

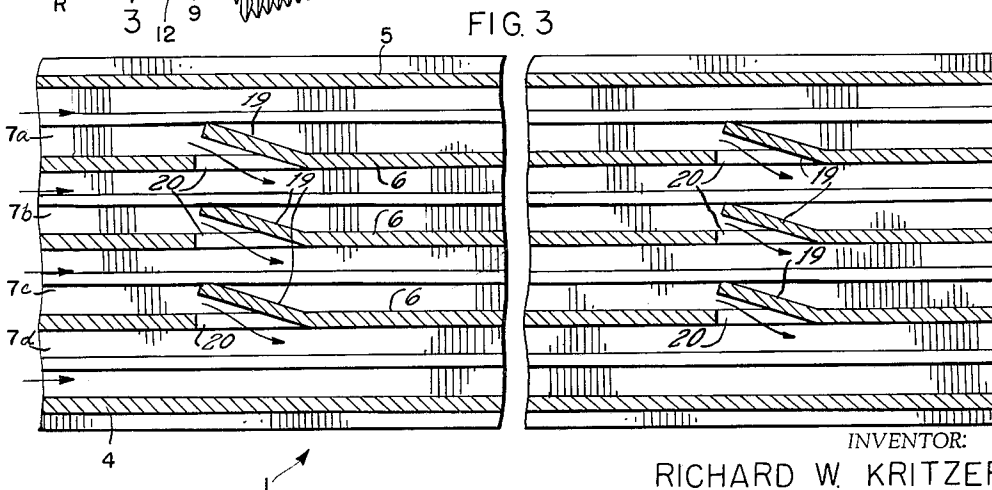
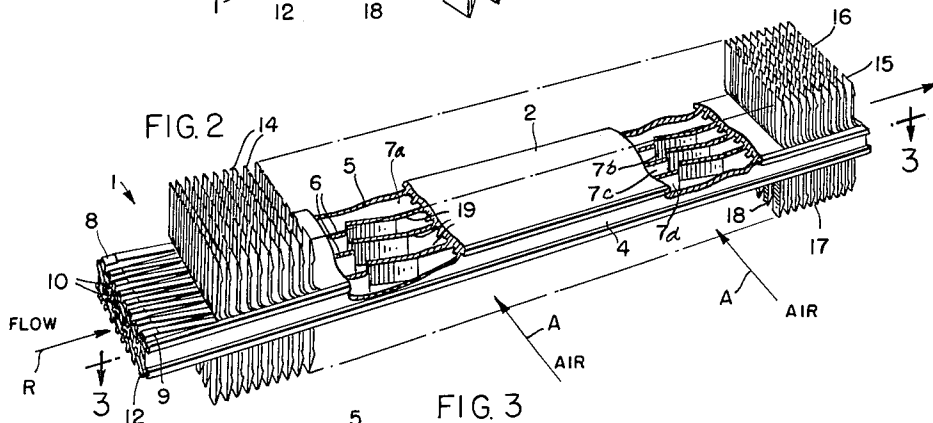
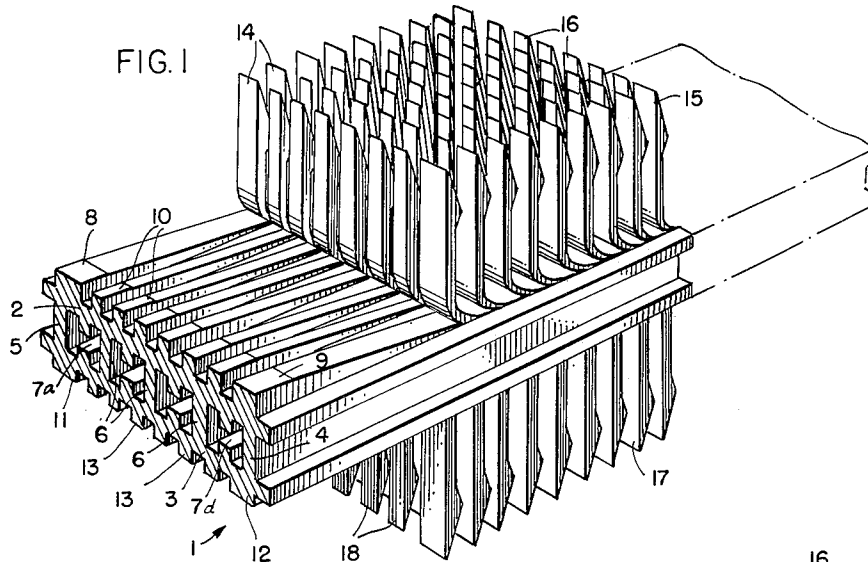
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HEAT EXCHANGE ELEMENT WITH INTERNAL FLOW DIVERTERS

