

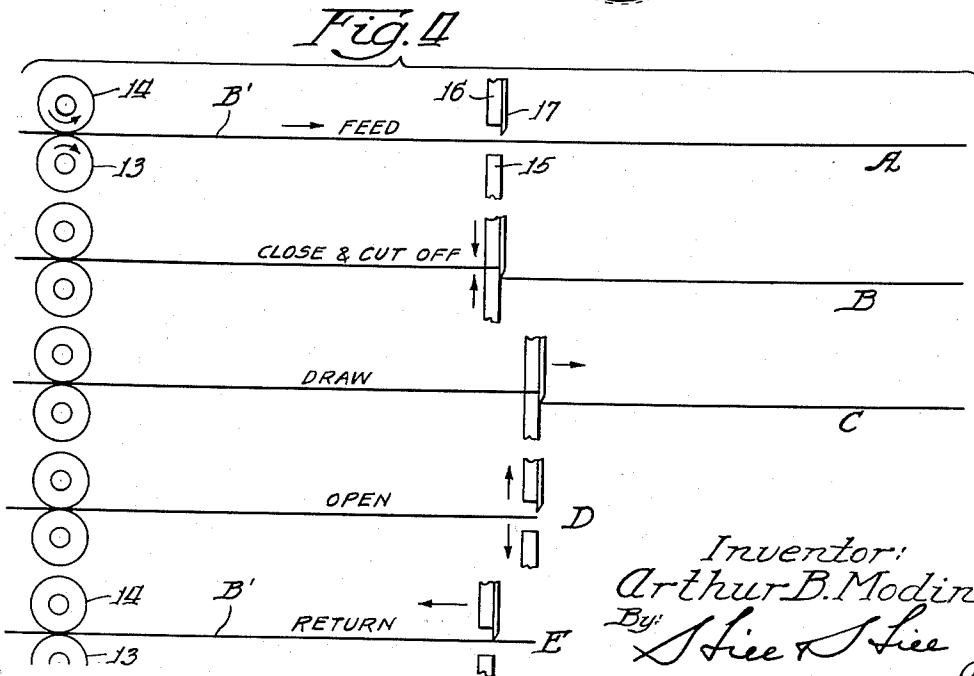
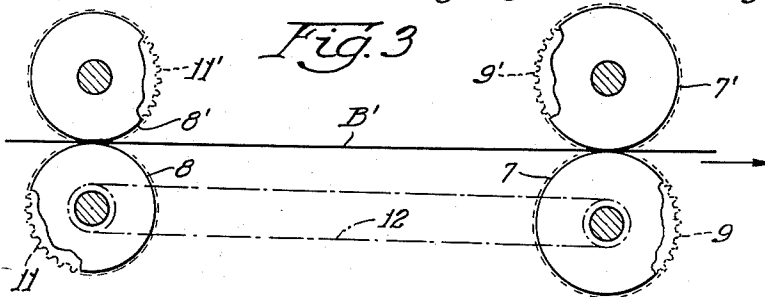
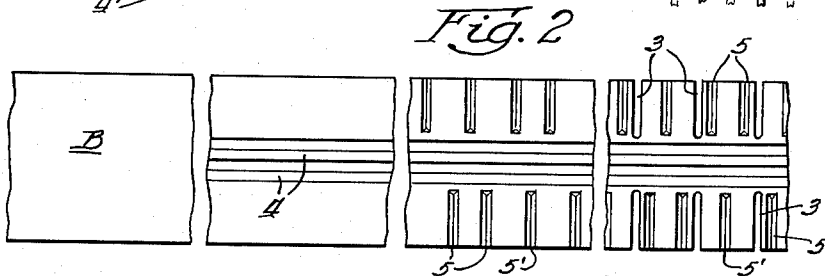
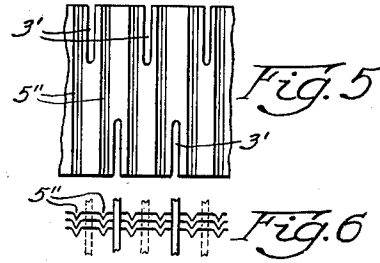
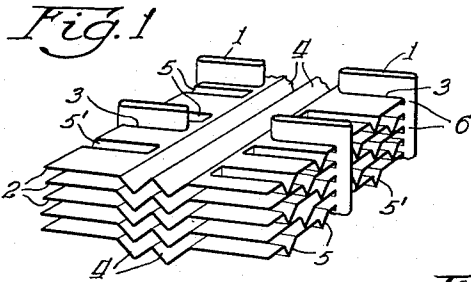
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HEAT EXCHANGE STRUCTURE

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HEAT EXCHANGE STRUCTURE

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4 Claims. (Cl. 257—130)

The invention relates generally to a heat exchange structure and more particularly to a secondary heat transfer surface therefor.

