIGURE 1 is a diagrammatic cross-sectional view showing the tubular nest of heat exchanger according to the invention;

FIGURE 2 is a longitudinal section showing on a smaller scale the general structure of the heat exchanger of FIGURE 1;

FIGURE 3 is a fragmentary elevational view showing on a larger scale a detail of the nest of FIGURE 1;

FIGURE 4 is a cross section taken along the broken line IV—IV of FIGURE 3;

FIGURE 5 is a half axial section showing a detail of a heat exchanger tube according to a specific form of embodiment of the invention;

FIGURE 6 is a fragmentary elevational view showing a detail of a heat exchanger tube according to this invention, and

FIGURE 7 is a cross section taken upon the line VII—VII of FIGURE 6.

In the example illustrated in FIGURES 1 to 4 of the drawing a heat exchanger element (of which FIGURES 1 and 2 show in diagrammatic form, the outer housing **1** and the tubular nest **2**) is provided with baffle or guide plates P so disposed as to impart a general whirling or gyratory motion in the direction of the arrow *g* to the fluid circulating within the tubes in the direction of the arrow *f*, FIGURE 2. To this end, the plates P may be disposed to form a substantially helical surface. If desired, these plates may also, as illustrated, be disposed as helicoids or parallel to helicoids, the plates being or to surfaces similar to helicoids parallel to one another and having as a common axis the longitudinal axis of the tubular nest. Each plate P is associated with a given

group of tubes, for example all the tubes constituting one mesh of the pattern formed by this nest as seen in cross section. In the example illustrated this mesh pattern is of hexagonal configuration and each plate P receives therethrough the tube to constituting the central tube of the pattern, each plate having fitted and fits at its periphery the other six tubes t_1, t_2 . . . t_6 disposed at spaced intervals about the central tube t_0. Each plate P has a general hexagonal configuration and its peripheral edge **3** containing the six outer tubes t_1, t_2 . . . t_6 is formed to this end with notches **4** receiving these tubes. The plate is secured in the desired axial position for example by being welded at different points **9** with some or all of the tubes of the nest.

As a rule these plates P are disposed transversely and slightly inclined in relation to the longitudinal axis of the tubes. They are concavo-convex as illustrated in FIGURE 3 and may have the shape of portions of cylindrical surfaces.

Moreover, these plates are so arranged that, as exemplified by the plate P_1, the direction of the generatrices of this plate forms an acute angle with the radius r_1 issuing from the center O of the element and leading thereto, so as to produce locally a centripetal effect (see arrow *h*) in the fluid of which the general gyratory motion is designated diagrammatically by the arrow *g* (FIGURE 1).

Thus, the fluid circulating between the tubes is prevented from being thrown toward the periphery of the element as a consequence of its gyratory motion.

The tubes utilized in a nest of the type described and illustrated may be either plain or provided with thin transverse fins as illustrated diagrammatically at **5** in FIGURE 3.

In this case, it will be seen that the gyratory motion impressed on the external fluid by the plates P produces a transverse displacement of the fluid in a direction substantially parallel to the plate of these fins **8**, thus promoting (see arrow *i*) the contact and therefore the heat transfer between this fluid and the tube fins.

According to another form of embodiment illustrated in FIGURE 5 the fins **8** of these tubes **5** have a substantially V-shaped cross sectional configuration and their depth is preferably so determined as to produce one or a plurality of whirling motions within the external fluid circulating between these fins. Thus, for example, their contour and relative spacing may be so determined as to provide, through a kind of resonance, two complementary whirling actions as shown diagrammatically by the arrows *j* and *k*; in this case a rounded portion **11** developing the whirl *k* is provided at the junction of the registering walls **10**, **10'** of two adjacent fins **8**, **8'**, so that the external fluid is compelled to sweep the fins **8**, **8'** throughout their depth.

The structure of the tubular nest proper may also differ from that illustrated. Thus, instead of being connected to intermediate headers **6** the different tubes constituting one mesh pattern of the net may lead directly to a common header such as **7**.