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HEAT EXCHANGE ELEMENT WITH INTERNAL FLOW DIVERTERS

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This invention relates in general to improvements in heat exchange elements useful in the field of refrigeration or heating and is directed more particularly to a novel heat exchange element formed of extruded metal such as aluminum. In my copending earlier filed application, Serial No. 298,129 filed July 29, 1963, there is disclosed an example of an extruded heat exchange element which embodies particularly the improvement of providing thereon a great number of spines struck from the surface of the element, thereby to provide a high ratio of exposed surface to the mass in the spines for maximum thermal transfer efficiency from the wall of the element.

The present invention is directed primarily to the same general type of heat exchange element but is concerned more specifically with means to enable the refrigerant flowing therethrough to be distributed more evenly than would otherwise occur because of evaporation.

As was pointed out in my above referred to copending application, it is necessary in extrusions of this nature to provide a plurality of inner walls to aid in strengthening the element so that it may withstand the extreme pressures involved. These inner partitions or walls divide the element into a plurality of passageways through which the refrigerant flows. Air will normally flow over the element and pass from one side thereof to the other. Thus, the refrigerant flowing through the element will first be evaporated on that side of the element first contacted by the air flow. The refrigerant flowing through the element at the opposite side thereof which is the last to be contacted by the air flow will be the last to evaporate.

Where the heat exchange element consists of a conduit without separating walls therein, there is no evaporation or flow problem because the refrigerant occupies the single passageway therein. Where a plurality of passageways are provided through which the refrigerant flows, the evaporation characteristic of the element would be impaired unless the flow of refrigerant through the passageways were to be substantially equal or evenly distributed.

It is, therefore, a principal object of the present invention to provide a heat exchange element with means to equalize the flow of the refrigerant therethrough where there are a plurality of passageways through which the refrigerant flows.

Another object of the invention is to provide a heat exchange element formed of an extruded metal, such as aluminum, wherein the refrigerant flows therethrough in a plurality of passageways and wherein means are provided to maintain substantially an even distribution of the refrigerant throughout those passageways by causing or permitting the refrigerant to flow from one passageway to another.

A further object of the invention is to provide a heat exchange element wherein the refrigerant flows through a plurality of passageways therein and wherein means are provided to permit or cause the flow of the refrigerant to take place between adjacent passageways as well as lengthwise thereof from one side of the element to the other, thereby more evenly distributing the refrigerant flow and improving the evaporation characteristic of the element.

Still another and more specific object of the invention is to provide a heat exchange element wherein refrigerant flow takes place through a plurality of individual passageways and wherein impairment of the evaporation char-

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acteristic of the element is prevented by means of openings in the walls between adjacent passageways which are arranged in such a way as to cause the refrigerant to flow also from that side of the element last to be contacted by air flow toward that side of the element which is first to be contacted by the air flow.

A still further and specific object of the invention is to provide a heat exchange element having a plurality of passageways therein through which the refrigerant flows, with means connecting the interiors of adjacent passageways together with guide means associated with each of the first named means to guide some of the refrigerant from those passageways which are last to be contacted by the air flow into the passageways already contacted by the air flow, thereby equalizing the flow of refrigerant through the various passageways and improving the evaporation characteristic of the element.

Other objects and advantages of the invention will become apparent upon reading the following description taken in conjunction with the accompanying drawing, in which:

FIG. 11 is a perspective view of a section of a heat exchange element embodying the present invention;

FIG. 2 is a view similar to FIG. 1 but on a somewhat reduced scale and having certain parts omitted and broken away to clarify certain details of construction, and

FIG. 3 is a fragmentary longitudinal sectional view taken along the plane of line 3—3 of FIG. 2.

