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FINNED CONSTRUCTION FOR HEAT EXCHANGERS

Filed Nov. 15, 1957

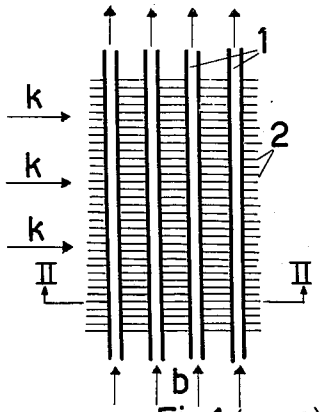


Fig.1. (PRIOR ART)

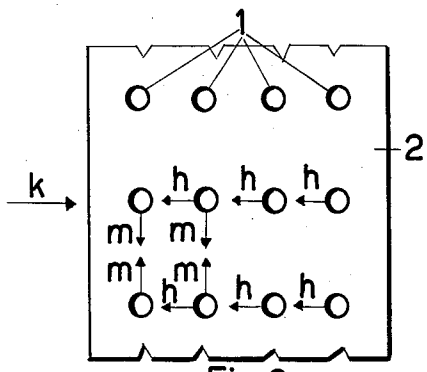


Fig.2. (PRIOR ART)

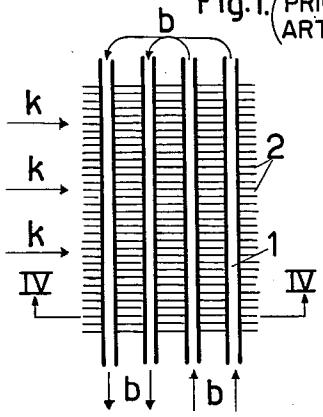


Fig.3.

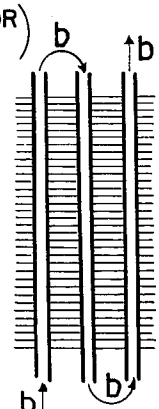


Fig.5.

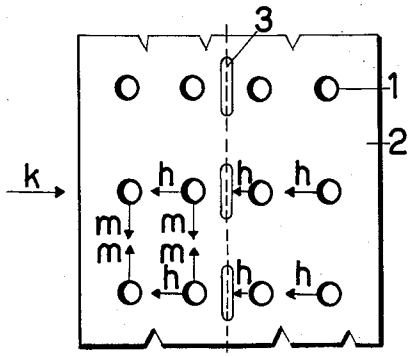


Fig.4.

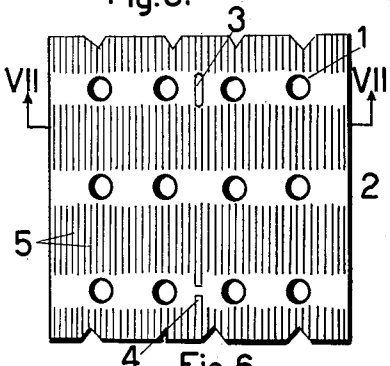


Fig.6.



Fig.7.

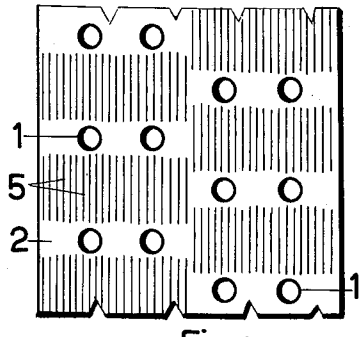


Fig.8.

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FINNED CONSTRUCTION FOR HEAT EXCHANGERS

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1 Claim. (Cl. 257—262.11)

This invention relates to a finned construction for heat exchangers.

The object of this invention is to increase the efficiency of a heat-exchange device without materially increasing its costs.

Theoretical investigations have shown that in a mere crossflow of heat in the tubes, the heat conduction in the fins is advantageous. The heat flow in the fins is a disadvantage, however, in the case of a transversely directed counterflow of heat in the tubes.

It is an object of this invention to overcome this disadvantage and provide for the interruption of the heat flow in fins where the flow of heat in the tubes is reversed.

In the drawings:

Fig. 1 is a longitudinal section of a heat exchanger of the prior art.

Fig. 2 is a cross section along lines II—II of a heat exchanger of the prior art disclosed in Fig. 1.

Fig. 3 is a longitudinal section of a heat exchanger representing a cross-counterflow in tubes according to this invention.

Fig. 4 is a cross section along lines IV—IV of the heat exchanger disclosed in Fig. 3.

Fig. 5 is a longitudinal section of a heat exchanger according to this invention with a double change of flow in the tubes.

Fig. 6 is a plan view of a fin according to this invention.

Fig. 7 is a cross section of the fin disclosed in Fig. 6 along lines VII—VII.

Fig. 8 is a plan view of another construction of a fin according to this invention.

When a heat exchange is to take place between two heat-carrying media having substantially different heat transfer coefficients, it is known that use is advantageously made of a heat exchanger the surfaces of which are provided with fins. The finned surface is used on the side having the lower heat transfer coefficient. Figures 1 and 2 respectively show diagrammatically a longitudinal section and a cross-section of a heat exchanger of this kind. In the figures, reference **1** denotes the tubes having a flat or round cross-section for the heat-carrying medium having the higher heat transfer coefficient and **2** the fins in thermally conductive metallic connection with the tubes. Said fins may for example be made from parts corresponding to the number of tubes forming the heat exchanger. For the purpose of reducing the costs of production, however, it is advantageous to press the fins **2** from one piece. Hereinafter reference will be made only to fins which, pressed from one piece, serve for a plurality of tubes and can be economically produced.

