

Dec. 1, 1931.

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1,834,604

HEAT EXCHANGE DEVICE

Filed Sept. 23, 1930

2 Sheets-Sheet 1

Fig. 1.

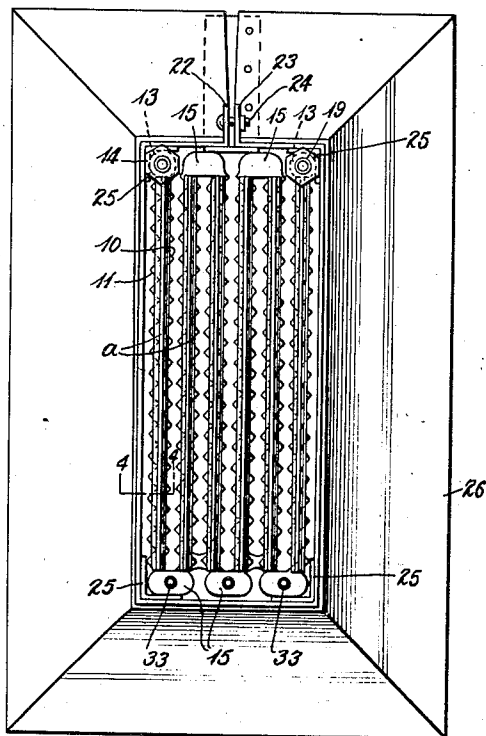


Fig. 2.

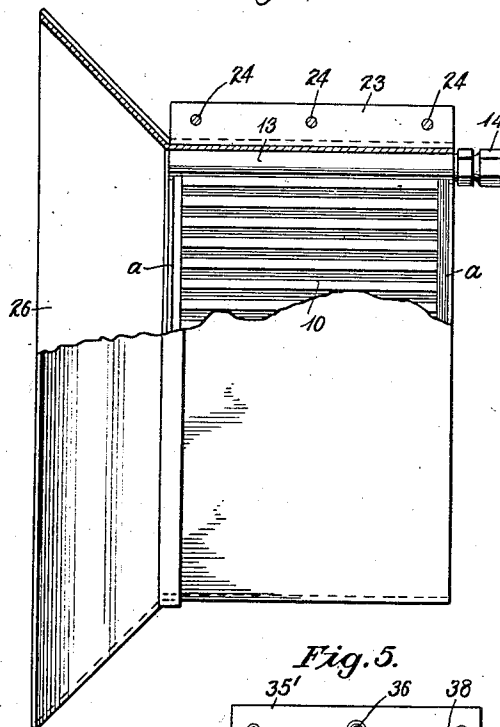


Fig. 3.

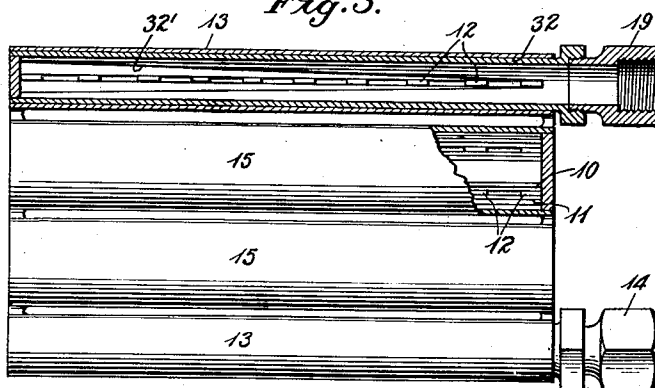
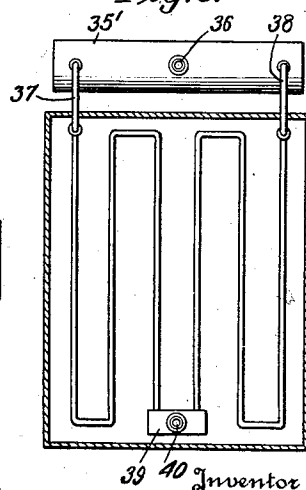


Fig. 4.



Fig. 5.



