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HEAT EXCHANGE DEVICES

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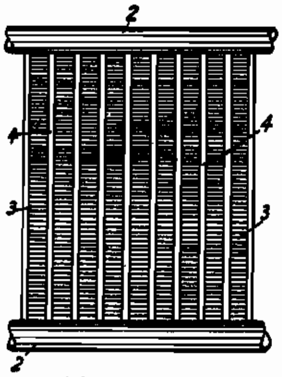

Fig. 1.

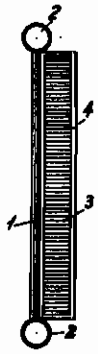

Fig. 2.

Fig. 3.

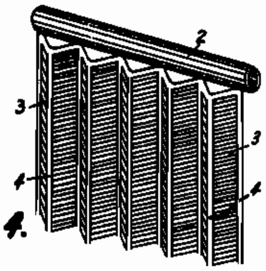

Fig. 4.

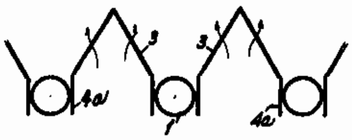

Fig. 5.

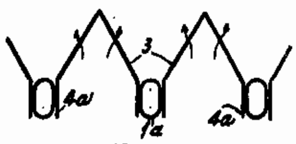

Fig. 6.

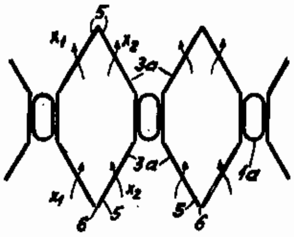

Fig. 7.

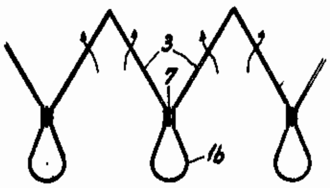

Fig. 8.

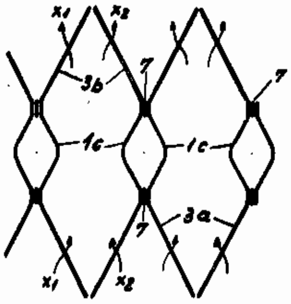

Fig. 9.

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HEAT EXCHANGE DEVICES

Stefan Beck, Budapest, Hungary; vested in the Alien Property Custodian

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The invention relates to an improvement of heat exchange devices in which the heat exchange surfaces in contact with the external medium, e. g. air, to be heated or cooled, are constituted by thin, plate-like apertured bodies through which the external medium flows in transverse or perpendicular direction. By means of such heat exchangers it is possible to obtain a high coefficient of heat transfer with greatly diminished weight of the apparatus. The heat exchanger structures in question may, for instance, consist of a thin perforated plate or of groups of different direction of fine strip-shaped elements or wires, e. g. of a wire mesh and their dimension measured in the direction of the flow of the external medium, e. g. air, is very small. The external medium flowing through such a heat exchange device leaves the surface already after a short contact; on each part of the surface there impinges fresh air which has not been in contact with the surface previously. In consequence hereof, the utilizable difference of temperature between the surface and the medium is increased and therefore the heat transfer becomes more favorable. In the case of earlier heat exchangers, in which the external medium was forced to stream along the heat exchange surfaces along a path of greater length, a heat-insulating layer (Prandtl's boundary layer), adhering to the surface, the thickness of which layer increases in proportion to the length of the surface, was formed along the heat exchange surfaces; as against this, in the apertured heat exchange surfaces possessing, as mentioned, only a very slight dimension in the direction of flow of the external medium, it is impossible for such a thick heat-insulating layer to be formed, by which fact the coefficient of heat transfer is still further increased.

