Feb. 28, 1933. H. V. DALGLIESH 1,899,080

HEAT EXCHANGE DEVICE

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Fig. 1.

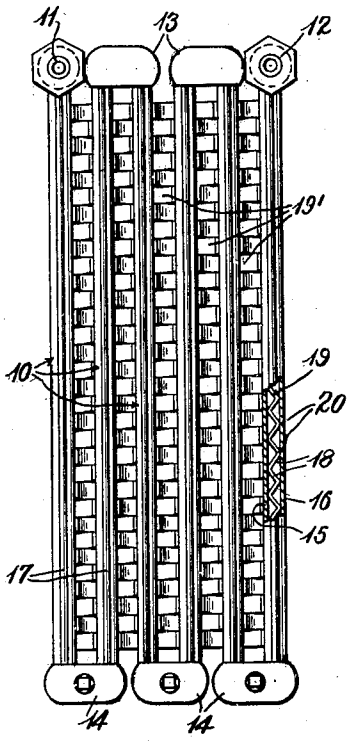


Fig. 2.

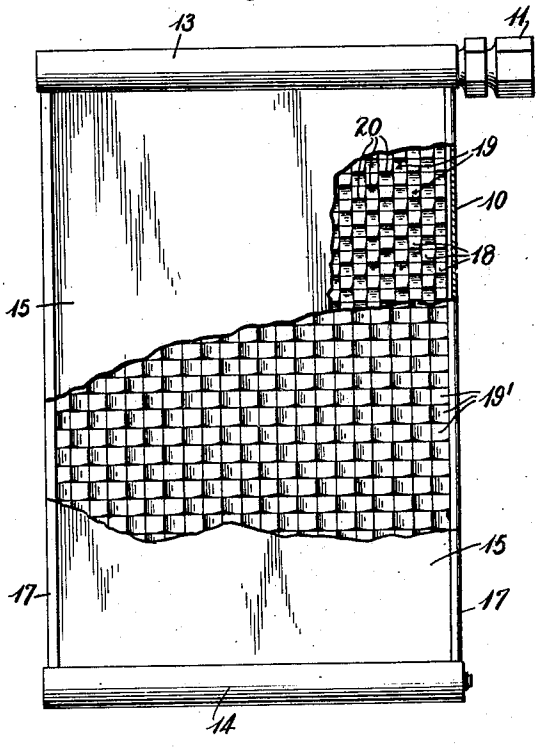
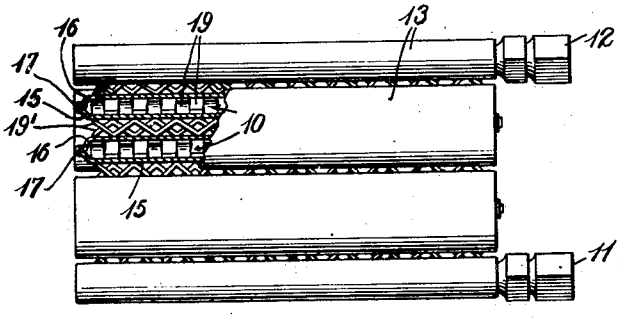


Fig. 3.



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HEAT EXCHANGE DEVICE

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Fig. 4.

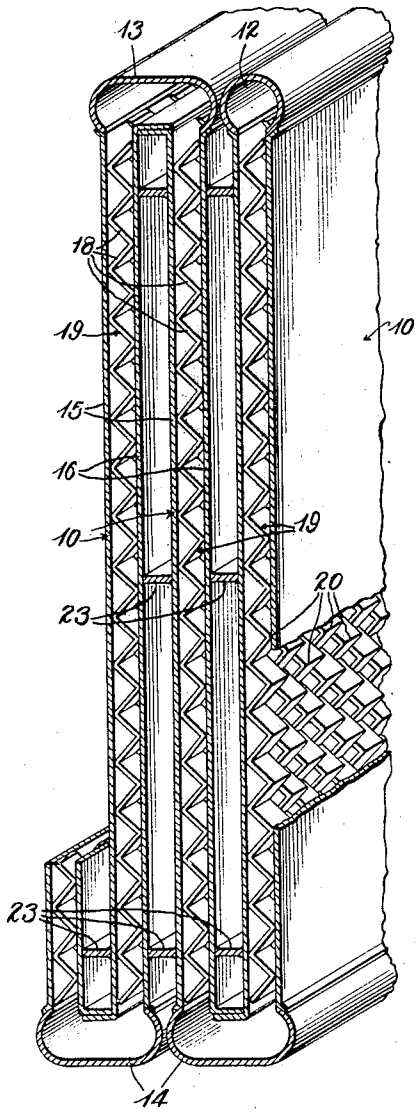


Fig. 5.