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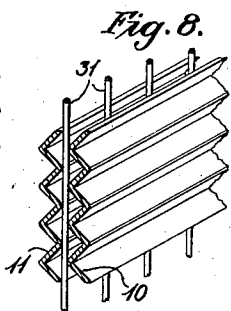
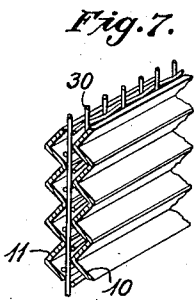
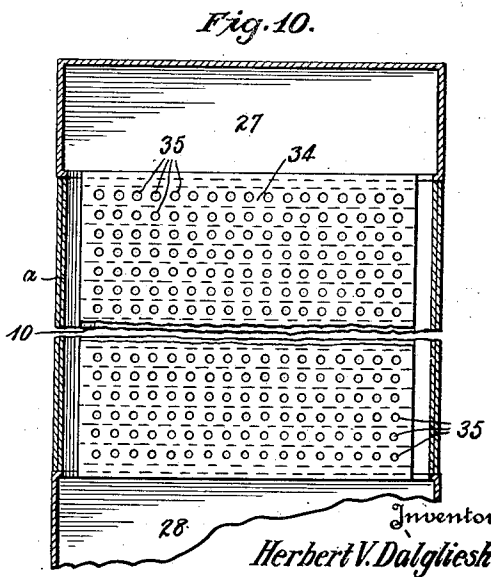
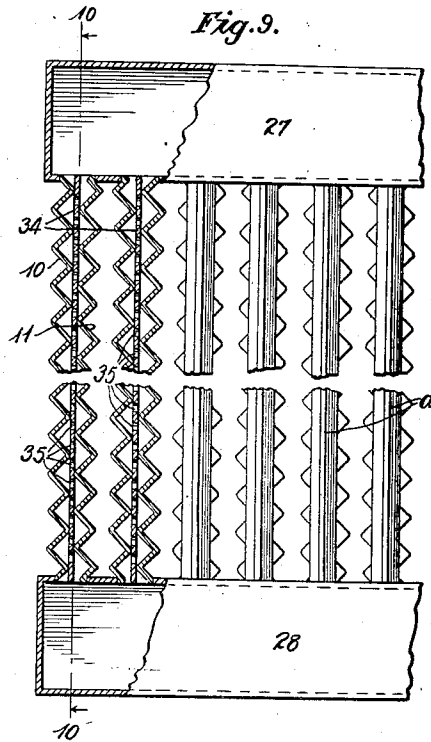
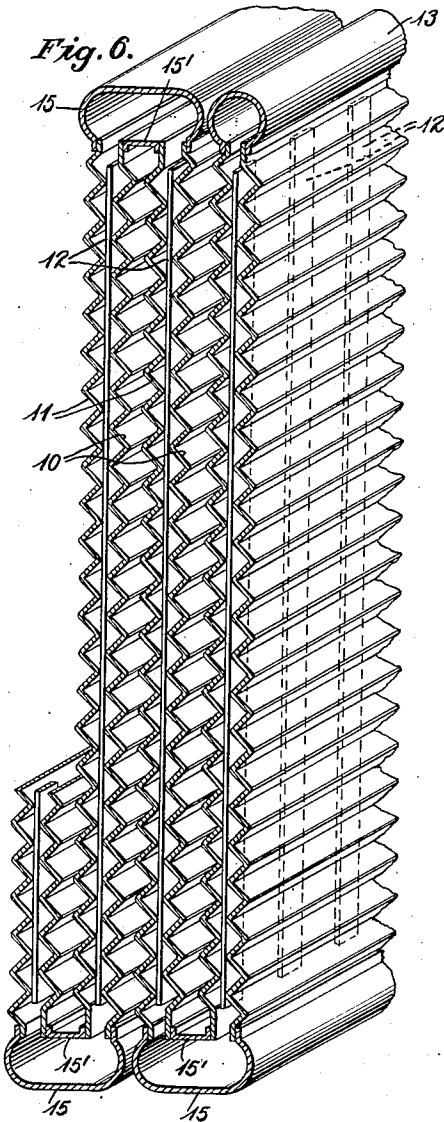
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2 Sheets-Sheet 2



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HEAT EXCHANGE DEVICE

Application filed September 23, 1930. Serial No. 483,942.