The invention has among its objects a heat exchange surface having a high ratio of surface area to weight, whereby a more efficient distribution of the metal is achieved and improved results are obtained over other structures utilizing the same amount of metal.

Another object of the invention is a heat exchange structure wherein the latter, while having very thin portions, is provided with a relatively high degree of rigidity or stiffness whereby it may be handled and assembled into a core structure with substantially normal manufacturing techniques.

Another object of the invention is the heat exchange structure having the above advantages in which some of the material used for extended surface and for increasing the rigidity of the structure may also be employed as means for spacing one fin member from the other and if desired, providing turbulence of air flow.

A further object of the invention is the use of a heat transfer fin whereby some of the metal which normally would be formed into tube-engaging flanges, or the like, may be utilized as a part of the heat transfer surface.

A further object of the invention is the development of a heat transfer fin or the like having the above advantages wherein the distribution of metal and an increase in surface area may be accomplished in a plurality of steps, one of which includes the more or less uniform stretching of the metal prior to forming operations and another which includes the stretching and forming of the material at desired points during the forming operation.

Many other objects and advantages of the construction herein shown and described will be obvious to those skilled in the art from the disclosure herein given.

To this end my invention consists in the novel construction, arrangement and combination of parts herein shown and described, and more particularly pointed out in the claims.

In the drawings, wherein like reference characters indicate like or corresponding parts:

Fig. 1 is a perspective view of a portion of a heat exchange structure embodying the present invention;

Fig. 2 is a top plan view of portions of a fin element during the forming thereof illustrating how successive operations may be performed in carrying out the invention;

Fig. 3 diagrammatically illustrates one way in which initial stretching of the material may be accomplished;

Fig. 4 diagrammatically illustrates successive steps which also may be utilized in the initial stretching of the material;

Fig. 5 is a top plan view of a portion of a modified fin element embodying the invention; and

Fig. 6 is an end elevational view of a plurality of stacked elements such as that illustrated in Fig. 5.

The present invention contemplates the formation of heat transfer elements from sheet metal comparable to

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that presently employed for such operations, and by utilization of the present invention results in such an element having increased surface area, better distribution of metal, and a higher efficiency than elements heretofore made from like material.

Referring to the drawings, Fig. 1 illustrates the embodiment of the invention in a secondary surface fin structure adapted to be associated with a plurality of fluid conducting tubes 1, the fin structure comprising a plurality of fin elements 2 having slots 3 therein, and of a size to receive respective tubes 1. While the particular construction illustrated discloses the tubes as being insertable from the longitudinal or side edges of the strips 2, the means for receiving the prime surface elements of the heat exchange structure may be suitably formed in any desired manner, as for example, in the form of apertures whereby the fin element completely encircles each tube.

In the embodiment of the invention illustrated in Fig. 1, each fin strip 2 is provided along its opposite longitudinal edges with longitudinally spaced recesses 3 adapted to receive the tubes 1 and positioned between the slots 3 along one edge of the fin strip and the slots along the opposite edge of the fin strip are a series of longitudinally extending continuous corrugations 4, the latter being illustrated as disposed more or less uniformly on opposite sides of the faces of each strip. Positioned between corresponding pairs of slots 3 along the same side edge of the strip is a plurality of transversely extending deformations or corrugations 5 and 5', so arranged that every other intermediate portion between the slots 3 is provided with a pair of corrugations 5, while each alternate portion is provided with a single corrugation 5'. As illustrated in Fig. 1 and more clearly shown in Fig. 2, the slots 3 along one edge of the strip may be transversely aligned with the corresponding slots along the opposite edge of the strip, with the corrugations intermediate adjoining tubes being reversed along opposite edges of the strip, whereby a portion between a pair of tube-receiving slots is provided with two corrugations 5, while the corresponding portion along the opposite edge of the strip is provided with a single corrugation 5'. Thus by reversing alternate strips end for end as illustrated in Fig. 1, the corrugations 5 and 5' may be staggered to form effective means for properly spacing the fin strips along the tubes 1 and eliminate a necessity of providing unnecessarily long flanges along the tubes 1 for the purpose of spacing the strips as is common practice in structures of this type.

