Nov. 5, 1929. F. SCHUBART 1,734,274

HEAT EXCHANGE APPARATUS

Filed June 11, 1928

Fig. 1

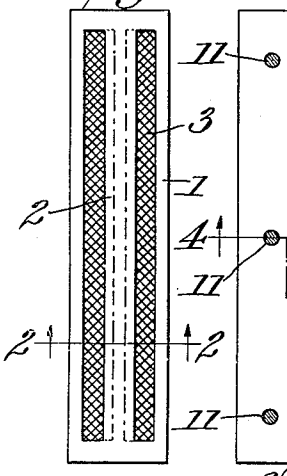


Fig. 3.

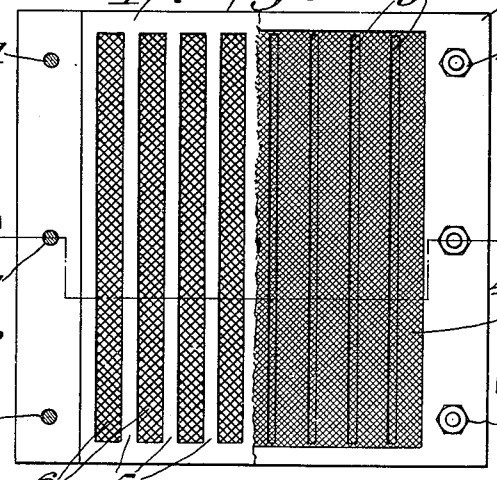


Fig. 6.

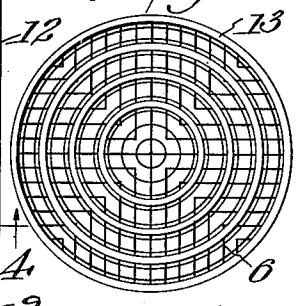


Fig. 7.

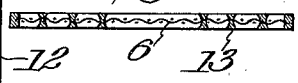


Fig. 2.

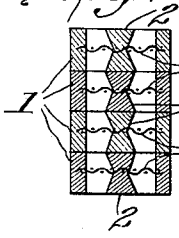


Fig. 4.

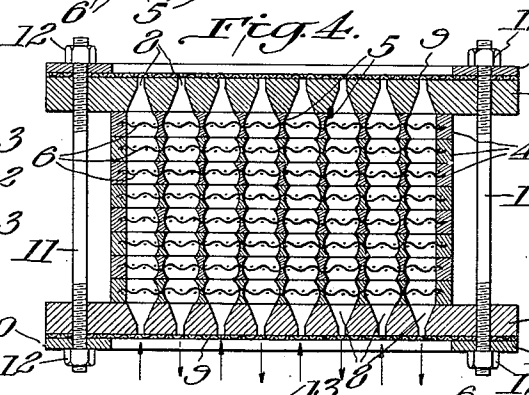
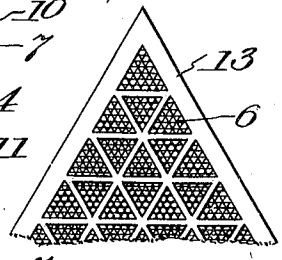


Fig. 9.



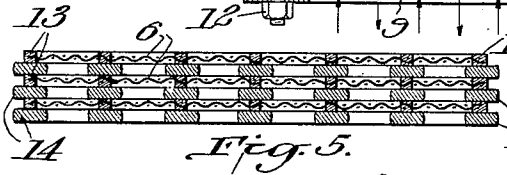


Fig. 5.



Fig. 10.

Fig. 11.

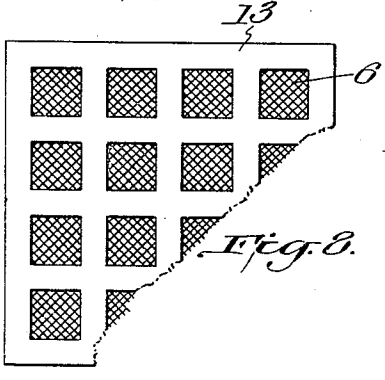
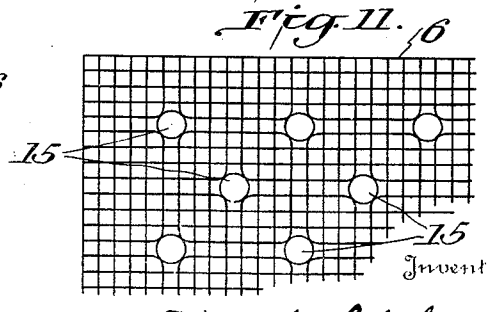


Fig. 8.



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UNITED STATES PATENT OFFICE

FRIEDRICH SCHUBART, OF MONTERREY, MEXICO

HEAT-EXCHANGE APPARATUS

Application filed June 11, 1928. Serial No. 284,608.

