Aug. 27, 1957 A. HUET 2,804,287

FINNED TUBE HEAT EXCHANGER

Filed July 2, 1951

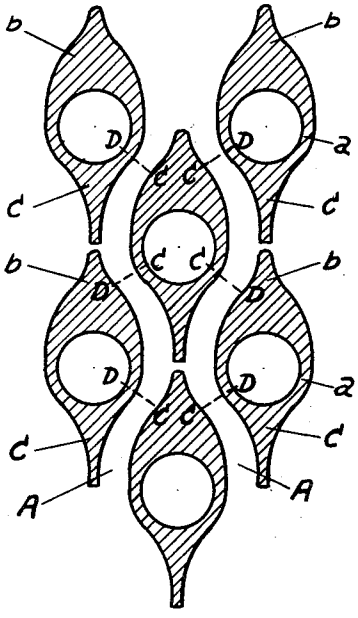

Fig. 1.

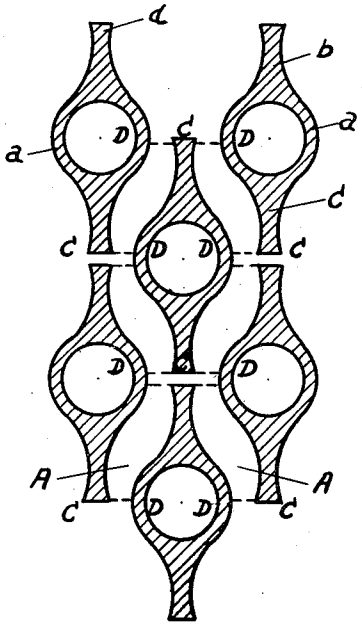

Fig. 2.

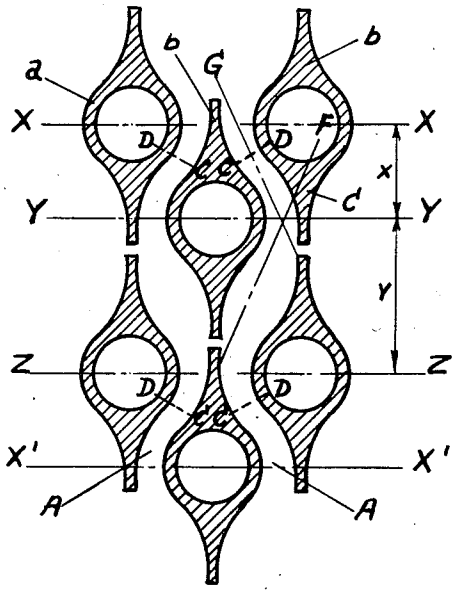

Fig. 3.

ANDRE HUET
INVENTOR.

BY James J. Whalen
ATTORNEY

United States Patent Office 2,804,287 Patented Aug. 27, 1957

2,804,287

FINNED TUBE HEAT EXCHANGER

André Huet, Paris, France

Application July 2, 1951, Serial No. 234,814

2 Claims. (Cl. 257—262.22)

The present invention concerns heat exchangers made up of parallel rows of tubes, preferably staggered, and traversed by a fluid which exchanges its heat with a fluid circulating outside of the tubes. The tubes of such an exchanger can be equipped with longitudinal fins which have the effect of increasing the surface of the tubes at the same time as forming passages which canalize the fluid circulating outside of the tubes.

In an earlier application filed on April 6, 1950, under Serial No. 154,213, now Patent No. 2,677,532, dated May 4, 1954, for "Heat Exchanger with Rational Flow," the applicant described an exchanger of the above type, in which the tubes have tangential fins, that is to say, the general plane of which is tangent to the surface of the tube, and in which the profile of the tangential fins is such that the passages made by said fins between the tubes have alternations of narrowings and widened parts, these variations of section assuring variations of speed and of pressure in the speed of the outer fluid circulating in these passages. Furthermore, the passages thus made have changes of direction of flow which are also favorable to the efficiency of the exchanger.

The present invention has as its subject a heat exchanger with fins, enjoying the same advantages with regard to the courses of the outer fluid, with this particularity that the fins instead of being tangential are diametrical, that is to say, that their general plane is in a diametrical plane of the tube. To obtain in this case changes of direction and of section in the passages made between the fins in the passages, it is provided, according to the present invention, that the fins may be asymmetrical, that is to say that the two fins of the same tube do not have the same profile, one being, for example, thicker than the other; or else the fins are indeed symmetrical, but they have at their end an increased thickness which has the purpose of producing a narrowing of the passage.

The same result may also be obtained according to the present invention by an asymmetry in the staggered arrangement of the exchanger tubes, the interval between two successive rows of tubes being alternately smaller and larger than in the regular staggering.

Moreover, in the case of the asymmetrical staggering method of execution, the general current of the fluid circulating in the passages has changes of direction of flow which may be less than in the case of the exchangers described in the above-cited patent application, and may become as small as desired. This arrangement is important in the case where the outer fluid circulating between the tubes traverses them at quite a high speed, for example greater than 15 m./sec. at atmospheric pressure. The loss of load which results from the passage of the fluid through the canalization is then less than in the case in which the changes of direction are relatively large.

The description which follows, with respect to the attached drawings which are given by way of example, will make more understandable the manner in which the invention can be carried out.

Figure 1 shows diagrammatically in vertical section a portion of exchanger according to the present invention, with asymmetrical fins.

Figure 2 shows one variant of execution, with fins with widened tips.

Figure 3 shows another variant with irregular staggering of the tubes.