In practice there frequently arises the task to arrange heat exchange surfaces in the interior of a duct intended to intensify the flow of the external medium through the heat exchanger, or it may be desired to arrange the heat exchange surface so as to form the external boundary wall of a box possessing an effect similar to that of the duct referred to. In connection herewith, in the case of ducts or boxes of given dimensions, there arises the difficulty that a heat exchange surface capable of a given amount of heat transfer cannot be accommodated in the space available. One would therefore be compelled to arrange a number of heat exchange surfaces one behind the other in the direction of flow, which arrangement, however, would result in the disadvantage that the external medium would have to overcome an amount of flow resistance increased in accordance with the number of heat exchange plates and that it might possibly assume an undesirably high temperature. According to the invention these difficulties are eliminated by arranging the heat exchange plates in the form of a structure the cross-section of which corresponds to a broken or curved, e. g. to a zig-zag-shaped or undulating line. Particularly, the arrangement according to the invention may be such that all heat exchange surfaces are situated in parallel to the centre lines of the conduits (e. g. steam or hot-water pipes) serving for the distribution of the external medium. In other words, the apparatus according to the invention is characterized by a heat exchange structure the section of which perpendicular to the conduits referred to is shaped according to a broken or curved line.

The apparatus according to the invention will, in addition to the advantages of a very favorable heat exchange and of the shortening of the length of the collecting pipes by which the distributing pipes are mutually connected, also offer the advantages of very small space requirements and of the substantial diminution of the flow resistance of the external medium, notably when compared to a simple heat exchange surface arranged at right angles to the direction of flow of the external medium, as well as when compared to a plurality of flat heat exchange surfaces arranged one behind the other in the direction of flow.

Heat exchange devices have indeed already become known which comprise heat exchange plates arranged in zig-zag shape between the conduits serving for the circulation of the external medium, but the heat exchange plates of these devices were solid plates not presenting any apertures, the external medium flowing along these solid plates, such flow being burdened with the great disadvantage mentioned above of the increase of the thickness of the said Prantdl's insulating boundary layer. Whilst these devices enabled the single advantage of the diminution of space requirements to be obtained, it was of course not possible, in view of the disadvantageous kind of flow just mentioned, to obtain by their aid any diminution at all of the resistance to flow.

A device comprising heat exchange surfaces arranged in a zig-zag shape between the conduits of the internal medium, and fitted with apertures, have also already been proposed, but in the case of this arrangement the heat exchange surfaces were arranged in planes situated transversely to the centre line of the conduits in such a manner that it was not in a plane perpendicular to the centre line of these conduits but in a section plane parallel to them that the structure possessed a zig-zag-shaped cross section. In the case of this arrangement conduits possessing a flat cross section and an external surface of very great width had necessarily to be employed, in order to enable the heat exchange surfaces to be joined in a heat conducting manner to the conduits. As against this the apparatus according to the invention enable inexpensive types of any desired small cross section to be employed.

In the drawings some embodiments of the heat exchange device according to the invention are shown by way of example.

Fig. 1 is a part front elevation and

Fig. 2 a vertical section of one embodiment.

Fig. 3 shows a cross section of the same along a horizontal plane situated between the collecting pipes.

Fig. 4 illustrates the upper collecting pipe and a part of the heat exchange surfaces of this embodiment in perspective view.

Further embodiments are shown in diagrammatical part sections in Figs. 5 to 9.

In Figs. 1 to 4 **1** designates the distributing pipes for the internal medium, e. g. hot water, **2** the upper and lower collecting pipes, by which the distributing pipes are united and **3** the apertured heat exchange surfaces. Between the apertured panels solid strips **4** are left in order to ensure a higher degree of mechanical strength.

It appears clearly from Figs. 3 and 4 that the cross section situated at right angles to the pipes **1** is arranged according to a broken, in the example illustrated zig-zag shaped line; the same effect can also be obtained if the cross section of the heat exchange surface is shaped so as to represent a wave line. This heat exchange structure is fixed on the distributing pipes **1** so as to ensure metallic, i. e. heat conducting contact, for instance by means of soldering or welding, in such a way that each second peak part, e. g. each wave crest of the structure is connected to a distributing pipe, or the heat exchange surface may also be made integral with the distributing pipes. Broken or curved lines of any desired kind may be employed for shaping the device, and it is also possible for certain parts of the same projecting into the space between the distributing pipes, e. g. on different sides of the axis plane of the distributing pipes **1**. The arrangement shown in Fig. 3 according to which all parts of the heat exchange surface come to be situated on one side of the axis plane of the distributing pipes **1** possesses the advantage of more simple assembly and of the greater facility of cleaning the apparatus.