This invention relates to a heat exchange apparatus, whose separating walls between the hot and cold fluids are traversed by one or more wire nets which, by reason of their large surface and capacity for conducting heat, provide temperature equalization between the two fluids. The favorable properties of wire network for absorbing and giving up heat are well known, and use has been made thereof for a long time in the Davy safety lamp and laboratory purposes.

The efficiency of a heat exchange apparatus, leaving out of consideration the physical properties of the fluids passing therethrough, depends principally upon the size of those surfaces of the apparatus which produce the heat exchange, and upon the speed of heat dissipation from the region of the warm to that of the cold fluid. The rate of this heat dissipation depends in turn upon the physical constants of the material of which the heat transmitting parts are constructed, and upon the transmission path and cross section.

One object of this invention is to provide a heat exchange apparatus having a large surface for the elements by which the heat is transferred.

Another object is to provide a short path over which the heat passes from the hot to the cold fluid.

A further object is to provide a large cross section of such path.

A further object is to provide such heat exchange apparatus with above desirable characteristics formed of a plurality of separable elements, such that the size of the apparatus may be readily increased or decreased, and such that the parts may be readily disassembled for cleaning and repairs.

A further object is to provide such apparatus that the units thereof may be readily assembled with the joints thereof in fluid-tight engagement.

These and other objects will be apparent from the following description taken in connection with the accompanying drawings, wherein,

Fig. 1 is a plan of one form of the apparatus,

Fig. 2 is a section on line 2—2 thereof,

Fig. 3 is a plan of an enlarged form, parts being broken away for better illustration,

Fig. 4 is a section on line 4—4 of Fig. 3,

Fig. 5 shows a cross section of a modified form,

Fig. 6 is a plan, and

Fig. 7 is a cross-section of another modified form,

Fig. 8 is a plan of another modification,

Fig. 9 is a plan of a further modification

Fig. 10 is a cross section of a modified form somewhat similar to Fig. 5, and

Fig. 11 shows an enlarged plan of one of the wire meshes used in the various forms.

Referring to the drawings, and particularly to Figs. 1 and 2, the heat exchange apparatus consists of a series of open frames 1, each frame having a transverse partition 2, thus dividing the opening in each frame. The frames and transverse partitions are formed of plastic material such as rubber, asbestos, paper pulp, etc. which hardens after being molded. A wire network 3 is inserted into each frame 1 during production thereof, this wire mesh extending approximately through the center of each frame. The partition 2 of each frame is so molded that the cross-section thereof is smallest where the wire mesh 3 passes through it, as seen in Fig. 2.

The frames in Figs. 3 and 4, marked 4, are larger and have a plurality of transverse partitions 5, the wire mesh 6 passing through the smallest cross section of the partitions. A plurality of frames are assembled between end plates 7, these end plates having openings 8 in alignment with the spaces between partitions 5. Protective screens 9, of finer mesh than wire mesh 6, are secured over the openings in end plates 7, to prevent the entrance of foreign particles. These protective screens are secured in place by plates 10 and the whole structure is clamped into fluid-tight engagement by bolts 11 and nuts 12. The fluids, the temperatures of which are to be equalized, flow in opposite directions in adjacent channels, as shown by the arrows in Fig. 4. It will be understood, however, that the flow could be in the same direction.

The heat of the hot fluid is rapidly taken up by the wire nets and passed over the numerous very short paths presented by the latter into the adjacent chambers, where it is given off just as rapidly to the colder fluid. According to Fig. 4 the fluids flow perpendicularly to the plane of the wire net; but the principle of the invention also permits flow parallel or at any desired angle to the net. For this purpose the openings 8 must occupy a different position in plates 7 or the frames themselves must be perforated, as in the frames of filter presses. Current or flow distributors, not shown in the drawings, can be interposed in order that the fluids flow through the chambers of the system as uniformly as possible according to quantity and velocity.

It is apparent that the three requirements necessary for a heat exchanger, namely, large surface of the elements by which the heat is transferred, short path over which the heat is conducted, and large cross-section of this path, are fulfilled in simple manner and with greater efficiency than in any known apparatus of the kind. The wire nets are more suitable than any other constructional element for absorbing and giving off heat. The short path over which the heat is conducted within one and the same wire net is provided by the narrow form of the chambers of the system and the specific form of transverse subdividing members of the frame, which are thinnest at the points at which the wire net passes through them (see Figs. 2 and 4). The large cross section required for the passage may be obtained either with a large number of nets or of chambers.