Preferably, a nest adapted to be easily inscribed in a cylindrical outer casing **1** or in a regular polygonal inner casing **1***a* will be used in order to provide, by using the corresponding polygonal mesh pattern, a maximum coefficient of filling and a distribution as uniform as possible of the external fluid among the tubes.

Considering tubes disposed in the central zone of the element and free of any baffle plates, these tubes *t'* may have greater diameters and be disposed at a smaller relative spacing than the other tubes t_0 . . . t_6, so as to create, in this central zone, cross-sectional passage areas providing for the external fluid a resistance of the same order as in the remaining section of the element with a view to render the heat transfer more uniform.

In the alternate embodiment illustrated in FIGURES 6 and 7 of the drawing the guide plates P of the preceding examples consist of the transverse fins **13** of finned tubes **12** constituting the tubular nest. To obtain the desired gyratory motion these fins are curved or bent in opposite directions at two substantially diametrically opposite points as shown at **14** and **14'**, so as to force the external fluid along the path shown by the arrows *l*.

Preferably, the plane of curvature of these fins with respect to the longitudinal axis of the heat exchanger element is directed like the planes of curvature of the guide plates P of the preceding examples, that is, with a view to create within the external fluid a general gyratory motion and a local centripetal effect about each tube. Of course, it would not constitute a departure from this invention to provide in the fins **13** a single curved or bent portion **14** at the place where these fins act as leading edges with respect to the external fluid.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention as defined by the appended claims.

What I claim is:

1. In a heat exchanger, a cylindrical casing for a fluid circulated in a general longitudinal direction, a nest of transversally finned straight tubes distributed according to substantially regular intercommunicating mesh patterns to form a plurality of tube bundles arranged in concentric layers which are symmetrically disposed about a common longitudinal axis, guiding plate means fitting each bundle of each layer, said guiding plate means being so disposed along said tubes as to constitute with the relevant plate means of the other bundles of the layer concerned at least one discontinuous substantially helicoid surface winding about said longitudinal axis thereby imparting a transverse gyratory motion to said fluid in order to force same between and along the fins provided on said tubes.

2. A heat exchanger according to claim **1** wherein each of said bundles is constituted by transversally finned straight tubes in polygonal mesh arrangement, said guiding plate means of substantially polygonal contour comprising cutout portions fitting the tubes of said bundles and being inclined with respect to said longitudinal axis of said nest of tubes to impart said gyratory motion.

3. A heat exchanger according to claim **2** wherein said guiding plate means are concavo-convex plates.

4. A heat exchanger according to claim **1** wherein said guiding plate means are so directed with respect to the gyratory motion impressed to the fluid that they are each exerting locally a centripetal effect on said fluid.

5. In a heat exchanger, a cylindrical casing for a fluid circulated in a general longitudinal direction, a nest of transversely finned straight tubes distributed according to substantially regular intercommunicating mesh patterns and symmetrically disposed about a common longitudinal axis, guiding plate means fitting said tubes so as to constitute with the relevant plate means of the other tubes at least one discontinuous substantially helicoid surface winding about said longitudinal axis thereby imparting a transverse gyratory motion to said fluid in order to force same between and along the fins provided on said tubes, said guiding plate means consist of the very fins of said transversally finned tubes, each of said fins having at its periphery at one point thereof a concave portion turned towards the incoming fluid.

6. In a heat exchanger, a cylindrical casing for a fluid circulated in a general longitudinal direction, a nest of transversely finned straight tubes distributed according to substantially regular intercommunicating mesh patterns and symmetrically disposed about a common longitudinal axis, guiding plate means fitting said tubes so as to constitute with the relevant plate means of the other tubes at least one discontinuous substantially helicoid surface winding about said longitudinal axis thereby imparting a transverse gyratory motion to said fluid in order to force same between and along the fins provided on said tubes, said guiding plate means consist of the very fins of said transversally finned tubes, each of said fins having at its periphery, at two diametrically opposite points thereof, two portions having their concavities turned towards the incoming fluid and towards the opposite direction respectively.

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