The invention relates to heat exchange devices and aims to provide novel means for heating or cooling fluids by contact with a wall having its exterior in contact with a cooling or heating medium.

It is an object of the invention to provide a heat exchange device formed of deformed plates spaced apart by means of strips spanning the deformities whereby fluid flowing between the plates and through the passages between said strips may gain access to the inner surfaces of the deformed plates behind the strips thereby securing the substantially full conductivity of the plates and providing turbulence in the streams of fluid by reason of the contact between said streams and the fluid in the deformities behind the strips.

It is a further object of the invention to provide a heat exchange device made up of elements comprising fluid containing flattened passages spaced apart, said elements wedge-shaped at their edges whereby gases to be heated or cooled by heat exchange between the same and fluid in the passages may be compressed to some extent as it enters the spaces between the elements and whereby furthermore to provide a strong connection between the plates making up the elements.

Various additional objects and advantages will become apparent from the following description taken in connection with the accompanying drawings showing illustrative embodiments of the invention and wherein:

Fig. 1 is an end elevation;

Fig. 2 is a side elevation, partly broken away;

Fig. 3 is a plan view, also partly broken away;

Fig. 4 is a detail sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a diagrammatic elevation of a series parallel arrangement;

Fig. 6 is a detail perspective view illustrating the interior of the heat exchange device;

Figs. 7 and 8 are detail perspective views of modified forms;

Fig. 9 is a vertical sectional view through

a further modified form of the invention wherein a perforated plate is used; and

Fig. 10 is a vertical sectional view taken on line 10—10 of Fig. 9.

As shown the heat exchange elements of the present invention are formed of corrugated plates 10, 11, which may be of steel, brass, or any other suitable metal, and are shown as specifically formed with angular corrugations although the latter may obviously be curved if desired.

In order to space said plates 10, 11 apart and to serve as a connection between the corrugations thereof, a plurality of spaced strips 12 are used.

The strips 12 are as shown applied to one of the plates, as for instance plate 10, with the apices of the interior corrugations of the plate 10 in contact with the strips at points opposite the interior troughs of the plate 11 and the plate 11 is thus arranged in contact with such strips 12 with the apices of the inner corrugations of the plate 11 in staggered relation to the corrugations of the plate 10. The result of such assembly is that the corrugations of the plates 10 and 11 are in nested relation but spaced apart from each other, providing a zigzag path for flow of fluid between the plates. With the parts arranged as described, the lines of contact between the strips 12 and the apices of the corrugations are secured by soldering, brazing, or electric welding.

In view of the presence of the strips 12, the fluid flowing between the plates has access to the inner surfaces of the plates 10, 11, not only between the strips 12 but behind such strips and the fluid flowing between the plates will flow more rapidly in the spaces between such strips 12 than does the fluid which enters the spaces behind the strips.

The feature of thus causing the flow or movement of the fluid behind the strips 12 and over all of the exposed surfaces at the front, rear, and edges thereof, is to be emphasized since it forms a material advance in aiding more rapid heat transfer. The action mentioned provides a multiplicity of eddies in the fluid which causes all portions of the same to become thoroughly mixed as

it flows between the plates and around the strips and the entire body of the fluid to be cooled or heated uniformly as it emerges from between the plates.

5 The strips 12 and the inner surfaces of the plates may be first "tinned" with solder and then the plates and strips pressed together and heated to cause the contacting portions of the plates with the strips to adhere by
10 virtue of the solder, thus providing a structure which is inwardly reinforced sufficiently to prevent bulging of the plates, under any reasonable pressure.

15 The plates 10, 11 and the strips 12 may be made of steel or metals other than brass, copper, or the like, in which event, instead of the joints being soldered, they may be secured by electric welding, or brazing.

