This invention relates to heat exchange devices.

One object of the invention is to provide a heat exchange device, or element for use therein, in which the passages or conduits for the various fluids are formed in a novel manner such that the construction of the device is inexpensive and such that there is effected a good heat exchange between the fluids flowing through and around the various passages or conduits.

The invention is illustrated in the accompanying drawings in which:

Fig. 1 is a vertical sectional view of a portion of a heat exchange device illustrating the manner in which the passages for the fluids are formed;

Fig. 2 is a vertical sectional view of a heat exchange device constructed as illustrated in Fig. 1, but with slight modifications;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional view of another type of heat exchange device constructed in accordance with the invention; and

Fig. 5 is a more or less diagrammatic sectional view illustrating the application of the invention to a heat exchange device in which the inner tubes or conduits are of one piece instead of composite as it is in the other figures.

Referring first to Fig. 1, the device therein illustrated is made up of a plurality of thin sheet metal plates 1. Each plate has a drawn or stamped cup-like projection 2 which is slightly tapered so that the cup-like portions may nest, or partly nest, without bringing the plates into actual contact, but leaving them in spaced relation. The bottom of each cup-like member 2 is perforated to provide a ring or tube contacting member 3 and a plurality of openings 4 located between the ring 3 and the walls of the cup-like member (see also Fig. 3). The provision of the openings 4 leave radially extending arms 5 which connect the ring 3 with the walls of the corresponding cup-like member. The plate of the end cup-like member 2 may have a flange 7, and a collar 8 serves to clamp a portion of the header between itself and the flange 7. The rings 3 serve to contact with, and in some cases may actually support a central tube. This tube in the case of Fig. 1 is a composite one made up of a plurality of tube sections or tubular members 9. Each of these tubular members has a flange 10 which is supported on or overlies the corresponding ring 3 and the tubular members are slightly tapered so that they will nest, or partly nest, as shown in Fig. 1. The end tubular section 9 may be of slightly different form so as to extend to any compartment in communication with which it is desired to place the interior of the tube formed by the tube sections 9—9'. Each tubular section 9 has at least one transverse extending strip 10' which acts as a baffle to the flow of fluid through the tube sections. The strips 10' of the different tube sections may be disposed in different directions as shown in Fig. 3 so as to more effectively baffle or stir up the stream of fluid passing through the tube sections. This staggered arrangement of the strips 10' may be obtained simply by angularly displacing each tube section with respect to the preceding one, as it is positioned. Likewise, the openings 4 may be so formed in the various cup-like members 2 that the radial arms 5 of one cup-like member will lie in a different direction from the arms of an adjacent cup-like member so that the fluid flowing through the cup-like members and around the inner tube will also be baffled or stirred up. When the arms 5 are not located symmetrically with respect to the longitudinal center line of the plates 1, all of the plate elements may be made alike and still a staggered relation of the arms 5 may be obtained by reversing the position of the alternate plates. The baffle strips 10' and baffle arms 5 are of particular value when oil is the fluid medium, or one of them, because oil is very sluggish and the more it is stirred the better will be the heat exchange.

It will now be noted that the walls of the cup-like members 2 form a continuous conduit and the openings 4 afford a passage for the flow of fluid through this conduit. The
plates or fins 1 provide radiating or conduct- ing fins to afford a better heat exchange be- tween the medium contacting with these fins and the medium flowing through the passage formed by the cup-like members. The tubu- lar members 9 form an inner tube or conduit the passage within which is surrounded by the passage through the cup-like members 9.

Preferably the plates 1, cup-like members 2 and tubular sections 9 are all formed from relatively light sheet metal. The nesting cup-like members 2 and nesting tubular sec- tions 9 are forced together when they are as- sembled.

For some purposes the joints between the parts will be sufficiently tight to prevent leakage, but if desired the entire device may be placed in a solder bath so that all the joints will be secured together. In some cases the rings 3 may actually support the tube made up of the sections 3, in any event they make contact with the tube sections, or the tube made up of these sections, and there- fore, in conjunction with the radial arms 5 they serve as good heat conducting paths be- tween the walls of the outer conduit formed by the cup-like members 2 and the walls of the inner conduit formed by the tubular sec- tions 9. For instance if a medium to be cooled is flowing in the passage through the cup-like members 2, and a cooling medium is flowing through the inner conduit formed by the tubular members 9 and also in contact with the outer walls of the cup members 2, the arms 5 and rings 3 will serve to conduct the heat both outwardly to the walls of cup mem- bers 2 and inwardly to the walls of tubular members 9.