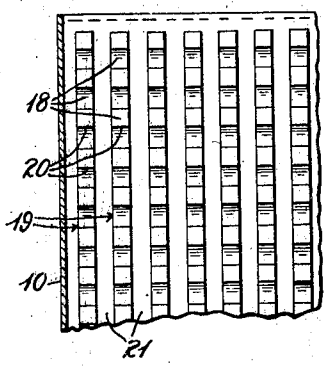


Fig. 6.

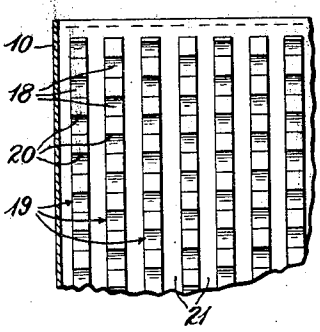


Fig. 7.

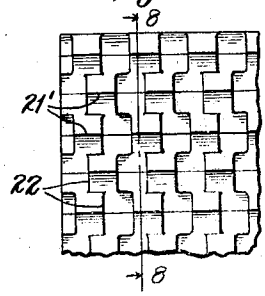
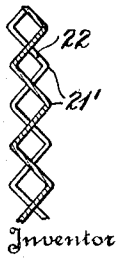


Fig. 8.



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HEAT EXCHANGE DEVICE

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Fig. 9.

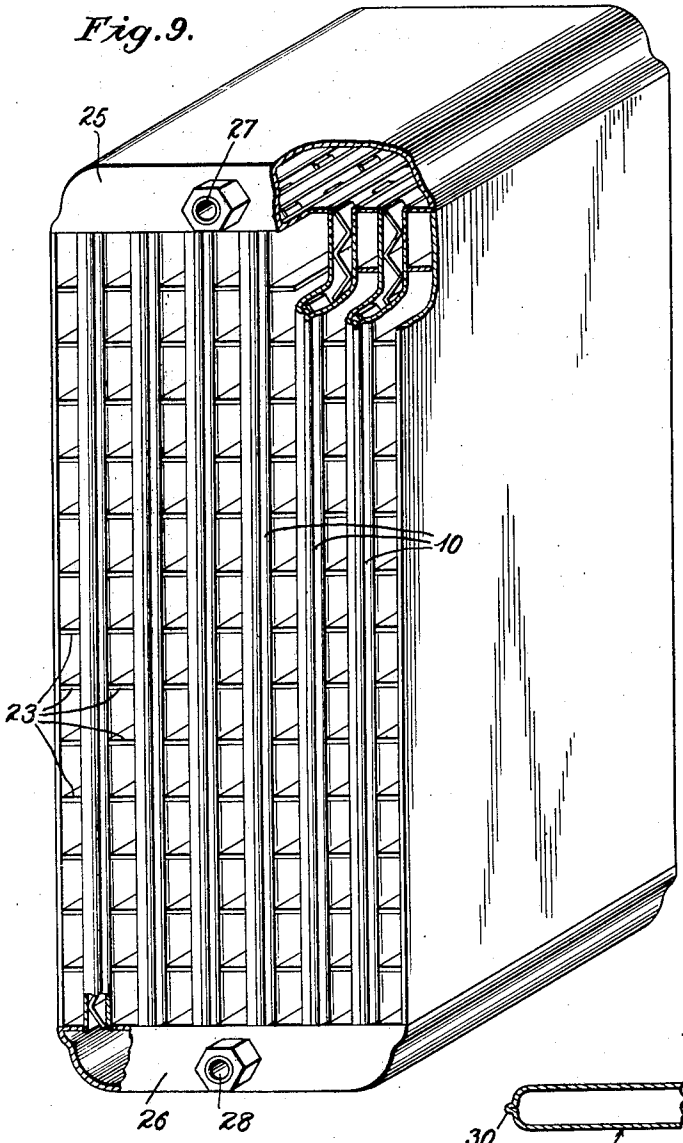


Fig. 10.