20 As shown in Fig. 4, the edges of the heat transfer elements are wedge-shaped as at "a" to provide a feather edge to facilitate entrance of the air or gaseous medium and to cause the passages between the heat exchange elements to be flared or widest at their edges
25 so that the air will be wedged or constricted as it passes between the heat exchange elements. As further shown in Fig. 4, at the portion "a", the plate 11 may overlap the plate 10, be clinched against the same and
30 soldered or welded or in any other way have a leakproof joint provided.

In the form of the invention shown in Fig. 7, the strips 12 are replaced by sheets or fabrics of wire mesh material 30. The wires
35 forming such sheets are shown as straight at the portions thereof which engage the apices of the corrugations of the plates 10 and 11. The wire mesh material 30 will cause a thorough mixing of the fluid flowing through the
40 tortuous passages and will also give substantially the entire radiating surface of the corrugated plates, especially since the fluid, as in the previous form of the invention, must pass behind, around and over the entire sur-
45 face of the wires or elements forming the material 30.

In the form of Fig. 8, the strips 12 are replaced by straight wires 31. In this form also the material result of the fluid passing
50 behind, around and over the entire surface of the wires to the maximum extent is realized.

In the utilization of the exchange element thus described as an oil cooler for use with
55 internal combustion engines in the forms described, the plates of a desired extent, that is a desired extent longitudinally of the corrugations are assembled in such manner as to cause flow of oil through the different ele-
60 ments in series.

65 As shown particularly in Figs. 1 and 6, the elements into which the liquid enters or from which the liquid leaves, being the outside elements in Fig. 1, have the plates forming such elements entered between open edges of a

substantially cylindrical header 13 lapping past the outturned opening in said header to which edges the plates may be secured as by solder, brazing, electric welding, or the like.

70 To provide a connection between the adjacent ends of successive heat exchange elements, the outer plates of a pair of elements are shown as connected to the outturned edges of a header 15 and the inner plates of said pair are shown as lapping with and secured to the edges of a channel shaped connecting member 15', thus providing a header
75 at the ends of the connected elements to conduct liquid from one element to the succeeding element in the series, the next pair of elements being likewise connected and the arrangement continued through the number of elements which it is desired to utilize, as for instance, the three pairs as shown.

80 As an outlet for oil from the final pair of plates of the series, a pipe 32 is inserted into the outlet header 13, which pipe is provided with a coupling 19. The pipe 32 is shown as slotted at 32' with the slot wider at the end remote from the coupling than at the end
90 adjacent thereto. As a result the flow of oil will be substantially uniform across the width of the last element from bottom to top thereof.

95 The ends of the lower headers are shown as provided with clean-out screw plugs 33.

In utilizing the structure as an oil cooler a casing or shell surrounds the same, being of sheet metal and rectangular in form, with the ends turned into parallel flanges 22, 23,
100 secured together as by bolts 24.

Desirably angle members 25 are secured in each corner of the casing 21 to space the heat exchange structure from the walls of the casing 21 to permit flow of air therebetween.
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To direct air into the space between the plates 10 and 11, casing 21 has its walls formed into a flaring extension as indicated at 26.

110 In the use of the structure for cooling the lubricating oil used in an internal combustion engine as for instance of an automobile, the device may be supported in any suitable manner as at one side of the motor with the flaring member 26 directed toward the
115 stream of air from the fan of the cooling water circulating system of the motor and the oil passages of the device are connected into the pipes providing the line of circulation of the oil of the motor by means of cou-
120 plings 14 and 19.

125 Desirably the device is connected in series with the usual oil cleaner, therefore being in a bypass of the main lubricant circulation to the bearing surfaces of the motor. This arrangement is desirable since experiments have shown that so connected the cooling of the oil will be sufficient with relatively small overall dimensions of the device and because in the bypass the pressure upon the oil will
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be less than would be met with in the main oil circulation. Obviously however the device may be placed in the said main circulation system, in which event a larger device must be utilized to provide passage of the large quantity of oil therethrough without developing too great internal pressures.

It is obvious that the device may be placed as a section of the water radiator of the automobile, and when so applied may be formed with a less number of vertical elements of greater height, if desired.