In the case of a heat exchange with a purely transverse flow, the medium having the lower heat transfer coefficient (outer medium) flows in the direction of the arrows *k*, while the medium having the higher heat transfer coefficient (inner medium) flows in the direction of the arrows *b*. In consequence of the heat exchange according to the flow diagram shown in the drawing, the temperature of the two flow media alters in the direction of the arrows *k* and *b* respectively. The temperature variation of the inner medium proceeds in the same direction (either heating or cooling) in each of the tubes 1, but the extent of the temperature variation is different (even when there are equal flows in the various tubes). On examination of the temperature distribution inside the various fins it can be established that the temperature of the fin material at the point of entry of the inner medium near every tube is the same since at this point the temperature of the inner medium in each tube is also the same. Accordingly, at this point there takes place in the individual fins in consequence of the heat exchange a thermal flow only in the direction of the arrows *m* as shown in Figure 2 which are rectangular to the direction of flow of the outer medium. In the direction of the arrows *h* however there is no thermal flow because the temperature of the inner medium flowing in the tubes is the same in each tube. The temperature variation of the inner medium is unequal in the direction of the arrows *b*, so that at a certain distance from the point of entry of the inner medium near the various tubes, temperature differences in the direction of flow of the outer medium can be detected even within a single fin. Accordingly, a thermal flow occurs here in the various fins already in the direction of the arrows *h*. This thermal flow, which can be designated secondary, promotes the heat exchange until a purely cross flow is present.

There are however also cases in which, in order to utilise the temperature difference between the heat-carrying media participating in the heat exchange, it is advantageous to select a so-called cross-counterflow arrangement, which is shown diagrammatically in Figure 3, instead of a purely cross flow. The arrows *b* and *k* denote the directions of flow of the inner and outer media respectively. As will be seen from the drawing, the lowermost fin coincides with the inlet and outlet point of the inner medium, i.e., with that point where the temperature difference between the incoming and outgoing inner medium has the maximum value. Thus in this fin, as will be clear from Figure 4, a thermal flow takes place both in the direction of the arrows *m* and also in the direction of the arrows *h*. In this case, however, the amount of heat flowing transversely to the line broken in the drawing has an adverse effect since it reduces the temperature difference which has arisen in the inner heat-carrying medium in consequence of the heat exchange.

This disadvantage can be obviated in two ways. The first two and the second two tubes in the direction of the arrows *h*, in which the inner heat-carrying medium flows in the same direction, are each provided with special fins, which fins are independent of one another; or, on the other hand, an incision **3** as illustrated in Figure 4 is provided in the material of the fin disposed jointly over the four tubes, between the second and third tube according to the invention. In the former case, in which the fins are made from a plurality of parts according to the tube groups which convey the inner medium in one direction, the greater number of pieces entails increasing production costs. With the invention, however, the fins, independently of the direction of flow of the inner medium, can be made from one piece and hence with low production costs.

Figure 3 illustrates only an exemplified embodiment. It may be that only one tube, or else more than two tubes, are required to produce the flow of the inner medium in the one direction. In such cases, the incision **3** preventing the disadvantageous conduction of heat is

provided between two tubes in which the inner medium flows in countercurrent.

In the exemplified embodiment illustrated in Figure 5, the inner medium changes its direction of flow in the heat exchanger twice. It is, however, also possible to construct heat exchangers with three or even more changes of direction. In such cases, the incision 3 preventing the thermal conduction is in each case provided between two tubes in which the flow of the inner medium is contradirectional. This principle can equivalently be applied even to heat exchangers the fins of which are split up into thin strips for the purpose of promoting the heat transfer.

Figure 6 is a plan view of a fin in which incisions 5 are provided perpendicular to the direction of flow of the outer medium, the fin being subdivided by said incisions. Figure 7 shows the same fin in cross-section on the line VII—VII in Figure 6. The adverse thermal conduction is avoided in such fins by an incision 3 as shown in the top part of Figure 6 or else it is obviated by making the narrow incisions in the fins longer, between the tubes in which the flow of the inner medium is contradirectional, as is clear in the bottom part of Figure 6 at 4.

The embodiment of the type shown in Figure 8 is also suitable for solving the object of the invention, the tubes carrying the inner medium in countercurrent being mutually staggered by half the tube spacing. With this embodiment the fins can also be cleaned by a water jet from both sides of the heat exchanger without the individual fin strips being covered by a tube from the jet of water arriving from outside.

What we claim is:

A heat exchanger comprising a bank of tubes subdivided into groups for carrying a heat exchange medium, one group of said tubes serving for carrying the medium in one direction and another group of said tubes serving for carrying the medium in an opposite direction, a plurality of fins spaced apart longitudinally of the tubes, each fin extending transversely of the tubes and embracing both groups of tubes, said fins having areas between the tubes of each group extending transversely of the groups and provided with a plurality of spaced parallel slits extending longitudinally of the groups of tubes and terminating short of the tubes to form narrow strips pressed out of the fins, at least one pair of the slits in the areas between the groups of tubes extending between the corresponding tubes of each group to form incisions for reducing the flow of heat in the fins between the two groups of tubes.

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