This invention relates to heat exchange devices and is more particularly directed to that general type of device which embodies in the structure a series of parallel tubes and associated fins.

It is an object of the present invention to provide a structure embodying parallel tubes and associated radiating fins of corrugated form with the corrugations thereof of such depth as to extend from one tube to the next adjacent tube with the several alternate crests of said corrugations directly engaging and formed to embrace the adjacent tubes, whereby, a good thermal contact between the tubes and fins and a relatively large total area of heat radiating surface is provided, the entire space between adjacent tubes becomes divided into a multiplicity of transverse air passages, and the several corrugations provide directly connected reinforcing elements connecting the several tubes to form an integral self-supporting structure.

A further object of the invention is to provide depressions in all of the several crests, with the several depressions longitudinally aligned to receive the adjacent tubes, whereby the several crests partly embrace and thus form better thermal contacts with the associated tubes than can be had by merely engaging the apices of the several corrugation crests with said tubes.

Another object of the invention is to form such depressions by depressing and crimping a portion of each crest of said fins in such a manner as to form ridges and folds at such depression and to distort the adjacent connecting wall so as to provide distorted air passages which will produce an appreciable turbulence in the air currents passing through the unit.

It is another object of the invention to provide a fin structure formed entirely of deformed material, and since it is preferable that such deformations extend perpendicular to the air passages or lengthwise of the strip of metal from which the fin is made, it is a further object to provide a structure in which each of these fins is formed of a metal ribbon which has been relatively slightly pre-corrugated longitudinally.

Various other objects and advantages will be more fully apparent from the following description of the accompanying drawing which forms a part of this disclosure and which illustrates a preferred form of embodiment of the invention.

Of the drawing:

Fig. 1 is an elevation of a heat interchanger embodying the features of the present invention, certain minute details not being shown on account of the small size of the view which is mainly intended to illustrate the general arrangement of the parts.

Fig. 2 is an end elevation partly broken away and in section.

Fig. 3 is an enlarged detail elevation of a portion of Fig. 1, partly in section to more clearly show the details of construction.

Fig. 4 is an elevation of one of the supporting brackets of said unit.

Fig. 5 is a perspective view of a portion of one of the radiating fins of the device shown in Fig. 1.

Fig. 6 is an end elevation of a multi-plicity row unit, partly broken away and in section.

Fig. 7 is a perspective view of a portion of one of the radiating fins of the unit shown in Fig. 8.

Fig. 8 is an end elevation of a single circuit double row unit employing two series of the radiating fins disclosed in Fig. 5.

Fig. 9 is a plan view of a portion of the pre-corrugated metal ribbon from which the respective fins are formed, and

Fig. 10 is an end elevation of said metal ribbon.

The single circuit or single pass single row unit illustrated in Fig. 1 is of the general form usually employed in domestic refrigerating apparatus as a condenser unit and comprises a continuous conduit C bent to sinuous form to provide a row of relatively spaced parallel tubes 12 through 19 which the refrigerant is circulated, and a series of radiating fins F associated with the several tubes. In the manufacture of this unit, the several fins are assembled between the tubes and end plates or brackets B are slipped over the ends and return bends of the conduit and the entire dipped in a suitable flux and into a bath of molten solder or other suitable metal to bond together the several parts into an integral structure, the end plates having the necessary holes 11 and elongated apertures 12 to permit such assembling.

The fins are preferably assembled between the tubes of the sinuous conduit by sliding them longitudinally between two adjacent tubes, the successive fins thus entering at opposite ends of the tube unit between adjacent return bends with their depressions engaging the adjacent tubes.

It will be noted that each of the radiating fins is deeply corrugated so as to extend from one tube to the next adjacent tube, thus there is required only one of these fins for the space between each two adjacent tubes. The entire space between such tubes is by these fins divided into a multiplicity of transverse air passages, the fins in fact providing a series of partitions which directly...
contact and are connected to the adjacent tubes thus forming structural connecting members functioning as reinforcing elements each contributing towards the mechanical stability and strength of the unit, with the several fins providing a relatively large area of heat radiating surface.

These deeply corrugated fins provide alternate crests 13 and intermediate connecting walls 14 and, as more specifically shown in Fig. 5, each crest has a portion 15 which is depressed and crimped to form a depression 16 of semi-circular shape, with these depressions of each row of crests being longitudinally aligned to receive the associated tube 18. Such depressions enable the crests to more closely contact the tube and to partly embrace said tube and thus provide a good thermal contact and maintain the fin in place until the unit is bonded together.

Tests having proven that the unit will have a higher efficiency when the fins are somewhat deformed to provide distorted air passages for the purpose of creating certain turbulence in the air currents passing between the tubes and through said air passages, it is proposed to form the depressions 16 in a manner which will produce distorted surfaces which will promote such turbulence. To this end, the manufacture of these corrugated fins contemplates the forming of the depressions 16 by merely depressing and crimping a portion of each crest to form a semi-circular recess, the metal being allowed to form as it will into ridges, as indicated at 16, and plates, as indicated at 17.