Referring to the form disclosed in Figs. 9 and 10, upper and lower headers 27 and 28 have the heat exchange elements connected thereto so that the passages for the fluid to be cooled will be in parallel. In this form of the invention, between the plates 10 and 11, perforated metallic plates 34 are shown instead of the strips 12 or wires 30 and 31 of the preceding forms. The apices of the corrugations of plates 10 and 11 are soldered or welded to the plates 34.

Said plates 34 are straight and coextensive with the area of plates 10 and 11 and have the perforations or openings 35 thereof arranged in communication with the tortuous passages provided by the plates 10 and 11. The fluid circulating through the heat exchange elements will take a tortuous passage passing between the plates 10 and 11 and through the apertures 35 particularly behind and around all portions of plate 34 as an aid in securing maximum surface contact with the fluid to accomplish the same ends as mentioned relative to the preceding forms of the invention, namely, multiplicities of streams of fluid resulting and effecting maximum admixture and conductivity of all portions of the fluid and consequently maximum cooling or heating as the case may be.

In the arrangement of Fig. 1, the heat exchange elements are shown all arranged in series so that the fluid to be heated or cooled passes through all of the elements in series. For some purposes it may be desirable to pass the fluid through only a portion of the elements in series, a plurality of the series arrangement of the elements being arranged in parallel. Fig. 5 is a diagrammatic showing of such an arrangement.

To ensure that the fluid will be delivered to the parallel arranged sets of series, there is shown a feed reservoir 35' having an inlet connection 36 thereto, said reservoir being in turn connected to the inlet end of the sets of serially arranged elements as by conduits 37, 38.

The area of the cross-section of conduits 37, 38 is substantially equal to the cross-sectional area of inlet pipe 36.

In the above arrangement a common outlet header 39 is shown having an outlet conduit 40 connected thereto. It is obvious that more

than two sets of serially arranged heat elements may be thus arranged in parallel.

The series parallel arrangement thus described is found to be of value in certain cases where the maximum heat exchange effect is secured by a flow of fluid through a path less than the entire number of heat exchange elements or where the arrangement of heat exchange elements in all of a series would develop too high back pressure in the device. This arrangement may be found of value where fluid is to be cooled by immersing the heat exchange elements in a cooling liquid as water, as for instance in cooling of oil in motor boats or the like.

The device obviously may be used for many different purposes than as an oil cooler as described, and for instance as an automobile radiator, a heat radiator for use in mechanical refrigeration, in the heating of liquids, as a radiator in the heating or cooling of buildings, and in any instance where efficient heat exchange between liquids and gases is desired.

The spacing and heat conducting strips have been shown as separated from each other. For convenience in manufacture and assembly it is contemplated to form these strips in a grid assembly by stamping out and removing the material of an integral sheet to produce the strips connected together at their ends, the connecting strips to stand in the headers where they will not unduly obstruct fluid circulation.

Various changes may be resorted to in the physical embodiment of the invention within the spirit and scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A heat exchange element comprising in combination spaced deformed plates providing a tortuous passage therebetween, and means intermediate said plates, spanning the deformities thereof and in heat transfer relation therewith causing passage of fluid around and behind said means as well as in contact with the inner surfaces of said plates, said plates at their edges being in contacting relation and diverging away from the zone of contact.

2. A heat exchange element comprising in combination spaced deformed plates providing a tortuous passage therebetween, and means intermediate said plates, spanning the deformities thereof and in heat transfer relation therewith, causing passage of fluid around and behind said means as well as in contact with the inner surfaces of said plates, said plates at their edges being in contacting relation and diverging away from the zone of contact.

3. A heat exchange element comprising in combination spaced deformed plates providing a tortuous passage therebetween, and

means intermediate said plates, spanning the deformities thereof and in heat transfer relation therewith, causing passage of fluid around and behind said means as well as in contact with the inner surfaces of said plates, one of the first mentioned plates at the edges of the element extending beyond and bent around the edge of the remaining plate, and said plates from said edges diverging from each other to provide a substantially wedge-shaped edge of the element.

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