The exact manner in which the heat is con- ducted by the arms 5 and rings 3 and by the other metallic parts of the device will depend, of course, upon the relation between the var- ious fluid mediums. For instance, the fluid medium to be cooled may pass through the inner conduit formed by the tubular mem- bers 9 and one cooling medium, such as water, or the like, may pass through the passage formed by the cup-like members 2 while a second cooling medium, such as air, might flow in contact with the plates 1. In this case the rings 3 and arms 5 would conduct the heat outwardly first to the medium flow- ing around the inner tube and if it is not all absorbed by that medium the remainder would be passed on to the walls of the cup-like members 2 and to the fins 1.

The invention illustrated in Fig. 1 has numerous applications. It may be used in any heat exchange device where it is desira- ble to have a central passage such as that formed by the tube sections 9, and an annular surrounding passage such as that formed by the cup-like members 2. The plates or fins 1 may be omitted from the cup-like mem- bers 2, but in most instances the use of these will be desirable.

Fig. 2 shows the application of the in- vention to a heat exchange device such as a steam or hot water heater. The device shown in this figure may have any number of con- ducts formed by the cup-like members 2 and any number of inner conduits formed by the tubular members 9. Fig. 2, however, shows only two sets of conduits. The inner pas- sages formed by the tubular members 9 are in communication with a header or compart- ment 11, and the corresponding ends of the passages through the cup-like members 2 are in communication with a header or compart- ment 12. The compartments 11 and 12 have openings 13 and 14 one of which may be an inlet and the other an outlet. The direction of the arrows in Fig. 2 indicates that the opening 13 is an inlet and the opening 14 is an outlet, but this arrangement may, of course, be reversed. The other end of each passage through the tubular members 9 is in communication with the corresponding end of the passage through the cup-like members 2 as indicated by the arrows 15. The upper end of each tier of cup-like members may be closed by a cap 16 and these caps may be pro- vided with a connecting pipe 17 provided with an air escape valve 18. Caps 17' allow access to the header 11 and also permit in- sertion of the fastening sleeves 19.

When used as a steam or hot water radiator the device shown in Fig. 2 operates as fol- lows. The heating medium may enter at 13 as indicated by the arrow and it has a pos- itive flow through the inner passage formed by the tubular sections 9, and reversely through the passage formed by the cup-like members 2 to the outlet 14. The fins 1 radiate the heat to the surrounding air. When the device is arranged in an upright position with the fins 1 horizontally disposed, air may be forced between them, but if the device is so arranged that the fins 1 are vertically dis- posed then the air or other medium passing by the fins or plates 1 may have a natural up- ward movement.

It will be noted that the purpose of the inner and outer passages in Fig. 2, that is, the passages formed by the tubular sections 9 on the one hand, and the passages formed by the cup-like members 2 on the other hand, is mainly to effect a positive flow of the fluid through the device rather than for heat ex- change purposes between the fluid in these two passages. However, there are many in- stances where these passages may be so util- ized that there is a positive heat exchange between different fluids passing through the passages or between the same fluid at dif- ferent temperatures. For instance, the device shown in Fig. 2 may be used as a combined steam and hot water heater by keeping the inner and outer passages separate, and pass-
ing steam through the inner passages and water through the outer passages. This may be accomplished by constructing the upper portion of the device in the manner shown in Fig. 1, in which event the steam can be discharged through the tubular member 9" and the hot water through the header 6.

In Fig. 2, the rings 3 differ from those shown in Fig. 1 in that they are provided with bent over edge portions 3'. These bent over portions 3' form flanges extending in the direction of the walls of the inner tube and provide a greater surface contact for the inner tube. The larger surface contact not only produces a better heat conducting path but when the parts are soldered together a better joint can be made at this place than when the edges are straight and un bent as in Fig. 1. It will also be noted with respect to Fig. 2 that the expansion and contraction of the parts are automatically taken care of as the fastening means may be at one end and no tie rods are employed.

Figs. 4 and 5 illustrate other types of heat exchange devices and show further applications of the invention.

In Fig. 4, the tubular members 9 are inverted and one of the end tubular members such as that shown at 9' has a closed bottom so that the tier of tubular members forms a receptacle for holding a fluid represented at 19. The passage through the cup-like members 2 is in communication with a compartment 20 having an inlet 21. Hot air or steam may be admitted through the inlet 21 and passes upwardly around the receptacle formed by the tube sections 9 and may be discharged at 22. The fluid shown at 19 may be water which is heated by the medium flowing from inlet 21 to outlet 22 and furnishes the desired moisture to the air. The fins or plates 1 radiate the heat to the surrounding air and when the device is so arranged that these fins are in horizontal position it may be advisable to force the air between the fins. When the device is arranged so that the fins are in vertical position, the air may rise naturally between the fins without being forced. When the device is in this position the water may be poured into the receptacle formed by the tube sections 9 through a funnel 23 or the water may be allowed to drip slowly into this funnel so that the water is evaporated almost instantly.