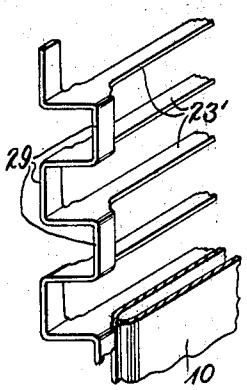


Fig. 11.

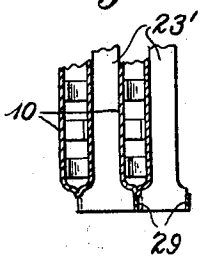


Fig. 12.

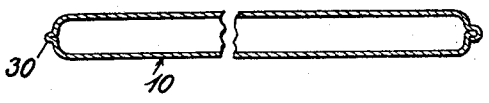
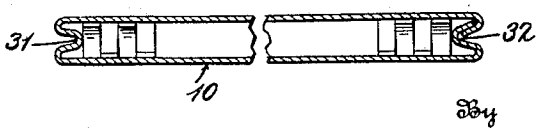


Fig. 13.



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Patented Feb. 28, 1933 1,899,080

UNITED STATES PATENT OFFICE

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HEAT EXCHANGE DEVICE

Application filed October 29, 1931. Serial No. 571,908.

The invention relates to heat exchange devices and has an object the provision of a device or this character made up of a novel form of elements.

It is a further object of the invention to provide a heat exchange device which is simple to manufacture and efficient in operation and possesses great strength to resist internal pressures.

Further objects of the invention will appear from the following description when read in connection with the accompanying drawings showing illustrative embodiments of the invention, and wherein:—

Fig. 1 is an end view partly broken away;

Fig. 2 is a side view broken away to show the interior of one of the elements and a portion of the space between elements;

Fig. 3 is a plan view partly broken away of Figs. 1 and 2;

Fig. 4 is a perspective view showing an end in vertical transverse section illustrating the preferred form of element and a modified form of spacing means between the elements;

Figs. 5 and 6 are detail face views of portions of modified forms of elements with the casing cut away;

Fig. 7 is a detail elevation of a still further modified form of spacing and heat exchange means to be used within an element;

Fig. 8 is a detail section on line 8—8 of Fig. 7;

Fig. 9 is a perspective view, partly broken away, showing an arrangement of elements in parallel arrangement;

Fig. 10 is a detail perspective view showing a modified form of element spacing and bracing structure;

Fig. 11 is a transverse section of the structure of Fig. 10 showing the relation of contiguous spacing members;

Fig. 12 is a transverse section of an element tube showing the parallel plates integral at one edge of the tube; and

Fig. 13 is a transverse section of a further modification of element tube.

As shown in Fig. 1, the device is made up of a plurality of like elements 10 connected for passage of fluid therethrough in series. To this end an inlet connection is shown at 11 and an outlet connection at 12 and opposite ends of the elements 10 are connected by means of headers 13, 14.

One manner of connecting the walls of the elements 10 to provide the headers 13, 14 is illustrated in Fig. 4. This connection and structure form no portion of the present invention.

The elements 10 are in accordance with the invention made up of spaced plates 15, 16, which as shown, and preferably for strength and simplicity of manufacture, are plain in both directions. The edges of the said plates are shown as bent inwardly and crimped together as at 17 in Fig. 3 to provide flat tubes open at their ends.

To preserve the spacing of the plates 15, 16, to brace the same against bulging when subjected to internal pressure, and to cause an efficient heat transfer between the interior of the body of fluid passing between the plates and the plates themselves to in turn bring about a heat exchange with a medium upon the outside of the tubes, the invention provides a plurality of transverse members extending between and attached to the opposed surfaces of the plates constituting each element.

As shown in each of the figures herein, the transverse elements extend not only transversely but diagonally in the spaces between the plates and for simplicity are desirably made in the form of continuous strips formed in zigzag formation, as clearly illustrated in Fig. 4 wherein the transverse elements referred to are shown at 18 as portions of the deformed strip 19.