Proper functioning of heat exchange elements requires that the refrigerant flowing therethrough be evaporated during the cycle of operation and this evaporation of the refrigerant takes place due to the flow of air over and around the element. The usual heat exchange element which is normally tubular in cross section provides but one passageway through which the refrigerant flows. Thus, even though that part of the refrigerant in the conduit which is first contacted by the air flow will tend to evaporate first, where there is only one passageway it makes no difference which part of the refrigerant evaporates first since it all flows together and evaporates uniformly.

Where more than one passageway is provided within the conduit or heat exchange element, a problem arises in attempting to prevent the evaporation characteristic of the element from being impaired. This is particularly true where the element is of a rectangular form, such as that shown in the drawing, because the air flow will first contact one side of the element so that the refrigerant flowing through the passageway on that side will evaporate first. Each successive passageway toward the opposite side of the element over which the air passes would normally contain progressively more refrigerant because less of it would be evaporated and thus the evaporation characteristic of the element would be impaired.

The advantages of an extruded heat exchange element are many. For example, it is much more economical to manufacture than heat transfer elements heretofore known, including copper tubing. An extruded conduit can be bent and formed into desired configurations more easily than a tubular conduit without interfering with the heat transfer efficiency of the spines thereon.

In such an extrusion, however, due to the pressures involved, it is necessary to provide a plurality of partitions or walls within the conduit to add strength thereto. These partitions necessarily result in dividing the conduit into a plurality of longitudinal passageways through which the refrigerant flows.

To overcome the disadvantages inherent in a heat exchange element having a plurality of passageways therein, from the standpoint of the evaporation characteristic thereof, the present invention provides a plurality of longitudinally spaced-apart openings in each of the partitions

within the element together with an angularly disposed scoop-like member associated with each opening. These scoop-like members extend into the path of the refrigerant flowing therethrough so as to divert at least some of the refrigerant from one passageway into the next adjacent passageway. These members are so positioned as to divert the refrigerant from those passageways last to be contacted by the moving air into those which have already been contacted by the moving air. Because of this cross flow of refrigerant from one passageway to another, there will be uniform evaporation.

Referring now more particularly to the drawing, the heat exchange element may be said to consist of a main body generally indicated by the numeral 1. While the cross sectional configuration may take any desired form, it is shown herein for purposes of illustration as being substantially rectangular. One wall of the conduit or element is indicated at 2 and the opposite wall thereof is indicated by the numeral 3. The end walls 4 and 5 complete the rectangular configuration.

A plurality of inner walls or partitions 6 extend between the walls 2 and 3, thereby to provide increased strength to the element to enable it to withstand the extreme pressures involved.

Between each of the inner walls 6 and between these walls and the outer walls 4 and 5, respectively, there are defined a plurality of passageways extending lengthwise of the conduit body through which the refrigerant fluid is adapted to flow. These passageways in the embodiment shown herein are identified for convenience by the numerals 7a, 7b, 7c, and 7d.

In the embodiment of the invention shown herein the outer wall 2 is provided at opposite sides thereof with ribs 8 and 9. Between these outer ribs 8 and 9 there is a plurality of intermediate spaced-apart ribs 10 which also project outwardly from the wall 2 and are formed integral therewith. Similarly at the opposite side of the conduit body there are provided the outer ribs 11 and 12 and the intermediate ribs 13 therebetween.

For maximum efficiency in heat transfer and as more fully described in my above referred to copending application, each of the ribs mentioned above has extending outwardly therefrom and integral therewith a plurality of spines. The spines extending outwardly from the ribs 8 and 9 are indicated respectively by the numerals 14 and 15. Those spines extending outwardly from the intermediate ribs 10 are indicated by the numeral 16. Likewise, those spines extending outwardly from the opposite ribs 11 and 12 are the spines 17. Those extending from the rib 11, however, are not visible in the views of the drawing. The intermediate spines extending outwardly from the ribs 13 are indicated by the numeral 18. These spines are gouged from the ribs in such a way that their bases remain integral with the ribs over an area sufficient to effect an efficient heat transfer from the rib through the edges of the spines. Each spine is formed in such a way as to provide a relatively high ratio of exposed surface to the mass of the spine, thereby to insure maximum efficiency in heat transfer.