In actual practice, the thickness of the stock from which the fins 2 may be formed is normally very thin and varies from a foil-like thickness of only several thousandths to seven or eight thousandths or more. Flat strips of material on the order of this thickness are quite flexible and easily bent or distorted. Likewise, the assembly of such flexible strips in a core structure would be extremely difficult. However, by utilizing means such as the corrugations 4 and 5, extremely thin strips may be employed, at the same time having a satisfactory degree of rigidity or stiffness to enable the use of substantially normal manufacturing techniques.

Fig. 2 illustrates the formation of a fin structure of the type illustrated in Fig. 1 from a blank strip to the finished fin element, and while the forming of the strip is illustrated in a series of individual steps, two or more of such steps may be simultaneously performed as will hereinafter be discussed in detail. In the sequence illustrated in Fig. 2, the blank strip B may be initially provided with longitudinally extending corrugations 4, following which the transverse corrugations 5 and 5' may be produced. The last section of strip material illustrated in Fig. 2 discloses the finished strip with the slots 3 formed therein,

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with the arrangement being such that opposite portions of the strip are provided with corrugations 5 and 5'.

The corrugations 4, 5 and 5' are produced by stretching the metal forming the same and should not be confused with the usual type of corrugated structure wherein the corrugations are formed with substantially little stretching of the material comprising the same, the overall dimensions of the material being correspondingly reduced as the corrugations are made. However, it will be apparent that in the construction illustrated in Fig. 2, the width and length of the strip remains substantially constant prior and subsequent to the formations of the particular corrugations. Consequently, the thickness of the material forming the corrugations will be less than the thickness of the material of uncorrugated portions of the strip. In forming a structure such as that illustrated in Fig. 2, I normally prefer to form the slots 3 or other equivalent means simultaneously with the formation of the corrugations 5 and 5', whereby a portion of the metal that would normally comprise the flanges 6 may be drawn into the intermediate portion of the fin strip, eliminating unnecessary thickness of the flanges and resulting in more effective use of the material.

While in some cases it may be possible to reduce the thickness of the material during the forming operations in connection with the corrugations 4, 5 and 5', for most cases I prefer to accomplish a portion of the reduction prior to the forming operation, and Figs. 3 and 4 illustrate means for accomplishing a substantially uniform stretching of the material prior to the forming operations.

Fig. 3 illustrates two pairs of rollers 7 and 7' and 8 and 8', each pair of rollers being operatively connected by respective pairs of gears 9 and 9' and 11 and 11'. Assuming the lower rolls 8 and 9 are rotated in a clockwise direction and the rolls 8' and 9' in a counterclockwise direction, sheet material B' will be advanced in the direction of the arrow or to the right as viewed in Fig. 3, so that the rolls 7 and 7' may be considered the leading rolls and 8 and 8' trailing or succeeding rolls. The driving rolls 8 and 9 may be operatively connected by suitable means, as for example, a chain 12 indicated diagrammatically in Fig. 3. In the embodiment illustrated in Fig. 3, the rolls 7 and 7' have a periphery of approximately ten percent greater than the periphery of the rolls 8 and 8', and if both pairs of rolls are driven at the same speed, the leading rolls 7 and 7' will advance the blank B' at a greater rate than the rolls 8-8', resulting in a stretching of the material substantially proportional to the difference in size of the rolls. To insure adequate traction on the material passing through the rolls, one roll of each pair may be knurled or otherwise suitably shaped, while the cooperating roll may be relatively resilient, as for example, provided with a face of rubber or the like. In this type of operation, strip material in coils may be fed into the stretching mechanism and subsequently coiled or fed directly into the forming mechanism. Rolls of equal diameter could also be employed, in which case the leading rolls would be rotated at a sufficiently greater speed to provide the desired results.