In the form of the invention at present preferred the strips 19 are placed between the plates 15, 16 with their crests 20 in staggered relation, as clearly shown in Figs. 1–4, inclusive, that is, the points of contact between the crests and the plates 15 and 16 of the alternate strips are in vertically spaced planes. The vertical displacement of said planes is preferably one-half the distance between crests. When assembled in this manner, the edges of the strips 19 at the crossing point between the diagonal components thereof are

desirably in contact or substantially so and when so arranged fluid passing between the plates of the element will be thrown into an intense turbulence resulting in a very thorough mixing of the mass of the fluid and an even heat exchange between all portions of the fluid and the medium to which the heat is conducted in contact with the outside surfaces of the plates, so that as it is delivered from the element there will not be warmer or cooler portions existing in the body thereof.

The transverse elements 18 are preferably connected at their ends to the inner surfaces of the plates 15, 16 at the points of contact therewith as by means of solder, brazing, or the like. These elements aside from their function of producing turbulence as above referred to accomplish the result of a very thorough bracing of the plates so as to make the assembled element very strong to resist internal pressures tending to bulge the plates. Moreover, being in contact with the interior of the body of fluid and in efficient heat transfer contact with the material of the plates themselves, the elements serve to efficiently transfer heat from the mass of the fluid to the material of the plates which heat may then be efficiently transferred to a medium in contact with the outer surfaces of the plates.

In the form of the invention shown in Figs. 5 and 6, the strips 19 formed as described are spaced apart to provide clear passages 21 therebetween thus considerably reducing the internal resistance of the elements but at the same time also reducing the heat exchange value of each element. In this form of the invention the fluid flowing in the passages 21 will be thrown into turbulence by the dragging effect of the fluid in the triangular spaces between the components 18 of the strips 19, therefore introducing a considerable turbulence into the flow of the fluid.

In Fig. 5 the crests of the spaced strips 19 are arranged in common planes while in Fig. 6 the crests of alternate strips are arranged in planes spaced vertically of the element.

In Figs. 7 and 8 the spacing means is shown as formed by slitting and deformation of a single sheet of material, which slitting lines are indicated at 22 and the portion between the slits is deformed in opposite directions to provide the crests 24, alternately oppositely directed. A sheet of material so formed may be utilized to replace the separate strips of the form of Fig. 4 whereby to accomplish the objects of the invention, and for many reasons is preferable.

In Fig. 4 the separate elements making up the heat exchange device are shown as separated by spacing and bracing means 23, in the form of flat strips placed edgewise between the elements and desirably soldered thereto. To secure the full value of the principle of the invention, the spacing means between the assembled elements of the heat exchange device may, as indicated in Figs. 1–3, be composed in the same manner as the bracing and spacing means between the individual plates of each element.

In Figs. 1–3 there are shown a plurality of strips 19′ placed between the assembled elements and desirably in the direction of the flow of the fluid between said elements upon the same plan and with the same effect as are the strips 19 arranged within the element.

In Fig. 9 is shown an assembly of the heat exchange elements 10 arranged for flow of fluid therethrough in parallel. To this end the elements 10 each open into headers 25, 26, having inlet and outlet connections 27, 28, a multiplicity of spacing members 23 being shown between the elements.

To simplify assembly, the spacing elements may be produced in the manner shown in Figs. 10 and 11. The structure shown therein may be produced by stamping from sheets of material to leave the spacing elements 23′ connected at their ends by the members 29, which stamping may then be deformed to the form shown. These structures may be assembled with the heat exchange elements prior to the connection of the assembly of elements to the headers 25, 26 or 12, 13, 14. When so assembled the members 29 will stand in front of the edges of the elements 10 and serve as a protection for such edges.

In Figs. 12 and 13 the tubes of the elements are shown with the spaced plates making up the tubes integral with each other at one edge of the tube. The bead 30 of Fig. 12 is not essential but better serves to direct air to the spaces between the tubes as in automobile radiators or oil coolers. In Fig. 13 the edges of the tube are shown as reentrant at 31, 32, thus serving to readily position the elements 19 in their assembly with the tubes.

The structure and operation of the device will be clear from the above description. Minor changes may be made in the physical embodiments of the invention within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A heat exchange element comprising, in combination, spaced plates providing a fluid flow space therebetween, a plurality of members extending diagonally and transversely of said space and presenting flat surfaces to the path of fluid flow, the ends of said members contacting and secured to said plates to space and brace the same, causing turbulence of fluid flowing in said space and causing heat transfer between the interior of the body of said fluid and said plates.