Referring now more particularly to FIGS. 2 and 3, it will be seen that the refrigerant flow will be from the left toward the right as viewed in the figures, and as indicated by the refrigerant flow arrow identified by the letter "R." Each of the intermediate walls or partitions 6 is provided with a scoop-like member 19 which is punched or otherwise formed out of the walls 6. That is to say, each wall 6 has formed as an integral part thereof and cut or gouged therefrom a plurality of these scoop-like members 19, each leaving an opening 20 in the wall from which it was formed. These members 19 are spaced apart along the length of the heat exchange element and are so directed as to extend into the path of flow of the refrigerant in one of the passageways. These members will divert the flow of some of the refrigerant from one passageway to the one next adjacent thereto, as may be more clearly

understood by viewing FIG. 3 and the directional arrows shown therein. Thus, some of the refrigerant flowing toward the right in passageway 7a will be intercepted by the scoop-like members 19 and diverted into the passageway 7b. Likewise, the refrigerant flowing through passageway 7b will be intercepted by the similar members 19 in the path thereof and be diverted into the passageway 7c. In the same manner some of the refrigerant in passageway 7c will be diverted into the passageway 7d. Some of the refrigerant that was not intercepted by the first of the members 19 may be intercepted by the next one of those members so that an additional amount of refrigerant will thereupon be diverted into the next adjacent passageway.

It is important that the refrigerant be diverted into the proper adjacent passageway. This will depend upon the direction of the air flow over the element. The directional arrows indicated at A in FIG. 2 illustrate the point that the air moves laterally across the heat exchange element where it will first contact the side of the conduit containing the passageway 7d. The air then continues to flow across the conduit and over the walls forming the passageways 7c, 7b, and 7a, respectively. Thus, in a refrigerant system the warm air when flowing in this manner will first cause an evaporation of some of the refrigerant flowing through passageway 7d. If the refrigerant in that passageway were not replenished, it would eventually evaporate but there would still be some refrigerant left in passageway 7c which had not evaporated. As the air is cooled in its passage from one side of the element to the other, less of the refrigerant in conduit 7b and in conduit 7a will have been evaporated. If this is allowed to occur, the evaporation characteristic of the element will have definitely been impaired.

This impairment of the evaporation characteristic is prevented, however, by providing the scoop-like members 19 which divert progressively the refrigerant in those passageways last to be contacted by the air flow into those passageways where some evaporation has already taken place. Thus, by this construction the flow of refrigerant is uniform, the evaporation thereof is likewise uniform, and the evaporation characteristic has not been impaired.

It will, of course, be evident that it will be possible to utilize the extruded heat exchange element of the present invention without the numerous spines thereon, but the heat transfer efficiency would be less than when those spines are present. For the greatest efficiency thereof, in this type of heat exchange element, the spines should be used for the greatest heat transfer efficiency, and the connecting openings, together with the refrigerant diverting scoop-like members, should be used for the greatest efficiency of the evaporation characteristic. When these advantages are combined with the economy of the extrusion process in making the heat exchange element of the present invention, it will become evident that improved results are obtained with decreased costs.

Changes may be made in the form, construction and arrangement of parts from those disclosed herein without in any way departing from the spirit of the invention or sacrificing any of the attendant advantages thereof, provided, however, that such changes fall within the scope of the claims appended hereto.

The invention is hereby claimed as follows:

1. A heat exchange element comprising an elongated conduit having a substantially rectangular cross-sectional shape, a plurality of walls defining passageways in said conduit extending lengthwise thereof and positioned adjacent each other in a transverse direction and through which a refrigerant is adapted to flow, a plurality of openings through the walls separating adjacent passageways and spaced along the length thereof, and diverting means associated with each of said openings projecting into the path of flow of the refrigerant and in a direction opposed to the direction of flow thereof, thereby to intercept and divert the flow of some of the refrigerant in each passage-

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way into the next adjacent passageway and to distribute more evenly the overall flow of refrigerant through said conduit.

2. The combination of elements as defined in claim 1, wherein each said diverting means consists of a scoop- 5 like member formed integrally with the wall and extending angularly away therefrom from an edge of the opening with which it is associated.

3. The combination of elements as defined in claim 2, wherein each said diverting means terminates short of the 10 adjacent wall toward which it extends.

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