In Fig. 6 there is shown a triple pass triple row unit including three of the conduits C, arranged side by side in spaced relationship with their parallel tubes 10 transversely aligned. The inlet and outlet ends of said conduits may be connected by manifold fittings 18, if desirable or necessary, and the end plates B 5 may be constructed similar in form to the plates B of the single pass unit of Fig. 1, excepting that they will have three rows of the holes 11 and apertures 12.

The corrugated fins F of this multiple unit are exactly of the same form and construction as the fins F of the single unit previously described excepting the crests 13 of greater width and are provided with, three rows of aligned depressions 15 to accommodate the three rows of parallel tubes. With reference to Fig. 6, it will be noted the single series of wide fins F extend across each of this triple unit and thus not only reinforce each coil but effectively tie all three coils together at a multiplicity of points throughout the entire area of the unit.

In Fig. 8 there is shown a single pass double row unit in which a single sinuous conduit C is formed to provide two relatively spaced rows of parallel tubes, with the tubes of said rows staggered transversely, said conduit providing an elongated spiral coil forming a continuous circuit alternately including in sequence the tubes of both rows.

Appropriate end plates B 5 are provided with their elongated apertures 22 angled to correspond to the angular disposition of the several return bends of the conduit. Associated with each row of tubes, of this unit, is a series of the radiating fins F similar in every detail to the radiating fins of the unit of Fig. 1.

The present invention further includes an improved structure in which a more effective interchange of heat is had by reason of the fact that the radiating fins are formed of metal ribbon which has first been deformed throughout its entire area to augment the turbulence of the air passing through the several air passages formed by said fins. The preferred method of constructing these fins contemplates a pre-deforming of a metal ribbon throughout its entire area and then forming the above described fin from such pre-deformed metal ribbon, and while it is within the intended scope of this invention that deformations may be of any particular desired shape and arrangement, I prefer to make such deformations in the form of relatively slight corrugations extending longitudinally of the metal ribbon, as shown in Figs. 9 and 10. The fins formed in this manner have the walls 14 thereof provided with relatively fine corrugations 28 which extend perpendicular to the air passages, as shown in Figs. 5 and 7.

Thus instead of providing straight-wall passages such as would permit a smooth undisturbed passage of the entrained air, my improved type of baffle fin provides air passages formed entirely of deformed metal so that the air contacts only undulating or roughened walls which will induce a turbulence of the air throughout its entire travel through the air passages. This continuous air turbulence produces a higher efficiency of heat interchange than can be had with those types of fin construction in which the fins are deformed only at spaced intervals.

Further, my improved baffle fin produces a structure which has a degree of strength and stability not inherent in those forms of fins which are perforated and stamped to provide deflecting tangs, it being obvious that such perforations lessen the structural stability of any form of radiating fin.

Heat interchange devices of this nature, having the described improved type of radiating fins incorporated therein, provide a highly efficient structure in which a large area of heat exchange is provided, with such surfaces deformed throughout their entire area to induce the continuous turbulence of entrained air necessary to a rapid and effective transfer of heat, the fins further providing direct mechanical connections of good thermal conductivity forming heat-conducting bridges between the several tubes of the entire structure, and while the preferred form of structure shown in the drawing has been described as being adapted for use in connection with refrigerating or air conditioning apparatus, it is to be understood that the invention is not to be limited in this regard for it is also well adapted for use in any situation in which a heat interchange is to be effected between two liquids or two gases or between a liquid and a gas, and is susceptible of embodiment in various other forms, all coming within the scope of the following claims.

I claim:

1. A heat interchange device comprising a plurality of parallel tubes arranged in adjacent rows disposed in spaced relationship with the similar tubes of all of said rows in transverse alignment; and a single series of radiating fins, each of said fins being disposed between similar adjacent tubes of the several rows and being corrugated to form alternate crests closely engaging adjacent tubes and intermediate connecting walls extending between the tubes of the several rows, relatively spaced portions of each of said crests having
depressions formed therein with the depressions of the several crests longitudinally aligned to receive the respective tubes.

2. A heat interchange device comprising a plurality of parallel tubes arranged in adjacent rows disposed in spaced relationship with the similar tubes of all of said rows in transverse alignment; and a single series of imperforate radiating fins, each of said fins being disposed between similar adjacent parallel tubes of the several rows and being formed of a single metal ribbon corrugated to form alternate crests engaging and forming good thermal contacts with the adjacent parallel tubes and to form intermediate undulated connecting walls, said fins having transversely spaced depressions formed in all of their respective crests, with said depressions of the several crests longitudinally aligned to receive the respective tubes.

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