2. A heat exchange element comprising, in combination, a pair of plain spaced plates providing a fluid flow space therebetween, a plurality of zigzag shaped strips presenting alternate oppositely directed crests, said crests contacting the opposed surfaces of

said plates, the portions of said strips between the crests providing diagonally transverse spacing and bracing members disposed in and presenting flat surfaces to the path of fluid flow between said plates whereby to cause turbulence in the body of said fluid and heat transfer between the interior of said body and said plates.

3. A heat exchange element comprising, in combination a pair of spaced plates providing a fluid flow space therebetween, a plurality of zigzag shaped strips presenting alternate oppositely directed crests and flat surfaces to the path of fluid flow, said crests contacting and attached to the opposed surfaces of said plates, the similarly directed crests of adjacent strips contacting the plates in vertically spaced planes.

4. A heat exchange element comprising, in combination, a pair of spaced plates providing a fluid flow space therebetween, a plurality of zigzag shaped strips presenting alternate oppositely directed crests and flat surfaces to the path of fluid flow, said crests contacting and attached to the opposed surfaces of said plates, the similarly directed crests of adjacent strips contacting the plates in vertically spaced planes, the edges of adjacent strips at the crossing points of the zigzag components thereof being substantially in contact.

5. A heat exchange element comprising, in combination, a pair of plain spaced plates providing a fluid flow space therebetween, a plurality of series of spacing, bracing, and turbulence-producing members attached at their ends to opposed surfaces of said plates, the members of each series vertically aligned in said space and presenting flat surfaces to the path of fluid flow, said series spaced apart to provide clear passages for fluid flow, passage of fluid about said members causing turbulence of flow through said passages, said members conducting heat from the body of the fluid to the plates for heat exchange with a medium in contact with the outsides of said plates.

6. A heat exchange element comprising, in combination, a pair of plain spaced plates joined at opposite edges to provide a flattened tubular structure, a plurality of strips of zigzag formation presenting a series of oppositely facing crests joined by diagonal members, said strips extending longitudinally in said tubular structure in spaced relation transversely thereof and the oppositely directed crests in contact with and secured to the inner surfaces of the respective plates.

7. A heat exchange element comprising, in combination, a pair of plain spaced plates joined at opposite edges to provide a flattened tubular structure, a plurality of strips of zigzag formation presenting a series of oppositely facing crests joined by diagonal members and flat surfaces to the path of fluid flow, said strips extending longitudinally in said tubular structure in spaced relation transversely thereof, the oppositely directed crests in contact with and secured to the inner surfaces of the respective plates, and the transverse plane of contact of each crest offset longitudinally of the structure from the transverse planes of contact of the next adjacent strips.

8. A heat exchange device, comprising, in combination, a plurality of spaced pairs of spaced plates, the spaces providing flow passages for media in heat exchange relation, a plurality of spaced turbulence-producing elements extending transversely between the opposed plate surfaces bounding each space, and presenting flat surfaces to the path of fluid flow said elements connected at each end to one of said surfaces and conducting heat between said plates and the interior of the body of the medium flowing thereabout.

9. A heat exchange device, comprising, in combination, a plurality of spaced flattened tubes, the spaces within the said tubes and between the same providing flow passages for media in heat exchange relation, a plurality of zigzag formed strips extending in each of said spaces longitudinally of the path of fluid flow therein, said strips each presenting alternately oppositely directed crests in contact with and secured to opposed plate surfaces to space and brace said plates and flat surfaces to the path of fluid flow, to cause turbulence in the mass of the media and conduct heat from the body of the media to the contacted plates.

10. A heat exchange element comprising, in combination, a pair of spaced plates providing a fluid flow space therebetween, spacing, bracing and turbulence-producing means between said plates comprising a sheet of material slitted and portions between the slits deformed out of the plane of the sheet to provide members in angular relation to said plane presenting oppositely directed crests and flat surfaces to the path of fluid flow, said crests contacting the opposed surfaces of the plates and inlet and outlet connections to said space to provide for flow of fluid in said space in the direction of the slitting of said material.

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