As may be seen from the drawings, the exchanger which is the subject of the invention is made up of parallel rows of tubes *a*, the tubes being staggered, that is to say that one tube is placed in the center of a square, rectangle, or parallelogram, the apices of which are occupied by the four surrounding tubes. Each tube is equipped with two diametrical fins *b*, *c*, that is to say, the general plane of which is in a diametrical plane of the tube, and which are such that the lower fin *c* of one tube comes near the upper fin *b* of the corresponding tube located in the second row below, so as to make between the tubes winding passages A which are traversed by the outer fluid which exchanges its heat with the fluid circulating inside of tubes *a*.

According to the present invention fins *b*, *c* are asymmetrical, that is to say that the upper fins *b* are of a profile which differs from the fins *c* and to be exact, are thicker. Between the thick section of each fin *b* and the adjacent tube *a* there is thus in the passage A a narrowed section marked C D in the drawing and indicated by a dotted line. One sees therefore that the fluid stream circulating in the passage A undergoes a contraction in each passage C D followed by an expansion in the interval which separates two consecutive regions of narrowing C D. The fins *b*, *c* provided on the tubes may be hollow or solid fins, joined or welded onto the tube in any suitable way, or else tube *a* may be integral with fins *b*, *c*.

In the mode of execution shown in Figure 2 fins *b*, *c* are symmetrical, that is, of identical profile, but having a swelling *d* at their ends, so that at the height of this swelling in each passage A there is produced a narrowing zone C D of the passage between said swelling and the part of the tube *a* opposite. As may be seen, with this arrangement, each passage A has, as in the preceding case, a series of narrowings C D separated by widened parts of the passage.

In the mode of execution shown in Figure 3 the same effect is obtained by fins *b*, *c*, symmetrical, and not thickened, but owing to an asymmetrical staggering of the tubes. That is to say that the tubes uniformly spaced in horizontal rows and the first row located along the plane X X, the second row Y Y is closer to the plane X X than the lower row along Z Z. It results therefrom that each tube finds itself no longer in the center of a rectangle, the apices of which are occupied by the four adjacent tubes. The distance *x* which separates the planes X X and Y Y is smaller than the distance *y* which separates the planes Y Y and Z Z, and the same arrangement is repeated over the entire height of the exchanger. Owing to this arrangement, the passages made between the fins and the tubes have narrowed parts C D at the places indicated on the figure, approximately at the height of the base of each upper fin *b* of the adjacent tube.

The fluid which circulates in the passages A undergoes in addition changes of general direction of flow, that is to say, that in the case of Figure 3, for example, between two narrowings C—D the fluid follows the general direction of arrow F shown in dotted line, then, in the neighborhood of each narrowing it follows the general direction of arrow G shown in dotted line. The angle of these two arrows measures the change of direction. In the case in which the staggering is regular the angle which the two arrows F G is maximum, but it may be seen that, if the staggering is irregular, as shown in

Figure 3, the arrows F G make between themselves an angle which tends to decrease.

If the fluid circulating outside has a great speed, for example more than 15 m./sec. at atmospheric pressure, it is well to lessen the change of direction in order to prevent the load losses due to these changes of direction from being too great.

One can, by a judicious choice of the irregularity of the staggering, give to the change of direction the value desired.

It goes without saying that changes of detail may be introduced in the carrying out of this invention, and that in particular, one can combine the different modes of execution proposed: asymmetry of the fins and irregular staggering to obtain all profiles of passages and changes of direction which might be favorable to the exchange of heat.

What I claim is:

1. In a heat exchanger having a passage through which heating gases flow over a plurality of fluid circulating tubes disposed transversely of the gas stream in parallel rows located in planes perpendicular to the direction of gas flow with the tubes in any row uniformly spaced and those of adjacent rows being staggered with respect to each other; a pair of heat transfer fins mounted on each tube to extend longitudinally thereof and projecting from the surfaces of the tubes in substantially a diametrical plane parallelling the general direction of gas flow and having lateral faces curved from their distal ends to their junction with the tube surface at points where the lateral fin surfaces become substantially tangential to the tube surface with the distal ends of fins on tubes in alternate rows alined with each other so as to divide said passage into a number of sinuous lanes between the tubes and form substantially continuous smooth boundaries therefor, the intermediate rows of tubes being closer to the row of tubes on the upstream side thereof with respect to the direction of gas flow than to the row on the downstream side thereof so as to juxtapose more of the surfaces of the tubes and fins of intermediate rows in confronting relation to the surfaces of tubes and fins in the upstream row and thereby narrow the gas lanes in these regions.

2. A heat exchanger having tubes each provided with a pair of diametrically located longitudinal fins and disposed in separated relation in parallel rows and those of adjacent rows being staggered with respect to each other, the fins having lateral faces concavely curved from their distal ends to their junctions with the tube surface at which points where the lateral fin surfaces are substantially tangential to the tube surface with the distal ends of fins of tubes in alternate rows alined with each other so as to divide said passage into a number of sinuous lanes between the tubes and form substantially continuous boundaries therefor, the intermediate rows of tubes being closer to the row of tubes on one side thereof with respect to direction of gas flow than to the row at the other side thereof so as to juxtapose more of the surfaces of the tubes and fins of intermediate rows in confronting relation to the surfaces of tubes and fins in the row on said one side of the tube and thereby narrow the gas lanes in these regions while widening the gas lanes between the tubes of said intermediate row and said other row as compared with the width of lanes from between similarly finned tubes disposed in uniformly spaced rows.

References Cited in the file of this patent

FOREIGN PATENTS

397,664	Great Britain	Aug. 31, 1933
411,319	Great Britain	June 7, 1934