In Fig. 5, the inner tubes 9', instead of being composite ones made up of tubular sections, are one-piece pipes or tubes. The tubes 9' make contact with the bent over edges 3' of the tube rings or supports 3. The tubes 9' may be actually supported by the rings 3 and bent over edges 3' and may be soldered to them, or the tubes may be supported on headers 24 and 25 as shown at 26. In any event it is desirable that the bent over edges 3' or rings 3 make actual contact with the tubes for heat conducting purposes. Fluid may pass from one header to the other through the passage formed by the cup shaped members 2 and a different fluid may pass through or fill the tubes 9'. The device shown in this figure may be useful as a condenser in an ice machine and may be arranged so that air may pass between the fins 1, water may be held stationary in the tubes 9', or allowed to flow through them, and the refrigerant may pass through the passages around the tubes or this arrangement may be reversed. In this way the refrigerant is cooled by the outside medium passing between the fins 1 and also by the inside medium in the tubes 9'. Obviously the cooling medium in the tubes 9' can be the same as the cooling medium passing between the fins 1. The arms 5 and rings 3 conduct the heat from the medium flowing around the tubes 9', both outwardly to the fins 1 and inwardly to the walls of the tubes 9'.

The bent over edges 3' on the rings 3 are of special value when continuous or one-piece tubes such as shown at 9', in Fig. 3 are used, but obviously they may be omitted in this type of device.

I claim:
1. In a heat exchange device a plurality of nesting sheet metal cup-like members, the bottom of each cup-like member being perforated to provide a tube contacting member and to provide openings between said tube contacting member and the walls of the cup-like member, and a tube in contact with said tube contacting members the openings in the bottoms of said cup-like members around said tube contacting members affording a continuous passage through the cup-like members and around the tube.

2. In a heat exchange device a plurality of nesting sheet metal cup-like members, the bottom of each cup-like member being perforated to provide a ring and to provide openings between said ring and the walls of the cup-like member, and a tube extending through the rings of said cup-like members, the openings in the bottoms of said cup-like members around the rings forming a continuous passage through the cup-like members and around the tube.

3. A device in accordance with claim 1 in which said tube comprises a plurality of nested tubular members each of which is in contact with one of said tube contacting members.

4. A device in accordance with claim 1 in which said tube comprises a plurality of nested sheet metal tubular members each of which is in contact with one of said tube contacting members and each of which has at least one integrally formed transversely extending strip adapted to act as a baffle to the flow of fluid through the tube, the strips
of successive tubular members being disposed in different directions for the purpose described.

5. A device in accordance with claim 2 in which each ring has a bent inner edge forming a flange contacting with and extending substantially parallel with the walls of said tube.

6. In a heat exchange device a plurality of nesting sheet metal cup-like members, the bottom of each cup-like member being perforated to provide a tube contacting member supported from the walls of the cup-like member by radially disposed arms, and a tube extending through and contacting with said tube contacting members.

7. A device in accordance with claim 6 in which the radially disposed arms of one cup-like member are disposed in a different direction from those of the succeeding cup-like member for the purpose described.

8. In a heat exchange device a plurality of superposed spaced sheet metal plates, each plate having at least one cup-like projection which is in nesting relation with the corresponding cup-like projection of the succeeding plate, the bottom of each cup-like member being perforated to provide a ring and to provide openings between said ring and the walls of said cup-like member, and a tube extending through the rings of said cup-like members.

9. In a heat exchange device a plurality of superposed spaced plates each of which has at least one cup-like projection which nests with the corresponding projection of the succeeding plate, the bottom of each cup-like member being perforated to provide a tube contacting member and to provide openings between said member and the walls of the cup-like member, and a tube contacting with said tube contacting members.

10. A heat exchange device comprising a plurality of nesting sheet metal cup-like members, the bottom of each cup-like member being perforated to provide a tube contacting member and to provide openings between said member and the walls of the cup-like member, said openings in the bottoms of the cup like members affording a passage through the cup-like members, and a tube contacting with said tube contacting members affording a passage which is surrounded by said first named passage, said heat exchanger device having a compartment in communication with one end of said tube passage and a separate compartment in communication with the corresponding end of the passage through said cup-like members, the other end of the tube passage being in open communication with the corresponding end of said passage through the cup-like members whereby there may be a positive flow of fluid through one of said passages and reversely through the other, one of said compartments having an inlet and the other having an outlet.

11. A heat exchange device in accordance with claim 10 in which each cup-like member is formed on a sheet metal plate which is spaced from the adjacent plate of the next cup-like member.

In testimony whereof I affix my signature.

GERHARD FLINTERMANN.