Fig. 4 illustrates an intermittently operated stretching mechanism adapted to form the stretched metal into blanks of predetermined length. In this construction the material may be initially fed by a pair of rollers 13 and 14 adapted to feed the material B' through a pair of co-operable clamping jaws 15 and 16, one of which may be provided with a shearing blade 17. The clamping jaws 15 and 16 may be actuated by suitable mechanism for longitudinal movement toward or away from the rolls 13 and 14, whereby following closing of the jaws 15 and 16 as illustrated in Fig. 4B, following feeding of the strip, the members 15 and 16 may be moved away from the rollers 13 and 14, the latter being suitably held in stationary relationship during such movement, as illus-

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trated in Fig. 4C, thus stretching the material extending between rollers 13 and 14 and the jaws 15 and 16. The jaws 15 and 16 may then be opened as illustrated in Fig. 4D, following which they may be returned to their original position as illustrated in Fig. 4E and the material B' advanced as indicated in Fig. 4A, and the cycle then repeated. Several of the steps illustrated in Fig. 4 may be combined, as for example, returning of the jaws 15 and 16 and feeding of the strip material. After one sequence of operation has been performed, on the closing of the jaws during the next cycle the stretched portion of the strip will be severed by the shearing member 17 to form a stretched blank of predetermined length.

Figs. 5 and 6 illustrate a modified arrangement or corrugations in conjunction with a staggered tube arrangement. In this construction, as illustrated in Fig. 5, the tube-receiving slots 3' adjacent one longitudinal edge of the strip are longitudinally offset or staggered with respect to the corresponding slots along the opposite longitudinal edge, and extending between each adjacent pair of slots is a pair of transversely extending corrugations 5', the corrugations in this construction being aligned on the assembled fins, whereby such corrugations are not employed as spacing means.

By means of the present invention, the thickness of the fin material may be reduced, resulting in a more efficient use of the metal therein, and increased efficiency in the heat exchange structure. Likewise, while lighter materials may be employed, suitable rigidity and stiffness in the fin element is achieved to enable normal handling and assembly techniques.

As previously pointed out, it will be noted that the corrugations, both transversely and longitudinally, are formed from metal that has been stretched to provide the increased area required without a corresponding decrease or shortening of the blank which would normally occur in the fabrication of the usual type of corrugated structure. In other words, the overall dimensions of a length of fin structure produced in accordance with the present invention, as well as the width, will remain substantially constant from the initiation of the forming operations to the completion thereof.

Having thus described my invention, it is obvious that various immaterial modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts herein shown and described or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. A heat exchange structure of the finned tube type comprising laterally and longitudinally spaced vertically extending tubular heat exchange elements, a plurality of stacked metal fin strips formed from strip material of substantially uniform foil-like thickness having insufficient rigidity in an unformed condition to be self-supporting in a planar state, each of said fin strips including means longitudinally spaced along opposite side edges thereof for engagement with the tubular heat exchange elements, said tubular elements being disposed in a plurality of series, each extending longitudinally along the fin strips with one series disposed adjacent one longitudinal edge and another adjacent the other longitudinal edge of the respective strip, the intermediate portion of each fin strip between said series comprising longitudinally extending corrugations therein operative to impart a longitudinal stiffening of such fin elements, each fin strip having transversely extending corrugations therein disposed between adjacent tubular elements of a series and terminating at their inner ends adjacent said first mentioned corrugations operative to impart a transverse stiffening of the respective portions of each strip intermediate the longitudinal edges of the strip and the longitudinally extending corrugations therein, the material of

said longitudinally and transversely extending corrugations being provided from the distribution of material of uniform thickness of each strip with the material of said strips adjacent said tubular elements so that the thinned portions of each fin strip disposed between the tubular heat exchange elements provide in effect, in addition to said stiffening action, tapered fin portions whereby the heat transfer surface of said fin strips has a high ratio of surface area to weight, said tubular elements and fin strips being bonded together in heat exchange relation.

2. A heat exchange structure as defined in claim 1, wherein said corrugations are V-shaped in cross section.

3. A heat exchange structure as defined in claim 2, wherein said transverse corrugations are engaged with adjacent fin strips to also provide means for spacing such adjacent fin strips.

4. A heat exchange structure as defined in claim 3, wherein said transverse corrugations are disposed to provide two corrugations between certain pairs of tubular elements and one corrugation between others, whereby upon reversal of alternate fin strips, each transverse corrugation is disposed out of vertical alignment with the corresponding corrugations of the adjacent fin strips.

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