It is evident, however, that particularly in the case of devices of greater output capacity and in cases in which the possibility of accommodating the device within a relatively small volume of space is desirable in a higher degree still, it will be possible in connection with the zig-zag or wave shaped arrangement according to the invention to arrange the distributing pipes, which may in the given case also be required in higher number, in such a manner, that for instance, two or more distributing pipes are coordinated to each wave of the heat exchange surface; in this case a plurality of collecting pipes can be provided.

In the case of the embodiment according to Figs. 1–4 the solid strips **4** left between the aperture panels and serving for the fixing of the heat exchange surfaces are joining on to such parts of the external surface of the distributing pipes **1**, the tangential plane of which is, as appears from Fig. 3, parallel to the axis plane of the distributing pipes **1**; this method of fixing may in certain cases give rise to an undesirable resistance against the flow of the external medium and possibly also to the formation of eddies. In order to avoid this, the solid strips **4** of the various parts of the heat exchange services **3** are in accordance with Fig. 5 fixed on such places of the external surface of the distributing pipes **1**, on which the tangential planes of the external surface (in the example represented also the strips **4** themselves) are situated at right angles to the axis plane of the distributing pipes **1**.

The embodiment according to Fig. 6 differs from the embodiment according to Fig. 5 in that the cross section of the distributing pipes is flattened in a direction perpendicular to the plane of the solid strip **4**. This results in the advantage that it is along a greater surface area that the fixing strips **4** are in contact with the external surface of the distributing pipes **1a**, which appears to be more advantageous from the point of view of mechanical strength and on the other hand also from the point of view of heat transfer from the distributing pipes to the heat exchange plates.

As already mentioned above the various parts of the heat exchange plate may also be arranged on different sides of the axis plane of the distributing pipes **1**. Such an embodiment is shown in Fig. 7, the mutually adjacent heat exchange plate parts **3a** being arranged in such an inclined position relatively to each other as to cause ducts of e. g. hexagonal cross section to be formed between them through which part currents x_1—x_1 and x_2—x_2 of the external medium are flowing in such a manner as to cross the aperture plate parts twice and thereby being heated to a higher temperature. Accordingly this embodiment can be employed advantageously in such cases, when e. g. the air of a room has to be heated to a higher temperature. It is not indispensable that the edges **5** of the plate parts inclined relatively to each other should be in mutual contact or soldered to each other, it being in fact also possible to leave clearances **6** between them for reasons of easier manufacture; in this case, however, these clearances should be made of such narrow width only as to ensure that the width of the clearances only amounts to a small fraction of the mutual distance of the distributing pipes, in order to ensure that it should not be possible for the external medium to flow through in any appreciable extent between the edges of the apertured plate parts, and that accordingly it is substantially only through the apertures of the plate parts that the external medium should flow.

From the embodiment according to Fig. 6 it is possible to arrive at an advantageous further embodiment as shown in Fig. 8, by making the heat exchange plate parts **3** entirely or partly integral with the walls of the distributing pipes **1b**. This arrangement will automatically eliminate in advance the method of fixing mentioned above according to Fig. 3 which method of fixing may possibly be undesirable in a given case. In addition hereto the cross section of the distributing pipes 1b is according to Fig. 8 made drop-shaped, i. e. of streamlined shape, which circumstance will for reasons per se known represent an advantageous shape as regards the flow of the external medium along the external surfaces of the distributing pipes. In order to effect tight closing off of the distributing pipes 1b solder strips are employed along the lines 7.

The embodiment according to Fig. 9 results from a combination of the embodiments according to Figs. 7 and 8. According to this embodiment the apoaratus will on the one hand become suitable for a higher heating output, owing to the fact that the various part currents x_1-x_1 and x_2-x_2 of the external medium already mentioned in connection with Fig. 7 are crossed twice by the apertured plate parts 3a, 3b, whilst on the other hand the plate parts 3a, 3b following each other in the direction of flow of the external medium, are integral with each other and each of them is integral with one half of the distributing pipes 1a. For the purpose of tightly closing off the pipes 1c solder strips are employed in this case also along the lines 7. It is evident, however, that in case a substantial heating or cooling of the external medium is desirable, it is also possible to employ the heat exchange devices according to Figs. 7 and 9 in multiple succession one behind the other in the direction of flow of the external medium.

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