Two other requirements which for the most part are not mentioned as obvious with other heat exchanges are: First, that the separating walls between the flowing media must be liquid and gas tight, and second, that the apparatus must be easily disassembled for cleaning or repairs. Both of these requirements are provided for in the present invention. Points of leakage might occur in the numerous frames. If, on the other hand, the walls were made of one piece instead of single frames the chambers between the wire nets would always be inaccessible and could not be mechanically cleaned, which latter would constitute a defect, and for this reason this invention provides subdivision into individual frames. In order to avoid leak points without excessively lengthening the path over which the heat is carried by widening the separating bars, the transverse members of the frame are given the cross sectional form shown on Figs. 2 and 4, which leaves the path for the passage of the heat very short, but at the same time provides the frames with large contact surfaces for the packing.

Fig. 5 shows another method of assuring tightness and simultaneously the passage of the heat; here, the wire nets 6 at the points where the separating walls are positioned, instead of being embedded in the previously mentioned packing, are tightly embedded in metal strips 13 (by casting, welding, soldering, pressing, etc.). The metal strips—themselves very narrow—increase the important metallic cross section for the passage of the heat, while the packings 14 therebetween assure tightness.

If the metal strips are trick enough to impart sufficient stability to the frame constructed thereof, their surfaces may be ground (smoothed) and placed directly upon each other. Such construction is shown in Fig. 10 wherein the metal frames 13 are placed directly in contact with one another. If they are made of soft metal powerful pressing without grinding is sufficient, and all other soft packings may be omitted.

It is obvious that the rectangular casing form shown on the drawings or the direction in which the fluids flow do not comprise the limiting features of the invention. Triangular (Fig. 9), circular or other forms may be used with similar results; also the concentric form (Fig. 6) with single or plural exchange between cold and heat, the checkerboard form (Fig. 8), the honeycomb or similar arrangement of subdivisions, traversed alternately by the different fluids, are possible. The triangular form is particularly advantageous since, of all regular polygons, it has the least ratio between content and periphery.

Since the sum of all the cross sections of the net wires traversing the walls separating the media corresponds to the number of calories carried, it is desirable that the number of wires passing directly from one chamber of the system to the adjacent be as great as possible. With square (Fig. 8) or rectangular (Fig. 3) form of chamber this is accomplished by running the wires diagonally. Here, almost all the wires traverse two chambers, most of them through more than two. With concentric circular forms (Fig. 6), oval or similar cross section of separating wall, this requirement may be fulfilled by arranging the wires as shown on Fig. 6 or running them radially. In this also the triangular form is advantageous; because, by using a wire fabric in which the wires are arranged in three directions parallel with the sides of an equilateral triangle, all the wires, except at the corners, pass from one into two adjacent compartments, whereby the average distance from all points of a triangle to all points of the three adjacent triangles is shorter than with any other kind of compartment subdivision.

In order to prevent interruption in the flow

of the fluid in case the network should become clogged up by dirt, turbid material or crystallization, openings may be provided in the wire fabric, that is, in staggered relation from net to net, so that flow may proceed without the mesh of the net. Openings may also serve to accelerate the flow for the purpose of equalizing it at certain parts of the apparatus. These openings are shown in the enlarged view of one of the wire meshes shown in Fig. 11, the mesh being indicated by numeral 6 and the openings therethrough by numeral 15. These openings in adjacent frames 6 will be arranged in staggered relation when the frames are assembled.

It will be understood that various changes and modifications may be made within the scope of this invention as set forth in the appending claims.

I claim:—

1. In a heat exchange apparatus, a rigid frame having peripheral side walls defining an opening therebetween, a partition dividing said opening into a plurality of fluid passageways, and a wire mesh permanently embeded into said side walls and passing through said partition.

2. The structure as set forth in claim 1 wherein the wire mesh is embedded into the said side walls and partition in a plane spaced from the upper and lower edges thereof.

3. The structure as set forth in claim 1 wherein the cross-section of the partition is smallest where the wire mesh passes therethrough.

4. In a heat exchange apparatus, a rigid frame having peripheral side walls defining an opening, a plurality of partitions dividing said opening into a plurality of relatively small fluid passageways, and a wire mesh permanently embedded into said side walls and passing through said partitions, the said wire mesh being so arranged that substantially all wires thereof pass through a multiplicity of said fluid passageways.

5. A heat exchange apparatus comprising a plurality of frames, each frame having peripheral side walls defining an opening and a plurality of partitions dividing said opening into a plurality of relatively small fluid passageways, a wire mesh embedded into said side walls and passing through said partitions, and means to clamp said plurality of frames into engagement with the respective side walls and partitions thereof in fluid-tight engagement, to thereby define a mutiplicity of fluid passageways.

6. The structure as set forth in claim 5 wherein the wire mesh of each frame is provided with enlarged openings, and the said openings in adjacent frames are arranged in staggered relation when the frames are assembled.

7. The structure as set fort in claim 5 wherein a wire mesh of finer weave is secured over the ends of the fluid passageways.

In testimony whereof, I affix my signature.

DR. F. SCHUBART.